REVISED CONSTRUCTION COMPLETION REPORT
REMEDIAL SYSTEM OPTIMIZATION
PUMP AND TREAT SYSTEM

FORMER CHROMALLOY FACILITY
OPERABLE UNIT NO. 1
169 WESTERN HIGHWAY
WEST NYACK, ROCKLAND COUNTY, NEW YORK 12233
NYSDEC SITE NO. 344039

Submitted to:

NEW YORK STATE | Department of Environmental Conservation

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APRIL 17, 2026

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CERTIFICATION

I, Marie Dowd, certify that I am currently a New York State-registered professional engineer (License No. 080977) and that this Revised Construction Completion Report was prepared in accordance with all applicable statues and regulations and in substantial conformance with the Division Environmental Remediation Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved September 26, 2022 Remedial System Optimization Work Plan and any DER-approved modifications.

Seal and Signature

April 17, 2026
Date

ACRONYMS AND ABBREVIATIONS

AARCO	AARCO Environmental Services Inc, of Lindenhurst, New York
AES	Associated Environmental Services of Hauppauge, New York
Alpha	Alpha Analytical of Westborough, Massachusetts
APWA	American Public Works Association
bgs	Below Ground Surface
CAMP	Community Air Monitoring Program
CCR	Construction Completion Report
Chromalloy	Chromalloy Gas Turbine, LLC
Consent Order	March 2001 Order on Consent
CSXT	CSX Transportation, Inc.
DER-10	Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation
DPE	Dual Phase Extraction
EnviroTrac	EnviroTrac Ltd of Yaphank, New York
GAC	Granular Activated Carbon
GIS	Global Information System
gpm	Gallons Per Minute
GPR	Ground Penetrating Radar
HASP	Health and Safety Plan
HMI	Human-Machine Interface
LGAC	Liquid-Phase Granular Activated Carbon
LEDs	Light Emitting Diodes
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operations, Maintenance, and Monitoring
OU-1	Operable Unit 1
P&ID	Process and Instrumentation Diagram
P&T	Pump and Treat
PCBs	Polychlorinated Biphenyls
PID	Photo-ionization Detector
PPE	Personal Protective Equipment
PPL	Priority Pollutant List
psi	Pounds Per Square Inch
PVC	Poly Vinyl Chloride
ROD	March 1999 Record of Decision

ACRONYMS AND ABBREVIATIONS CONTINUED

RSO	Remedial System Optimization
SPDES	State Pollution Discharge Elimination System
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TCE	Trichloroethylene
TCL	Target Compound List
TOGS	NYSDEC Technical Guidance and Operational Series 1.1.1
TRC	TRC Engineers, Inc.
ug/l	Micrograms Per Liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UUSCOs	Unrestricted Use Soil Cleanup Objectives
VFDs	Variable Frequency Drives
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This Revised Construction Completion Report (CCR) has been prepared on behalf of Chromalloy Gas Turbine, LLC (Chromalloy), to document the activities implemented based on the September 26, 2022 Remedial System Optimization (RSO) Work Plan for Operable Unit 1 (OU-1) at the Former Chromalloy Facility (Site No. 344039) located at 169 Western Highway in West Nyack, New York (the Site). In January 2025, TRC submitted the initial CCR to the New York State Department of Environmental Conservation (NYSDEC) for review and approval. The NYSDEC conditionally approved the January 2025 CCR provided the Community Air Monitoring Program (CAMP) data was added and the CCR appendices were updated per their July 8, 2025 letter. A copy of the NYSDEC's July 8, 2025 letter is included in **Appendix A**.

The primary purpose of the CCR is to detail the work completed per the RSO Work Plan, and document the current configuration of the pump and treat (P&T) system at the Site, which was retrofitted as part of the RSO work. The CCR will also discuss the initial startup activities for the new P&T system, and will document the proposed operations, maintenance, and monitoring (OM&M) plan for the new P&T system.

This CCR is arranged as follows:

Section 1.0 **Introduction** – Describes the purpose and outline of the CCR.

Section 2.0 **Site Description and History** – Discusses the Site and surrounding property land uses.

Section 3.0 **Pre-Construction Activities** – Discusses the pre-mobilization activities to be conducted in support of the CCR.

Section 4.0 **Construction Activities** – Discusses the Site preparations, soil removal, waste management, soil sampling, and restoration activities.

Section 5.0 **System Start-up** – Discusses activities completed during system start-up.

Section 6.0 **Summary** – Discusses completion of work and the path forward.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location and Setting

The Site, identified as NYSDEC Site No. 344039, is located within the central portion of West Nyack, New York. The physical site address is 169 Western Highway, West Nyack, Rockland County, New York, and encompasses areas/properties near and adjacent to the intersection of Western Highway and Pineview Road, also located in West Nyack. The Site is bordered to the north by residential properties, to the east by woodlands followed by the Clarkstown Landfill, to the south by commercial properties, and to the west by a CSX Transportation, Inc. (CSXT) railroad line followed by commercial properties and the Hackensack River. The Hackensack River is approximately 0.1 miles west of the Site and the Hudson River is located approximately 2.3 miles east of the Site. A United States Geological Survey (USGS) 7.5-minute topographic map showing the Site's location and surrounding features is provided on **Figure 1**.

The property historically included three subdivision parcels, including the Former Chromalloy Facility. According to the Rockland County online Global Information System (GIS), the northern historical subdivision consisting of a residential home is zoned as one family residential, the Former Chromalloy Facility historical subdivision including the main/ancillary buildings and northern parking lot is zoned as heavy industrial, and the southern historical subdivision consisting of a parking lot is zoned as vacant. As identified on 2024 Rockland County tax mapping, the property now consists of one irregularly shaped parcel approximately 19.86 acres in size, parcel no. 65.13-2-11. It is zoned as Manufacturing.

The Site is currently owned by PG-OE 169 Western Highway Owner, LLC, and accessed via Western Highway and Pineview Road. Pineview Road traverses through the northwestern corner of the parcel and leads to the residential neighborhood. A chain link fence with secured access exists between the main building and southern parking lot and between the southern parking lot and western CSXT railroad line.

2.2 Site Features and Use

The main building located on-Site is currently used to store and prepare new vehicles for sale. Vehicle cleaning and detailing operations are completed in the southern portion of the main building. Vehicle maintenance is performed on hydraulic lifts located in the central and western portions of the main building. The main office space is in the northern portion of the building. Other than the aforementioned areas, the main building is largely an open warehouse utilized for vehicle storage. Multiple overhead doors are either continually open or periodically opened/closed throughout the workday to allow entry/exit of vehicles. Large parking areas, used for the storage

of cleaned/detailed cars, are located to the north and south of the main building. A figure showing Site layout can be found on **Figure 2**.

2.3 Pertinent Regulatory History

TRC Engineers, Inc. (TRC), on behalf of Chromalloy, manages Site remedial actions under the NYSDEC *March 1999 Record of Decision (ROD)* and *March 2001 Order on Consent (Consent Order),* for OU-1 to address volatile organic compounds (VOCs) in soil and groundwater. The NYSDEC - approved OU-1 remedial actions include P&T system operations to address bedrock groundwater impacts and dual phase extraction (DPE) system operations to treat localized shallow overburden soils and groundwater. The OU-1 remediation systems began operation in October 2002 and have shown to be effective in capturing and containing VOC constituent, trichloroethylene (TCE), to the Site boundaries.

The operation of the DPE system was shut down upon NYSDEC approval following a February 2014 Site status meeting since asymptotic conditions were achieved. The DPE System was decommissioned in accordance with the NYSDEC-approved *September 2019 OU-1 DPE System Decommissioning Request* in May and July 2020.

An RSO Work Plan, dated September 2022, was prepared by TRC to propose upgrades to the existing P&T system. The Work Plan was approved by NYSDEC on November 15, 2022. This report discusses the construction activities related to the upgrades that were completed between June 2023 and March 2024, in compliance with the RSO Work Plan, proposed design alterations to the treatment system, and the modifications to the January 2025 CCR requested by the NYSDEC in their July 8, 2025 letter.

2.4 Former Treatment System Status

To prepare for the treatment system repair/replacement work described in the RSO Work Plan, TRC conducted an evaluation of the system components and building housing the treatment system. The treatment system is housed in a building that shares the eastern wall with the main building. The interior footprint of the remediation system building is approximately 18.5 feet by 26.25 feet, or approximately 485 square feet. The concrete block portion of the building is approximately 12.5 feet in height, followed by structural and corrugated steel, to a total height of approximately 20 feet. There is a roll-top door on the north side of the building and a regular man-door on the west side of the building. The cooling fan, heater, and lights in the building were powered by the primary electrical panel. Lights in the building required replacement, the heater was not functional, and the fan was quite worn. Most of the remaining remediation system

equipment had been in operation for over 18 years. At the time of the preparation and implementation of the RSO Work Plan, much of equipment was dilapidated and approached the end of its useful life, while other pieces were in serviceable condition.

3.0 PRE-CONSTRUCTION ACTIVITIES

Pre-construction activities performed in support of the RSO project consisted primarily of preparation of a Health and Safety Plan (HASP), public and private utility locating, and review of Contractor submittals required by the RSO Work Plan. These pre-construction activities are discussed in the following subsections.

3.1 Health and Safety Plan

A Site-specific HASP was prepared for the work in compliance with 29 CFR 1910.120, the Hazardous Waste Operations and Emergency Response regulations. All subcontractors utilized on the project were also required to prepare and adhere to their own HASP that is commensurate with the work and activities.

A copy of the Site-specific HASP was made available at the Site during the construction activities to which it is applicable.

3.2 Contractor Workplans

On May 8, 2023, TRC received contractor work plans and submittals from EnviroTrac. This submittal included a process and instrumentation diagram (P&ID), specification sheets for the various equipment and trench drain to be installed. TRC reviewed the initial submittals and provided comments. On May 30, 2023, EnviroTrac provided a revision to the submittal which addressed TRC's comments. TRC reviewed the revisions and provided another round of comments, which were addressed in EnviroTrac's June 7, 2023 submittal. This submittal also included a proposed system layout figure and an updated equalization tank connection details sheet. TRC provided additional comments which were addressed in EnviroTrac's August 3, 2023 submittal, which included a modified proposed system layout. The final submittal was presented by EnviroTrac to TRC on August 17, 2023. This final submittal included specification sheets for the transfer pump, the water flow transmitter, the pH probe, and the pH sensor. Finalized contractor work plans and submittals are included in **Appendix B.**

3.3 Public and Private Utility Locating

Prior to the commencement of each ground-intrusive activity, TRC confirmed that the subcontractor, EnviroTrac Ltd of Yaphank, New York (EnviroTrac), contacted UDig New York, received/reviewed confirmation receipts from each utility, and verified public mark-outs prior to intrusive work. No changes or modifications to the design were made due to the utility mark-outs. A natural gas line and a private electrical line were identified within the work area. To avoid

damaging any utility lines, EnviroTrac opted to hand-dig within the work area. Information regarding the one-call notifications can be found in **Appendix C**.

4.0 CONSTRUCTION ACTIVITIES

The construction was based on the NYSDEC approved RSO Work Plan, dated September 26, 2022. The construction activities including the decommissioning of the former P&T system; installation of the optimized P&T system; and repairs to the RW-1 well piping system are described in the following subsections.

The system layout and a P&ID showing the final system configuration are provided on **Figures 3** and **4**. Progress photographs can be found in **Appendix D**.

4.1 Former Pump and Treat System Decommissioning

On June 13, 2023, EnviroTrac began decommissioning the former P&T system. EnviroTrac removed the air strippers (previously identified as AST-1 and AST-2) and all other equipment (control panel, piping, etc.) within the treatment building. EnviroTrac cleaned and refurbished the former bag filter housings at their facility located in Yaphank, NY, prior to returning them to the Site.

Following removal of the former P&T system, the building's interior was power washed and cleaned on June 14, 2023. The former personnel door into the building was replaced and equipped with an electronic lock. All water generated from the construction activities was containerized in 55-gallon steel drums and processed through the optimized P&T system following installation.

4.2 Installation

On June 14, 2023, EnviroTrac began installation of an under-slab trench drain and a 3.5-foot-deep sump using a jackhammer and a concrete saw. Work was temporarily paused due to equipment procurement delays and resumed on August 14, 2023, when the RW-1 well pump (approximately 230 feet below ground surface [bgs]) was removed by Associated Environmental Services of Hauppauge, New York (AES) for cleaning and servicing by EnviroTrac. Additionally in August 2023, EnviroTrac installed two manufacturer refurbished liquid-phase granular activated carbon (LGAC) vessels and filled them with 2,000-lbs of granular activated carbon (GAC), installed two new electric heaters, and replaced old fluorescent light fixtures with light emitting diodes (LEDs). The holes on the roof from the former air strippers were covered with dome caps. EnviroTrac began installation of the equalization tank, new manifolds, and the refurbished bag filter housings, according to the approved design configuration.

In September 2023, EnviroTrac continued piping and support installation for the optimized P&T system. EnviroTrac began working on the conduits, electric system, and the transfer pump and concrete pad. Work was temporarily put on hold due to back-orders of the Variable Frequency Drives (VFDs) for the downhole RW-1 and transfer pumps.

Work resumed on December 18, 2023, with the installation of conduits, valves, pressure gauges, sampling ports, pH meter, and flow meters for the P&T system. A new transducer was also installed in RW-1 to a depth of 200 feet bgs. EnviroTrac also installed vent caps on the roof.

Beginning on January 17, 2024, EnviroTrac continued the installation of conduits, the VFDs, and the process logic control (PLC) screen, and they also prepared hoses for the LGAC backwashes. EnviroTrac also installed a pressure gauge and a bleed valve for the transfer pump. EnviroTrac completed the installation of all equipment within the treatment building on January 26, 2024. The as-built layout is shown in **Figure 3**.

4.3 RW-1 Corrective Action

In February 2024, EnviroTrac began shakedown testing of the newly installed system and identified a leak adjacent to the RW-1 vault. EnviroTrac hand-dug an approximately 2-feet-wide by 2-feet-long area to 4 feet bgs. Within the exposed hand excavation, the leak source was identified at a steel piping union for the RW-1 well-head and connecting poly vinyl chloride (PVC) piping leading to the treatment building. TRC notified the NYSDEC of the leak and the required repair in a letter dated February 15, 2024. The NYSDEC approved TRC's request to excavate outside the RW-1 vault to repair the leaking piping in a subsequent letter dated February 16, 2024.

Prior to starting excavation work, EnviroTrac contacted UDig New York, received/reviewed confirmation receipts from each utility, and verified public mark-outs prior to intrusive work. On February 21, 2024, in addition to the public utility mark-outs, EnviroTrac identified all subsurface utilities or anomalies within a 5-foot radius around the RW-1 well vault using ground penetrating radar (GPR). Any detected subsurface structure within the investigated radius was identified on the ground surface with paint using the American Public Works Association (APWA) utility color codes.

Additionally, a representative from Orange and Rockland counties was on-Site during excavation work to identify a private electrical service line located near the work area. In accordance with NYSDEC Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation 10 (DER-10), TRC implemented a CAMP at the Site during the intrusive work.

The CAMP equipment deployed at the Site on a daily basis during the excavation work included two equipment stations: one in the upwind direction and one in the downwind direction of the excavation work area. The enclosures each contained a DustTrak II particulate meter and a MiniRae 3000 photo-ionization detector (PID) for VOC monitoring. Each enclosure was connected to an Aethair Thiamis datalogger and telemetry unit that uploads real-time data and automatically calculates continuous 15-minute average concentrations measured by both the DustTrak II and PID. The system will notify field personnel via short message service (SMS) text message and email in the instance of an exceedance in order to facilitate rapid investigation and corrective action. Additionally, one additional handheld PID was utilized within the excavation work area to field screen soil samples and monitor breathing zone air VOC concentrations.

During the piping repair work, the NYSDOH Generic CAMP action levels were not exceeded for either fugitive particulates or organic vapors. It should be noted that on February 21, 2024, the upwind telemetry modem experienced connectivity issues and some of the collected data were not transmitted to the cloud-based data server and on February 22, 2024, the VOC measurements did not transmit to the closed-based data server. Additionally, the difference (Δ) between the upwind and downwind CAMP stations were calculated, where applicable. The CAMP summary tables from February 21 and 22, 2024 are included as **Appendix E**.

EnviroTrac replaced the PVC coupling and reconnected the PVC pipe to the steel pipe. EnviroTrac backfilled the excavation with clean sand and topsoil, which were tested per NYSDEC requirements, placed with 6-inch lifts and compacted with a hand tamper. EnviroTrac containerized the excavated soil into three 55-gallon steel drums. All water generated from the excavation activities and decontamination activities were containerized in one 55-gallon steel drum to be processed through the P&T system.

TRC collected a composite sample of both backfill material and submitted it to Alpha Analytical of Westborough, Massachusetts (Alpha) for the following analyses, in general accordance with the NYSDEC DER-10 Table 5.4(e)10.:

- Target Compound List (TCL) VOCs by United States Environmental Protection Agency (USEPA) Method 8260D
- TCL Semi-Volatile Organic Compounds (SVOCs) by USEPA Method 8270E
- Target Analyte List (TAL) Metals by USEPA Method 6010D/7471B
- Polychlorinated Biphenyls (PCBs) by USEPA Method 8082A
- TCL Pesticides by USEPA Method 8081B

- TCL Herbicides by USEPA Method 8151A

Fill sample analytical results were compared to 6 New York Codes, Rules, and Regulations (NYCRR) Part 375 Unrestricted Use Soil Cleanup Objectives (UUSCOs). As indicated on **Table 1**, all analytes were either not detected above laboratory quantitation limits or were detected at concentrations below their respective UUSCOs. The laboratory analytical report for the fill material is provided in **Appendix F**.

4.4 Waste Disposal

TRC processed all generated groundwater and construction wash water (approximately 125 gallons) through the newly installed P&T system. Former equipment was disposed of by EnviroTrac at Teplitz, located at 108 West Nyack Road, Nanuet, New York 10954. Three 55-gallon steel drum of solids and four empty drums were removed from the Site by AARCO Environmental Services Inc, of Lindenhurst, New York (AARCO) in May 2024. The waste disposal manifest can be found in **Appendix G**.

5.0 SYSTEM START-UP ACTIVITIES

P&T system start-up activities began following installation of all new equipment installation and repairs to RW-1. The start-up activities included the initial testing of system components and activating system operations to ensure there were no defective connections and verify the functionality of the PLC, sensors, VFDs, and pumps. The initial startup activities, or system shake-down, were conducted by EnviroTrac and minor repairs and revisions to PLC programming were conducted until the system functioned as intended. A discussion of the transition to full-scale operations, along with a description of the routine OM&M activities is provided below. Further, a discussion of the initial round of quarterly water quality sampling results is discussed, along with the proposed future sampling frequency.

5.1 Start-Up Operations

On March 17, 2024, following completion of system shake-down activities, EnviroTrac provided TRC a walkthrough of system operations and training on the system controls and telemetry. TRC was provided with remote access to the treatment system controls through the telemetry system. The telemetry system provides near equivalent remote control and monitoring of the system operations via an identical human-machine interface (HMI). The treatment system PLC also records the operating parameters visible on the HMI and uses the telemetry system to send daily operating summaries to TRC staff via email.

TRC and EnviroTrac remained on-Site for the full day to monitor system operations. The system was operating in automatic mode, with near continuous pumping from RW-1 and batch treatment of extracted groundwater through the bag filters and the LGAC treatment vessels. Additionally, TRC and EnviroTrac conducted an initial bag filter change, reviewed the written procedure, and reviewed the written procedure for LGAC vessel backwashes to confirm accuracy and usability of the System OM&M Plan.

The treatment system flow rate is controlled by the water yield from RW-1. The system equalization tank is filled with extracted groundwater, up to the high-level sensor setting. The high-level sensor activates the transfer pump which then pumps water through the bag filters and LGAC vessels and to the off-Site outfall location. The RW-1 influent flow rate was held constant, at a rate of approximately 12 gallons per minute (gpm). The transfer pump drains the equalization tank at approximately 100 gpm, resulting in periodic treatment system operations but constant groundwater extraction.

5.2 System OM&M Plan

Based on the information that EnviroTrac provided, TRC prepared a System OM&M Plan that describes routine OM&M tasks and objectives for system inspection events. The System OM&M Plan can be found in **Appendix H**. The System OM&M Plan includes procedures for system monitoring, replacing bag filters, collecting quarterly water samples, and LGAC backwashing. Additionally, EnviroTrac provided an attachment to the System OM&M Plan that includes specification sheets and the routine preventative maintenance schedule for all installed equipment based on vendor/manufacturer information.

5.3 System OM&M Schedule

For the first six weeks, TRC completed weekly visits to collect system readings and to prepare the P&T system for long-term operations. Tools, personal protective equipment (PPE), spare sampling ports, and tubing were brought to and stored at the Site to support long-term operations. TRC labeled on all sample ports, pressure gauges, and valves within the P&T building.

Following the successful initial six weeks of operation, TRC transitioned to a schedule of bi-weekly site inspections. Treatment system readings are collected during both inspection events while bag filters are changed on a monthly basis. When the high differential pressure alarm is triggered, indicating the pressure drop across the bag filters exceed 10 pounds per square inch (psi), an additional Site visit is conducted for the purpose of changing bag filters.

5.4 Initial Quarterly Sampling

On May 6, 2024, the first round of quarterly samples was collected from the P&T system. Influent, mid-treatment, and effluent samples were collected and sent to Alpha for the analysis of TCL VOCs and Priority Pollutant List (PPL) Metals by USEPA Methods 8260D and 200.7, respectively. The sample results were compared to the NYSDEC Technical Guidance and Operational Series 1.1.1 (TOGS) Ambient Water Quality Standards and Guidance Values for Class GA water (drinking water) and are presented on **Table 2**.

Analytical results indicated that the following compounds were detected above Class GA Values in the influent sample: TCE (190 micrograms per liter [ug/l]), cis-1,2-dichloroethene (6.4 ug/l), and lead (51 ug/l). There were no Class GA Value exceedances detected in the effluent sample. Laboratory analytical reports for the completed sampling events are included in **Appendix I**.

The quarterly sampling follows the schedule and requirements of the State Pollution Discharge Elimination System (SPDES) permit that was formerly executed at the Site. The Site was formally

assigned SPDES permit identification numbers NY 010 5180 and DEC ID: 3-3920-00002. During operation of the P&T system, samples will continue to be collected on a quarterly basis. The Effluent Limitations and Monitoring Requirements governing the P&T system discharge are provided in **Appendix J**.

6.0 SUMMARY

The P&T System began full-time operations on March 17, 2024. Daily e-mails are sent to TRC and EnviroTrac from the on-Site PLC using the telemetry system, which summarizes minute-by-minute readings for pH, influent and effluent flowrates, operating pressures, and bag filter differential pressures. Site visits are routinely conducted to confirm proper operation, change bag filters, collect quarterly water samples for laboratory analyses, and verify the telemetry readings.

Site visits began on a weekly basis for the first six weeks to ensure proper operations and confirm system controls and automations functioned correctly. The frequent monitoring allowed TRC to develop a schedule for required bag filter changes, to maintain differential pressure readings below 10 psi. Based on initial operations, the bag filters will be changed monthly. Routine inspections will be conducted on a bi-weekly schedule, with every other event including a bag filter changeout. In the future, if operations proceed smoothly, the site visit frequency may be decreased to a monthly basis.

TRC has prepared System OM&M Standard Operating Procedures for routine tasks including bag filter changes, LGAC backwashes, and quarterly water sampling. The first quarterly sampling was conducted in May 2024, and the results (discussed herein previously) demonstrate that the system is adequately treating water to adhere to the discharge requirements.

TABLES

Table 1
Summary of RW-1 Backfill Sample Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, New York

	LOCATION	FILL_20240222	
	SAMPLING DATE	2/22/2024	
	LAB SAMPLE ID	L2409772-01	
Analyte	**UUSCO***	**Results (mg/kg)**	
VOCs			
Methylene chloride	0.05	0.0054	U
1,1-Dichloroethane	0.27	0.0011	U
Chloroform	0.37	0.0016	U
Carbon tetrachloride	0.76	0.0011	U
1,2-Dichloropropane	NC	0.0011	U
Dibromochloromethane	NC	0.0011	U
1,1,2-Trichloroethane	NC	0.0011	U
Tetrachloroethene	1.3	0.00054	U
Chlorobenzene	1.1	0.00054	U
Trichlorofluoromethane	NC	0.0043	U
1,2-Dichloroethane	0.02	0.0011	U
1,1,1-Trichloroethane	0.68	0.00054	U
Bromodichloromethane	NC	0.00054	U
trans-1,3-Dichloropropene	NC	0.0011	U
cis-1,3-Dichloropropene	NC	0.00054	U
Bromoform	NC	0.0043	U
1,1,2,2-Tetrachloroethane	NC	0.00054	U
Benzene	0.06	0.00054	U
Toluene	0.7	0.0011	U
Ethylbenzene	1	0.0011	U
Chloromethane	NC	0.0043	U
Bromomethane	NC	0.0022	U
Vinyl chloride	0.02	0.0011	U
Chloroethane	NC	0.0022	U
1,1-Dichloroethene	0.33	0.0011	U
trans-1,2-Dichloroethene	0.19	0.0016	U
Trichloroethene	0.47	0.00054	U
1,2-Dichlorobenzene	1.1	0.0022	U
1,3-Dichlorobenzene	2.4	0.0022	U
1,4-Dichlorobenzene	1.8	0.0022	U
Methyl tert butyl ether	0.93	0.0022	U
p/m-Xylene	NC	0.0022	U
o-Xylene	NC	0.0011	U
cis-1,2-Dichloroethene	0.25	0.0011	U
Styrene	NC	0.0011	U
Dichlorodifluoromethane	NC	0.011	U
Acetone	0.05	0.011	U
Carbon disulfide	NC	0.011	U
2-Butanone	0.12	0.011	U
4-Methyl-2-pentanone	NC	0.011	U
2-Hexanone	NC	0.011	U
Bromochloromethane	NC	0.0022	U
1,2-Dibromoethane	NC	0.0011	U
1,2-Dibromo-3-chloropropane	NC	0.0032	U
Isopropylbenzene	NC	0.0011	U
1,2,3-Trichlorobenzene	NC	0.0022	U
1,2,4-Trichlorobenzene	NC	0.0022	U
Methyl Acetate	NC	0.0043	U

Table 1
Summary of RW-1 Backfill Sample Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, New York

	LOCATION	FILL_20240222	
	SAMPLING DATE	2/22/2024	
	LAB SAMPLE ID	L2409772-01	
Analyte	**UUSCO***	**Results (mg/kg)**	
VOCs (cont.)			
Cyclohexane	NC	0.011	U
1,4-Dioxane	0.1	0.087	U
Freon-113	NC	0.0043	U
Methyl cyclohexane	NC	0.0043	U
SVOCs			
Acenaphthene	20	0.14	U
Hexachlorobenzene	0.33	0.1	U
Bis(2-chloroethyl)ether	NC	0.15	U
2-Chloronaphthalene	NC	0.17	U
3,3'-Dichlorobenzidine	NC	0.17	U
2,4-Dinitrotoluene	NC	0.17	U
2,6-Dinitrotoluene	NC	0.17	U
Fluoranthene	100	0.1	U
4-Chlorophenyl phenyl ether	NC	0.17	U
4-Bromophenyl phenyl ether	NC	0.17	U
Bis(2-chloroisopropyl)ether	NC	0.2	U
Bis(2-chloroethoxy)methane	NC	0.18	U
Hexachlorobutadiene	NC	0.17	U
Hexachlorocyclopentadiene	NC	0.48	U
Hexachloroethane	NC	0.14	U
Isophorone	NC	0.15	U
Naphthalene	12	0.17	U
Nitrobenzene	NC	0.15	U
NDPA/DPA	NC	0.14	U
n-Nitrosodi-n-propylamine	NC	0.17	U
Bis(2-ethylhexyl)phthalate	NC	0.17	U
Butyl benzyl phthalate	NC	0.17	U
Di-n-butylphthalate	NC	0.17	U
Di-n-octylphthalate	NC	0.17	U
Diethyl phthalate	NC	0.17	U
Dimethyl phthalate	NC	0.17	U
Benzo(a)anthracene	1	0.1	U
Benzo(a)pyrene	1	0.14	U
Benzo(b)fluoranthene	1	0.1	U
Benzo(k)fluoranthene	0.8	0.1	U
Chrysene	1	0.1	U
Acenaphthylene	100	0.14	U
Anthracene	100	0.1	U
Benzo(ghi)perylene	100	0.14	U
Fluorene	30	0.17	U
Phenanthrene	100	0.1	U
Dibenzo(a,h)anthracene	0.33	0.1	U
Indeno(1,2,3-cd)pyrene	0.5	0.14	U
Pyrene	100	0.1	U
Biphenyl	NC	0.38	U
4-Chloroaniline	NC	0.17	U
2-Nitroaniline	NC	0.17	U
3-Nitroaniline	NC	0.17	U

Table 1
Summary of RW-1 Backfill Sample Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, New York

	LOCATION	FILL_20240222	
	SAMPLING DATE	2/22/2024	
	LAB SAMPLE ID	L2409772-01	
Analyte	**UUSCO***	**Results (mg/kg)**	
SVOCs (cont.)			
4-Nitroaniline	NC	0.17	U
Dibenzofuran	7	0.17	U
2-Methylnaphthalene	NC	0.2	U
1,2,4,5-Tetrachlorobenzene	NC	0.17	U
Acetophenone	NC	0.17	U
2,4,6-Trichlorophenol	NC	0.1	U
p-Chloro-m-cresol	NC	0.17	U
2-Chlorophenol	NC	0.17	U
2,4-Dichlorophenol	NC	0.15	U
2,4-Dimethylphenol	NC	0.17	U
2-Nitrophenol	NC	0.36	U
4-Nitrophenol	NC	0.24	U
2,4-Dinitrophenol	NC	0.81	U
4,6-Dinitro-o-cresol	NC	0.44	U
Pentachlorophenol	0.8	0.14	U
Phenol	0.33	0.17	U
2-Methylphenol	0.33	0.17	U
3-Methylphenol/4-Methylphenol	0.33	0.24	U
2,4,5-Trichlorophenol	NC	0.17	U
Carbazole	NC	0.17	U
Atrazine	NC	0.14	U
Benzaldehyde	NC	0.22	U
Caprolactam	NC	0.17	U
2,3,4,6-Tetrachlorophenol	NC	0.17	U
Herbicides			
2,4-D	NC	0.169	U
2,4,5-T	NC	0.169	U
2,4,5-TP (Silvex)	3.8	0.169	U
Pesticides			
Delta-BHC	0.04	0.00156	U
Lindane	0.1	0.000651	U
Alpha-BHC	0.02	0.000651	U
Beta-BHC	0.036	0.00156	U
Heptachlor	0.042	0.000781	U
Aldrin	0.005	0.00156	U
Heptachlor epoxide	NC	0.00293	U
Endrin	0.014	0.000651	U
Endrin aldehyde	NC	0.00195	U
Endrin ketone	NC	0.00156	U
Dieldrin	0.005	0.000976	U
4,4'-DDE	0.0033	0.00156	U
4,4'-DDD	0.0033	0.00156	U
4,4'-DDT	0.0033	0.00156	U
Endosulfan I	2.4	0.00156	U
Endosulfan II	2.4	0.00156	U
Endosulfan sulfate	2.4	0.000651	U
Methoxychlor	NC	0.00293	U
Toxaphene	NC	0.0293	U

Table 1
Summary of RW-1 Backfill Sample Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, New York

	LOCATION	FILL_20240222	
	SAMPLING DATE	2/22/2024	
	LAB SAMPLE ID	L2409772-01	
Analyte	**UUSCO***	**Results (mg/kg)**	
Pesticides (cont.)			
cis-Chlordane	0.094	0.00195	U
trans-Chlordane	NC	0.00195	U
Chlordane	NC	0.013	U
PCBs			
Aroclor 1016	0.1	0.0487	U
Aroclor 1221	0.1	0.0487	U
Aroclor 1232	0.1	0.0487	U
Aroclor 1242	0.1	0.0487	U
Aroclor 1248	0.1	0.00808	J
Aroclor 1254	0.1	0.0487	U
Aroclor 1260	0.1	0.0487	U
Aroclor 1262	0.1	0.0487	U
Aroclor 1268	0.1	0.0487	U
PCBs, Total	0.1	0.00808	J
Metals, Total			
Aluminum, Total	NC	322	
Antimony, Total	NC	10	U
Arsenic, Total	13	2.01	U
Barium, Total	350	2.23	
Beryllium, Total	7.2	1	U
Cadmium, Total	2.5	2.01	U
Calcium, Total	NC	120	
Chromium, Total	NC	1.1	J
Cobalt, Total	NC	4.02	U
Copper, Total	50	1.24	J
Iron, Total	NC	1340	
Lead, Total	63	0.722	J
Magnesium, Total	NC	118	
Manganese, Total	1600	21.1	
Mercury, Total	0.18	0.07	U
Nickel, Total	30	0.517	J
Potassium, Total	NC	43.1	J
Selenium, Total	3.9	4.02	U
Silver, Total	2	1	U
Sodium, Total	NC	20.6	J
Thallium, Total	NC	4.02	U
Vanadium, Total	NC	2.36	
Zinc, Total	109	1.74	J

Notes

mg/kg : milligrams per kilogram
J : estimated value
U : analyte was not detected at the specified quantitation limit
NC : no criteria
VOCs : volatile organic compounds
SVOCs : semi-volatile organic compounds
PCBs : polychlorinated biphenyls
* : 6 New York Codes, Rules, and Regulations (NYCRR) Part 375 Unrestricted Use Soil Cleanup Objectives

Table 2
Summary of Pump and Treat System Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, NY

	LOCATION	INFLUENT	MIDFLUENT	EFFLUENT
	SAMPLING DATE	5/6/2024	5/6/2024	5/6/2024
	LAB SAMPLE ID	L2424744-01	L2424744-03	L2424744-02
Analyte	**Class GA Value***	**Results (ug/l)**		
VOCs				
Methylene chloride	5	2.5 U	2.5 U	2.5 U
1,1-Dichloroethane	5	2.5 U	2.5 U	2.5 U
Chloroform	7	2.5 U	2.5 U	2.5 U
Carbon tetrachloride	5	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1	1 U	1 U	1 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	1.5 U	1.5 U	1.5 U
Tetrachloroethene	5	2.4	0.5 U	0.5 U
Chlorobenzene	5	2.5 U	2.5 U	2.5 U
Trichlorofluoromethane	5	2.5 U	2.5 U	2.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	2.5 U	2.5 U	2.5 U
Bromodichloromethane	50	0.5 U	0.2 J	0.5 U
trans-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U
Bromoform	50	2 U	2 U	2 U
1,1,2,2-Tetrachloroethane	5	0.5 U	0.5 U	0.5 U
Benzene	1	0.53	0.74	0.62
Toluene	5	2.5 U	2.5 U	2.5 U
Ethylbenzene	5	2.5 U	2.5 U	2.5 U
Chloromethane	NC	2.5 U	2.5 U	2.5 U
Bromomethane	5	2.5 U	2.5 U	2.5 U
Vinyl chloride	2	0.09 J	0.07 J	1 U
Chloroethane	5	2.5 U	2.5 U	2.5 U
1,1-Dichloroethene	5	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	2.5 U	2.5 U	2.5 U
Trichloroethene	5	**190**	**29**	0.4 J
1,2-Dichlorobenzene	3	2.5 U	2.5 U	2.5 U
1,3-Dichlorobenzene	3	2.5 U	2.5 U	2.5 U
1,4-Dichlorobenzene	3	2.5 U	2.5 U	2.5 U
Methyl tert butyl ether	10	0.75 J	0.55 J	0.4 J
p/m-Xylene	5	2.5 U	2.5 U	2.5 U
o-Xylene	5	2.5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene	5	**6.4**	3.2	2.5 U
Styrene	5	2.5 U	2.5 U	2.5 U
Dichlorodifluoromethane	5	5 U	5 U	5 U
Acetone	50	5 U	5 U	3.3 J
Carbon disulfide	60	5 U	5 U	5 U
2-Butanone	50	5 U	5 U	5 U
4-Methyl-2-pentanone	NC	5 U	5 U	5 U
2-Hexanone	50	5 U	5 U	5 U
Bromochloromethane	5	2.5 U	2.5 U	2.5 U
1,2-Dibromoethane	0.0006	2 U	2 U	2 U
1,2-Dibromo-3-chloropropane	0.04	2.5 U	2.5 U	2.5 U
Isopropylbenzene	5	1.2 J	1.5 J	2.5 U
1,2,3-Trichlorobenzene	5	2.5 U	2.5 U	2.5 U
1,2,4-Trichlorobenzene	5	2.5 U	2.5 U	2.5 U
Methyl Acetate	NC	2 U	2 U	2 U

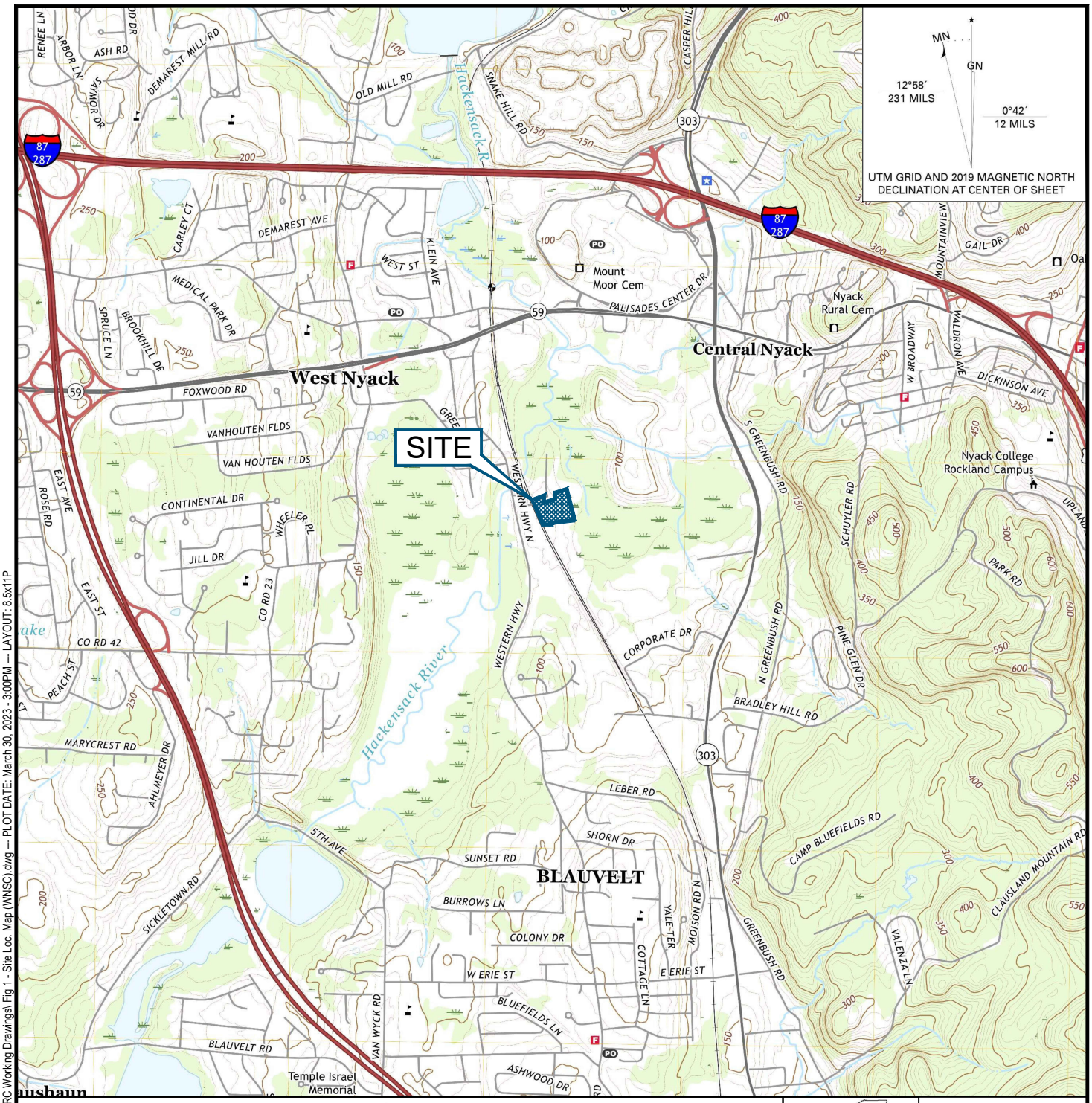
Table 2
Summary of Pump and Treat System Analytical Results
Former Chromalloy Facility (NYSDEC Site No. 344039)
West Nyack, NY

	LOCATION	INFLUENT	MIDFLUENT	EFFLUENT
	SAMPLING DATE	5/6/2024	5/6/2024	5/6/2024
	LAB SAMPLE ID	L2424744-01	L2424744-03	L2424744-02
Analyte	**Class GA Value***	**Results (ug/l)**		
VOCs (cont.)				
Cyclohexane	NC	10 U	10 U	10 U
1,4-Dioxane	0.35	250 U	250 U	250 U
Freon-113	5	2.5 U	2.5 U	2.5 U
Methyl cyclohexane	NC	10 U	10 U	10 U
Metals, total				
Arsenic, Total	25	2.7 J	5 U	2.9 J
Cadmium, Total	5	5 U	5 U	5 U
Chromium, Total	50	5.2 J	3.9 J	4.3 J
Copper, Total	200	115	15.6	24.4
Lead, Total	25	**51**	11.9	18.9
Nickel, Total	100	4 J	4.1 J	4.7 J
Zinc, Total	2000	143	31.8	55

Notes

ug/l : micrograms per liter
J : estimated value
NC : no criteria
U : analyte was not detected at the specified quantitation limit
VOCs : volatile organic compounds
* : New York State Department of Environmental Conservation Ambient Water Quality Standards and Guidance Values for Class GA Water, June 1998 with the April 2000 Addendum
Bold : indicates that the detected value exceeds the listed standard or guidance value

FIGURES



SCALE: 1:2400

1 0.5 0 KILOMETERS 1 2

1000 500 0 METERS 1000 2000

1 0.5 0 1

MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

FEET

QUADRANGLE LOCATION

MAP INCLUDES INFORMATION FROM THE FOLLOWING MAP SHEET(S): TP, NYACK, NY, NJ, 7.5 MINUTE DATED 2019.

MAP OBTAINED THROUGH USE OF TOPOVIEW WITH THE INTERFACE CREATED BY THE NATIONAL GEOLOGIC MAP DATABASE PROJECT (NGMDB), IN SUPPORT OF THE TOPOGRAPHIC MAPPING PROGRAM, MANAGED BY THE USGS NATIONAL GEOSPATIAL PROGRAM (NGP).

TRC
3 Corporate Drive, Suite 202
Clifton Park, NY 12065
Phone: 518.348.1190
www.trccompanies.com

PROJECT:

CHROMALLOY
FORMER CHROMALLOY FACILITY (NYSDEC SITE NO. 344039)
169 WESTERN HIGHWAY
WEST NYACK, NEW YORK 10994

TITLE:

SITE LOCATION MAP

DRAWN BY:	H. DELGADO
CHECKED BY:	J. KING
APPROVED BY:	J. LAROCK
DATE:	JANUARY 2025
PROJ. NO.:	190273.2021.0000
FILE:	Fig 1 - Site Loc. Map (WNSC).dwg

FIGURE 1

8.5x11 -- ATTACHED XREFS: -- ATTACHED IMAGES: NY_Nyack_20190930_TM;
DRAWING NAME: I:\Projects\190273 - West Nyack - Sequa Corp\Figures\TRC Working Drawings\ Fig 1 - Site Loc. Map (WNSC).dwg -- PLOT DATE: March 30, 2023 - 3:00PM -- LAYOUT: 8.5x11P

LEGEND

- MONITORING WELL LOCATION
- FORMER PRODUCTION WELL
- RECOVERY WELL
- PUMP AND TREAT SYSTEM OUTFALL
- SUB-SLAB VAPOR POINT
- DECOMMISSIONED DUAL PHASE EXTRACTION WELL OR MONITORING POINT
- PUMP AND TREAT SYSTEM
- FORMER CHROMALLOY FACILITY PROPERTY
- CHROMIUM EXCAVATION EXTENTS - OCTOBER 2017

NOTES:

1. FORMER CHROMALLOY FACILITY PROPERTY BOUNDARY IS APPROXIMATE.

2. MONITORING WELL LOCATIONS WERE SURVEYED BY A NEW YORK STATE LICENSED SURVEYOR IN JUNE 2011.

3. ALL DEPICTED WELL LOCATIONS, SUB-SLAB VAPOR POINT LOCATIONS, AND EXCAVATION EXTENTS ARE APPROXIMATE.

4. PROPERTY BOUNDARY PROVIDED FROM DIGITAL MAP PRODUCTS.

BASE MAP: NEAR MAP
DATA SOURCES: TRC

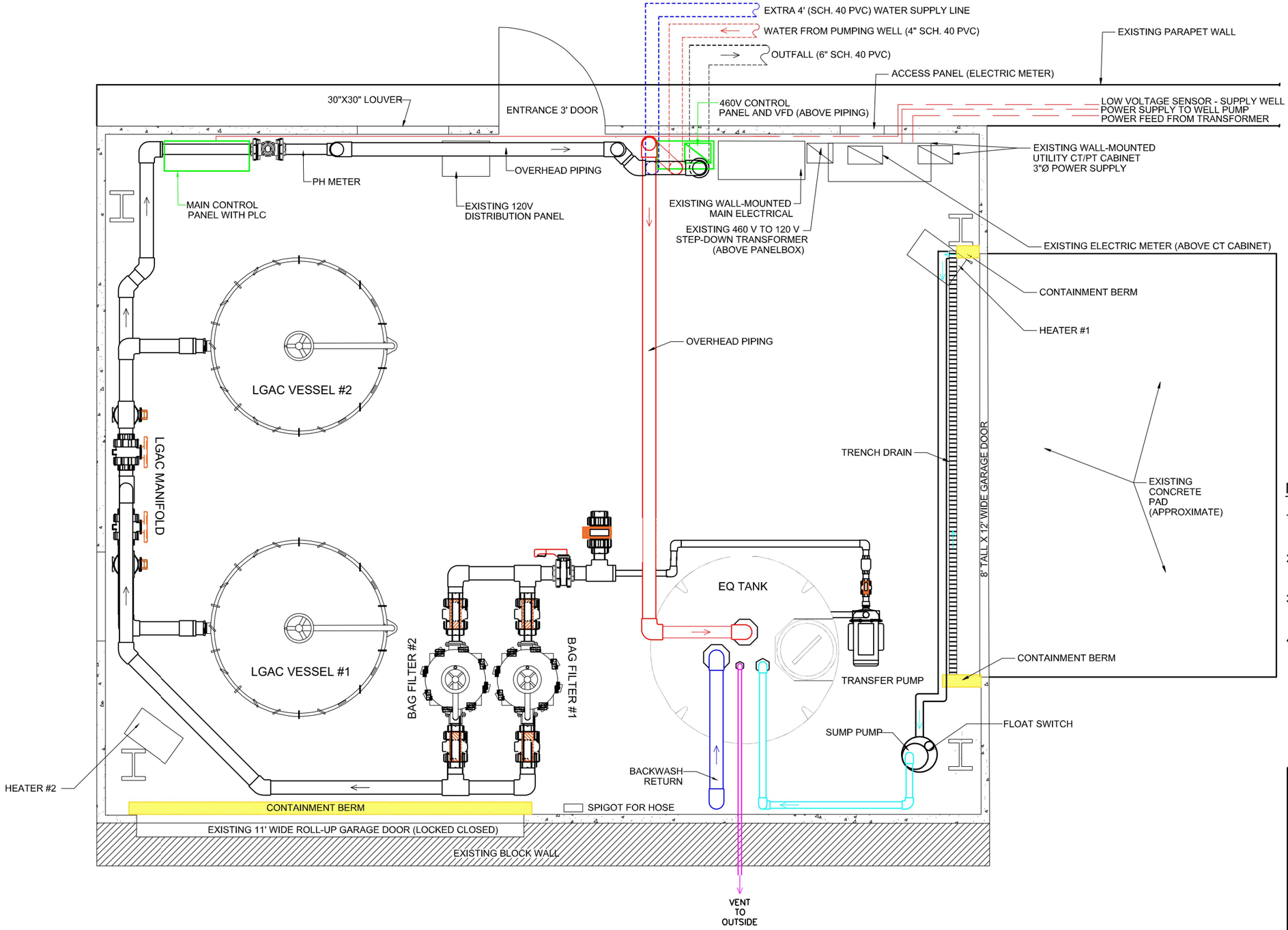
1:900
1" = 75'
0 75 150 FEET

PROJECT:	CHROMALLOY FORMER CHROMALLOY FACILITY WEST NYACK, ROCKLAND COUNTY, NEW YORK NYSDEC SITE NO. 344039
TITLE:	SITE LAYOUT MAP
DRAWN BY:	L. LILL
PROJ. NO.:	190273.2021.0000
CHECKED BY:	J. KING
APPROVED BY:	J. LAROCK
DATE:	JANUARY 2025
	FIGURE 2

TRC
3 Corporate Drive
Suite 202
Clifton Park, NY 12065
Phone: 518.348.1190

FILE: 2-APRX.aprx

Coordinate System: NAD 1983 StatePlane New York East FIPS 3101 Feet; Map Rotation: 90
Saved By: LILL on 1/24/2025 - 08:57:17 AM; File Path: T:\1-PROJECTS\Sequa Chromalloy\2-APRX\2-APRX.aprx; Layout Name: Figure 1 - Chromalloy Site Layout Map



NOTES:

1. FIGURE WAS PREPARED BY ENVIROTRAC LTD OF YAPHANK, NEW YORK (ET).
2. THE EQUALIZATION (EQ) TANK HOLDS 2,000-GALLONS OF UNTREATED GROUNDWATER.
3. EACH LIQUID-PHASE GRANULAR ACTIVATED CARBON (LGAC) VESSEL HOLDS 2,000-LBS OF LGAC.
4. THE PROGRAMMABLE LOGIC CONTROLLER (PLC) IS USED TO CONTROL ALL THE COMPONENTS OF THE TREATMENT SYSTEM.

0 4 8 FT.

SCALE: 1" = 4'
SHEET SIZE 11" BY 17"

PROJECT:
CHROMALLOY
FORMER CHROMALLOY FACILITY
WEST NYACK, ROCKLAND COUNTY, NEW YORK
NYSDEC SITE NO. 344039

TITLE:
SYSTEM LAYOUT

DRAWN BY:	B. ABRERA	PROJ NO.:	474150.0000.0000
CHECKED BY:	J. KING		
APPROVED BY:	J. LAROCK		**FIGURE 3**
DATE:	JANUARY 2025		

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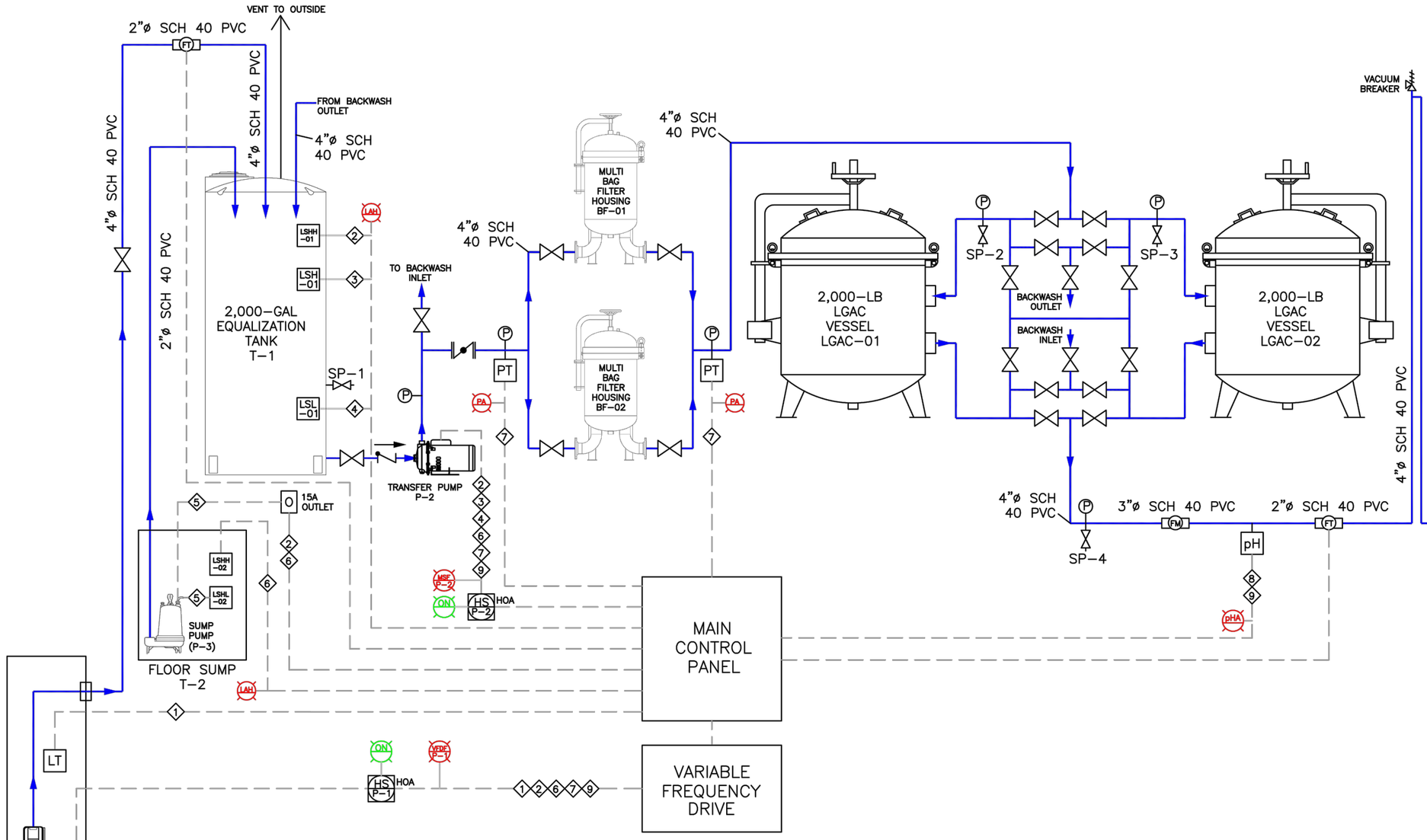
FILE NO.: Fig. 3 - System Layout.dwg

11x17 -- ATTACHED XREFS: -- ATTACHED IMAGES:
DRAWING NAME: \\CLIFTONPARK\VFP\cliftonpark\ECR\Projects\Sequa\190273_Sequa W Nyack\Deliverables\2024\2024.11_RSO CCR_DNU\ Fig. 3 - System Layout.dwg -- PLOT DATE: November 25, 2024 - 11:45AM -- LAYOUT: PDF
Version: 2017-03-03



SYSTEM LEGEND:

- PRESSURE GAUGE
- LS — LEVEL SWITCH
- LT — LEVEL TRANSMITTER
- PT — PRESSURE TRANSMITTER
- pH — pH TRANSMITTER
- FM — FLOW METER/TOTALIZER
- FT — FLOW TRANSMITTER
- BALL VALVE
- BUTTERFLY VALVE
- SP — SAMPLE PORT
- CHECK VALVE
- HS — HMI SWITCH
- CONTROL PANEL INTERLOCK
- ELECTRIC LINE
- AIR FLOW DIRECTION
- WATER FLOW DIRECTION
- ENCLOSURE LIMITS

HMI INDICATOR INDEX:

- LAH — LEVEL ALARM HIGH
- PAH — PRESSURE ALARM HIGH
- pHA — pH ALARM HIGH OR LOW
- VFDF P-1 — VARIABLE FREQUENCY DRIVE FAULT
- MSF P-2 — MOTOR STARTER FAULT
- ON — MOTOR RUN INDICATOR

INTERLOCK SCHEDULE:

1. PLC TO CONTROL VFD TO MAINTAIN GROUNDWATER LEVEL SETPOINT.
2. LEVEL AT LSHH-01 – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3 OUTLET.
3. LEVEL AT LSH-01 – TURN ON P-2.
4. LEVEL BELOW LSL-01 – TURN OFF P-2.
5. INTEGRAL SUMP PUMP FLOAT SWITCH LSHL-02 ENGAGED – SUMP PUMP TURNS ON AUTOMATICALLY.
   INTEGRAL SUMP PUMP FLOAT SWITCH LSHL-02 DISENGAGED – SUMP PUMP TURNS OFF AUTOMATICALLY,
6. LEVEL AT LSHH-02 – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3 OUTLET.
7. HIGH DIFFERENTIAL PRESSURE ACROSS BAG FILTERS – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.
8. HIGH OR LOW AVERAGE DISCHARGE pH – SEND WARNING NOTIFICATION.
9. HIGH OR LOW AVERAGE DISCHARGE pH – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.

NOTES:

1. FIGURE WAS PREPARED BY ENVIROTRAC LTD OF YAPHANK, NEW YORK (ET).
2. 10-PIPE DIAMETERS OF STRAIGHT PIPE RUN WAS INSTALLED BEFORE EACH FLOW METER OR FLOW TRANSMITTER.
3. 5-PIPE DIAMETERS OF STRAIGHT PIPE RUN WAS INSTALLED AFTER EACH FLOW METER/TRANSMITTER.

PROJECT:
CHROMALLOY
FORMER CHROMALLOY FACILITY
WEST NYACK, ROCKLAND COUNTY, NEW YORK
NYSDEC SITE NO. 344039

TITLE:
PROCESS AND INSTRUMENTATION DIAGRAM (P&ID)

DRAWN BY:	B. ABRERA	PROJ NO.:	474150.0000.0000
CHECKED BY:	J. KING		
APPROVED BY:	J. LAROCK		**FIGURE 4**
DATE:	JANUARY 2025		

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FILE NO.: Fig.4 - P&ID.dwg

11:17 -- ATTACHED XREFS: -- ATTACHED IMAGES:
DRAWING NAME: \\CLIFTONPARK-VFP\cliftonpark\ECR\Projects\Sequa\190273.Sequa W Nyack\Deliverables\2024\2024.11_RSO CCR_DNU\ Fig.4 - P&ID.dwg -- PLOT DATE: November 25, 2024 - 11:16AM -- LAYOUT: PDF
Version: 2017-03-03

APPENDIX A

NEW YORK STATE | Department of Environmental Conservation

KATHY HOCHUL
Governor

AMANDA LEFTON
Commissioner

Transmitted via Email

July 8, 2025

Justin King
TRC Engineers, Inc.
3 Corporate Drive, Suite 202
Clifton Park, NY 12065
jking@trccompanies.com

Re: Construction Completion Report for Remedial System Optimization
NYSDEC Site 344039 Chromalloy (SEQUA)
West Nyack, Rockland County

Dear Mr. King,

The New York State Department of Environmental Conservation and the New York State Department of Health (the Departments) have reviewed the Construction Completion Report for Remedial System Optimization (the Report) received on January 14, 2025. The Departments hereby approve the Report with the following modifications:

- Section 4.3 RW-1 Corrective Action, states "…TRC implemented a community air monitoring program (CAMP) at the Site during the intrusive work." Please provide CAMP data for the outlined activities.
- In the last sentence under Section 5.4 Initial Quarterly Sampling, please correct from Appendix G to Appendix H.

Please provide an updated Report with the requested modifications per 6 NYCRR Part 375-1.6(d)(3). If you have any questions or comments, please contact me at 518-402-9546 or michael.squire@dec.ny.gov

Sincerely,

Michael Squire
Project Manager
Remedial Bureau C
Division of Environmental Remediation

EC: Amen Omorogbe, NYSDEC
Steven McCague, NYSDEC
Michele Dolan, NYSDOH
John Lambert, Chromalloy jlambert@chromalloy.com

APPENDIX B

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 05/08/23**
TO:	**TRC** 10 Maxwell Drive Suite 200 Clifton Park, NY 12065 Attn: Peter Wanfried	***DATE RECEIVED:***_____

PROJECT:

Remedial System Optimization (RSO) RFP
Former Chromalloy Facility, West Nyack, New York

We are transmitting (Herewith ☒, Under separate cover ☐, Electronic ☒, Hard copy ☐), the following:

Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	Figure 1 – Pump and Treat System P&ID	01	☐ Yes ☒ No
2	LGAC Vessels Specifications	02	☐ Yes ☒ No
3	Transfer Pump Specifications	03	☐ Yes ☒ No
4	Equalization Tank Specifications	04	☐ Yes ☒ No
5	EQ Tank Float Switches Specifications	05	☐ Yes ☒ No
6	Sump Pump Specifications	06	☐ Yes ☒ No
7	Floor Sump High Level Float Specifications	07	☐ Yes ☒ No
8	RW-1 Level Transducer Specifications	08	☐ Yes ☒ No
9	Transfer Pump Pressure Transmitter Specifications	09	☐ Yes ☒ No
10	Mechanical Flow Totalizer Specifications	10	☐ Yes ☒ No
11	Water Flow Transmitter Specifications	11	☐ Yes ☒ No
12	pH Transmitter Specifications	12	☐ Yes ☒ No
13	pH Sensor Specifications	13	☐ Yes ☒ No

14	Pressure Gauge Specifications	14	☐ Yes ☒ No
15	Heater Specifications	15	☐ Yes ☒ No
16	HMI Touchscreen Specifications	16	☐ Yes ☒ No
17	PLC Specifications	17	☐ Yes ☒ No
18	Variable Frequency Drive Specifications	18	☐ Yes ☒ No
19	Steel Access Door Specifications	19	☐ Yes ☒ No
20	Keyless Door Lock Installation/User Guide	20	☐ Yes ☒ No
21	Trench Drain Specifications	21	☐ Yes ☒ No
22	Sump Pump Basin Specifications	22	☐ Yes ☒ No
23	Roof Drain Cover Specifications	23	☐ Yes ☒ No
24	Containment Berm Specifications	24	☐ Yes ☒ No

Remarks:_____

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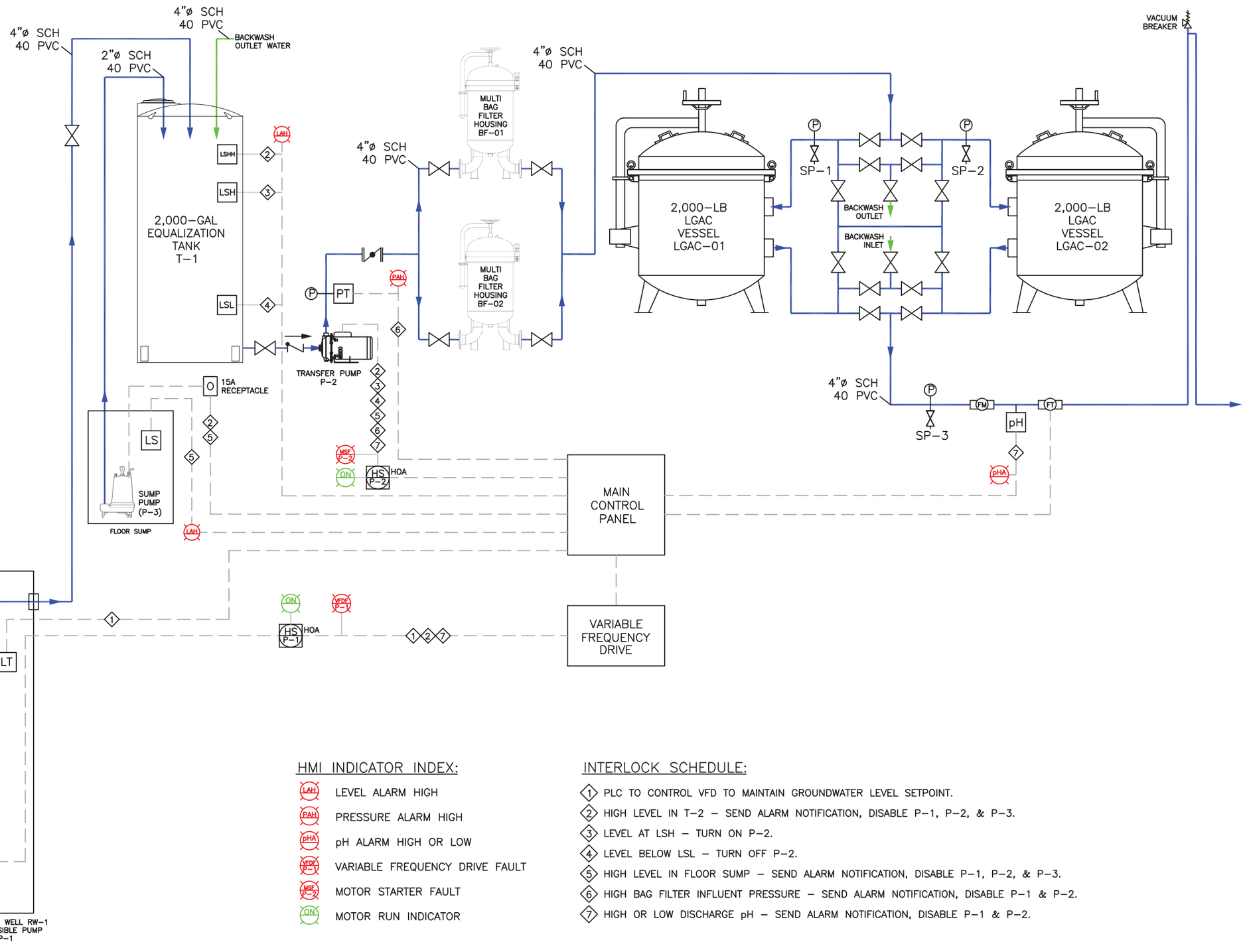
Signed:



SYSTEM LEGEND:

- P — PRESSURE GAUGE
- LS — LEVEL SWITCH
- LT — LEVEL TRANSMITTER
- PT — PRESSURE TRANSMITTER
- pH — pH TRANSMITTER
- FM — FLOW METER/TOTALIZER
- FT — FLOW TRANSMITTER
- BALL VALVE
- BUTTERFLY VALVE
- SP — SAMPLE PORT
- CHECK VALVE
- HS — HMI SWITCH
- CONTROL PANEL INTERLOCK
- ELECTRIC LINE
- AIR FLOW DIRECTION
- CONDENSATE WATER FLOW DIRECTION
- ENCLOSURE LIMITS

HMI INDICATOR INDEX:

- LAH — LEVEL ALARM HIGH
- PAH — PRESSURE ALARM HIGH
- pHA — pH ALARM HIGH OR LOW
- VFDF P-1 — VARIABLE FREQUENCY DRIVE FAULT
- MSF P-2 — MOTOR STARTER FAULT
- ON — MOTOR RUN INDICATOR

INTERLOCK SCHEDULE:

1. PLC TO CONTROL VFD TO MAINTAIN GROUNDWATER LEVEL SETPOINT.
2. HIGH LEVEL IN T-2 – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3.
3. LEVEL AT LSH – TURN ON P-2.
4. LEVEL BELOW LSL – TURN OFF P-2.
5. HIGH LEVEL IN FLOOR SUMP – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3.
6. HIGH BAG FILTER INFLUENT PRESSURE – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.
7. HIGH OR LOW DISCHARGE pH – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.

EnviroTrac
ENVIRONMENTAL SERVICES
5 OLD DOCK ROAD, YAPHANK, NEW YORK 11980
PHONE: (631)924-3001 FAX: (631)924-5001

REVISION DATE: 5/2/2023

REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

PUMP AND TREAT SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE # 1

PRM Carbon Systems - HP-2000-RDL

The HP Series Carbon units are used on remediation systems where standard flow volumes are required with minimal back-pressure. These units offer a 25% freeboard area for excellent backwash ratios. Typical applications are groundwater remediation for VOCs or industrial sites with similar applications. Several media types are available for removal of more specific compounds such as metals and other contaminants. Aggregate media specifically designed to be backwashed is also available.

APPLICATIONS:

- Remediation of contaminated water streams

STANDARD SPECIFICATIONS:

- 60”D x 73”H Tank Vessel With Removable Lid for easy access when changing your carbon media without affecting efficiency or performance
- 3 Inch Inlet/Outlet
- 80 psig maximum pressure
- High Flow Distributor Manifold
- Heavy Duty Welded Legs
- Approx. 2000 lbs. of GAC media based on a packed density bed of 30lbs/ft^3

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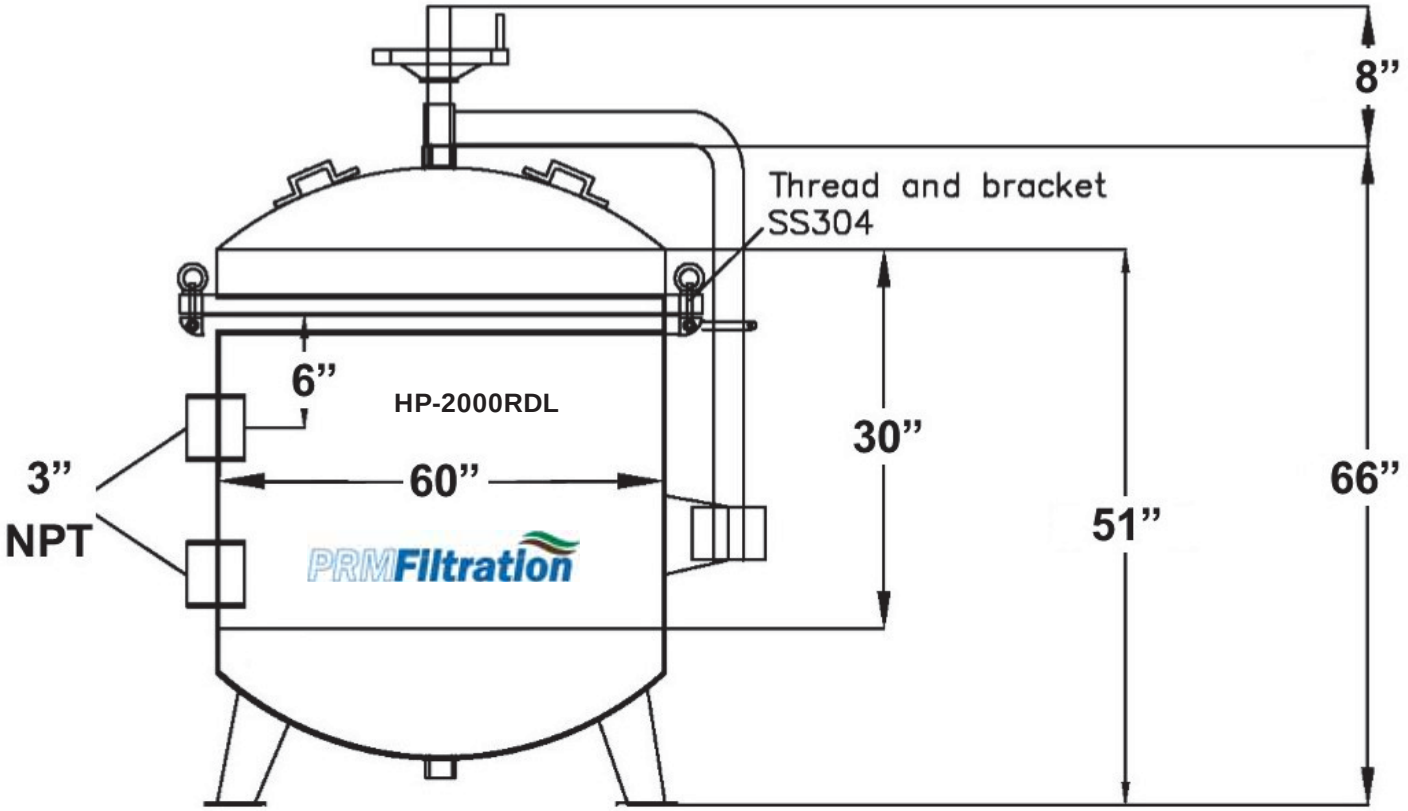
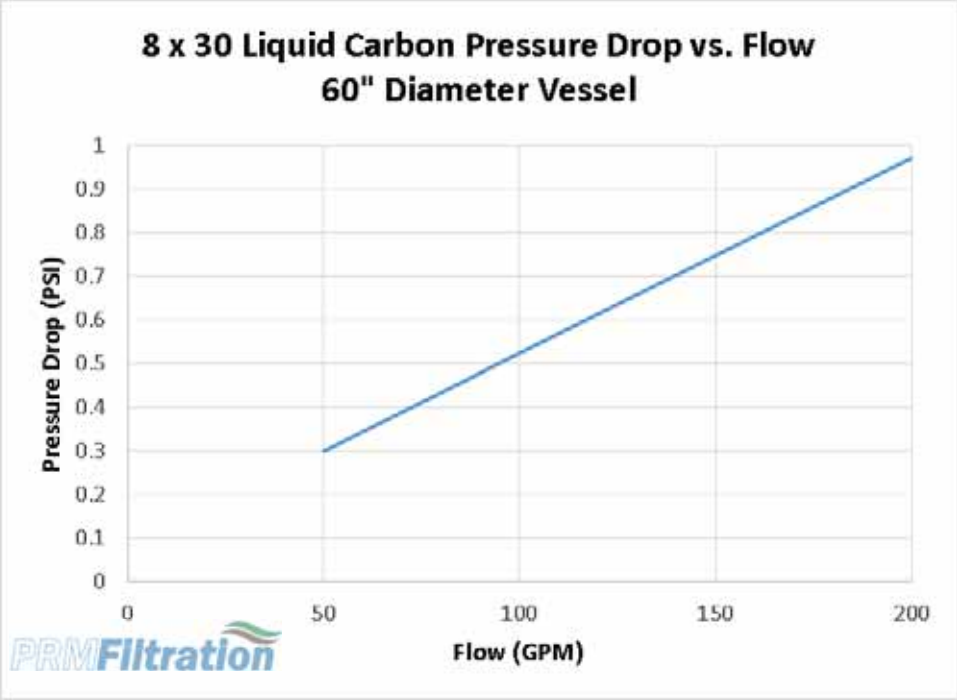
PRM Carbon Systems - HP-2000-RDL



Dimensions shown in inches.



AVAILABILITY: Build Item: Allow 3 to 6 weeks for manufacturing and shipping

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Centrifugal Pump: 1 1/2 hp, 208-230/460V AC, 119 ft Max Head, 1 1/2 in , 1 1/4 in Intake and Disch

Item **784RN3** Mfr. Model **2ST1F9H4**

Product Details

Pump Housing Material **Stainless Steel**
Phase **Three**
Horsepower **1-1/2 hp**
Nameplate Voltage **208-230/460V AC**
Maximum Flow Rate @ 60 Feet of Head **131 gpm**
Maximum Flow Rate @ 70 Feet of Head **122 gpm**
Maximum Flow Rate @ 80 Feet of Head **111 gpm**
Maximum Flow Rate @ 90 Feet of Head **99 gpm**
Maximum Flow Rate @ 100 Feet of Head **80 gpm**
Maximum Feet of Head **119 ft**
Connection Type **NPT**
Motor Enclosure **Totally Enclosed Fan Cooled**
Brand **GOULDS WATER TECHNOLOGY**
Compatible Intake Pipe Size **1-1/2 in**
Compatible Discharge Pipe Size **1-1/4 in**
Impeller Material **Stainless Steel**
Seal Material **316 Stainless Steel; Carbon; Silicon Carbide; Viton**
Wetted Material **316 Stainless Steel; Carbon; Silicon Carbide; Stainless Steel; Viton**

RPM (Maximum) **3,500 RPM**

Specific Gravity (Maximum) **1**

Shut Off Pressure **125 psi**

Standards **CSA Certified; NSF 61 Certified**

Mounting Orientation **Horizontal; Vertical**

Compatible with Media Type **Water**

Priming **Manual**

Shaft Material **Stainless Steel**

For Use With Potable Systems **Yes**

Best Efficiency Head **98 ft**

Discharge Type **NPT**

Frequency **60 Hz**

Best Efficiency Flow **90 gpm**

Flow Rate (Maximum) **91.1 gpm**

Duty Cycle **Continuous**

Manufacturer Part Number **2ST1F9H4**

Flow Rate (Minimum) **59.4 gpm**

Series **NPE**

Overall Height **8.7 in**

Overall Length **20 in**

Overall Width **8.5 in**

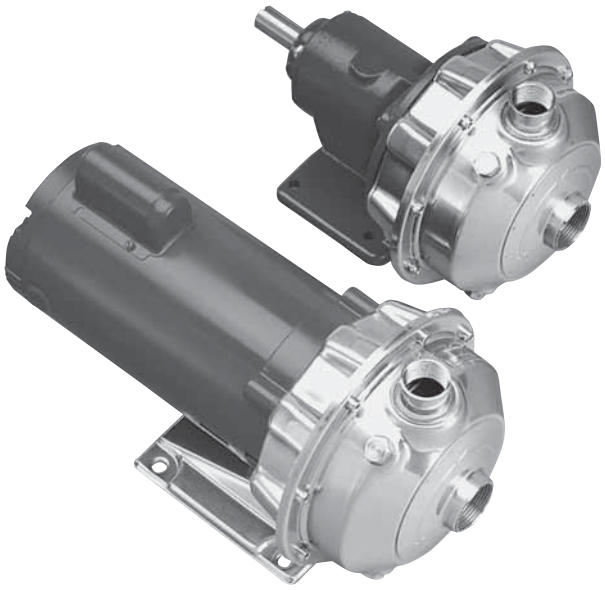
UNSPSC **40151503**

Country of Origin **USA (subject to change)**

Product Description
Straight centrifugal pumps with motors between 1 and 1-1/2 HP achieve higher head and flow rates than pumps with a lower HP motor.

xylem
Let's Solve Water

TECHNICAL BROCHURE
BNPE R8



NPE

316L SS

NPE SERIES END SUCTION CENTRIFUGAL PUMPS
BOMBAS CENTRÍFUGAS DE SUCCIÓN FINAL SERIE NPE

GOULDS
WATER TECHNOLOGY
a xylem brand

A FULL RANGE OF PRODUCT FEATURES
UNA GAMA TOTAL DE CARACTERÍSTICAS DEL PRODUCTO

Superior Materials of Construction: Complete AISI 316L stainless steel liquid handling components and mounting bracket for corrosion resistance, quality appearance, and improved strength and ductility.

Materiales Superiores de Construcción: *Componentes completos para manejo de líquidos en acero inoxidable AISI 316L y consola para el montaje para resistencia a la corrosión, apariencia de calidad, y fuerza y ductilidad mejoradas.*

High Efficiency Impeller: Enclosed impeller with unique floating seal ring design maintains maximum efficiencies over the life of the pump without adjustment.

Impulsor de Eficiencia Superior: *El impulsor encerrado con un diseño único de anillo del sello flotante, mantiene sin ajustes, la eficiencia máxima sobre la vida de la bomba.*

Casing and Adapter Features: Stainless steel construction with NPT threaded, centerline connections, easily accessible vent, prime and drain connections with stainless steel plugs. Optional seal face vent/flush available.

Características de la Carcasa y del Adaptador: *Construcción en acero inoxidable con NPT roscado, conexiones centrales, válvulas de fácil acceso, conexiones de cebado y drenaje con enchufes de acero inoxidable. Cara del sello válvula/chorro opcional disponible.*

Mechanical Seal: Standard John Crane Type 21 with carbon versus silicon-carbide faces, Viton elastomers, and 316 stainless metal parts. Optional high temperature and chemical duty seals available.

Sello Mecánico: *Estándar John Crane Tipo 21 con carbón en contraste con caras de silicón-carbide, elastómeros de Viton, y partes metálicas de acero inoxidable 316. Sellos de alta temperatura y productos químicos están disponibles.*

Motors: NEMA standard open drip-proof, totally enclosed fan cooled or explosion proof enclosures. Rugged ball bearing design for continuous duty under all operating conditions.

Motores: *Estándar NEMA a prueba de goteo, ventilador totalmente encerrado o recintos a prueba de explosión. Diseño robusto de balineras de bolas para trabajo continuo en todas las condiciones de funcionamiento.*

DRINKING WATER
NSF/ANSI 61 & 372

NSF 61 Certification: Pumps assembled at the factory are certified to the NSF/ANSI 61 Drinking Water System Components Standard.

Certificación del NSF 61: *Las bombas ensambladas en la fábrica se certifican a los componentes de consumición del circuito de agua de NSF/ANSI 61 estándar.*

* Premium efficiency where required by Department of Energy regulations.

** Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

The various versions of the NPE are identified by a product code number on the pump label. This number is also the catalog number for the pump. The meaning of each digit in the product code number is shown at left.

Las diferentes versiones de la NPE se identifican con un número de código del producto en la etiqueta de la bomba. Este número es también el número del catálogo para la bomba. El significado de cada dígito en el número de código del producto se muestra a la izquierda.

NPE PRODUCT LINE NUMBERING SYSTEM
LÍNEA DE PRODUCTO NPE SISTEMA DE NUMERACIÓN

Example Product Code, *Ejemplo Código del Producto*

1 ST 2 C 1 A 4 F R

Casing Rotation, Optional — ***Rotación de la cubierta, opcional***
R = 3 o'clock L = 9 o'clock B = 6 o'clock
R = 3 hora L = 9 hora B = 6 hora
NOTE: Rotation when viewed from suction end of pump. Standard discharge position is 12 o'clock.
NOTA: *Rotación cuando está visto del extremo de la succión de la bomba. La posición estándar de la descarga es las 12.*

Seal Vent/Flush Option, *Opción de Sello Válvula/ChorroSeal Ven*

Mechanical Seal and O-ring — ***Sello Mecánico y Anillo 'O'***
4 = Pre-engineered standard
For optional mechanical seal modify catalog order no. with seal code listed below.
4 = Estándar aprobado
Para sello mecánico opcional modificar el número de orden del catálogo con el código del sello anotado abajo.

John Crane Type 21 Mechanical Seal (⅝" seal), *Sello Mecánico John Crane Tipo 21 (sello de ⅝")*

Seal Code, *Código del Sello*	Rotary, *Rotativo*	Stationary, *Estacionario*	Elastomers, *Elastómeros*	Metal Parts, *Partes Metálicas*	Part No., *Pieza Número*
2	Carbon, *Carbone*	Silicon Carbide, *Carburo de silicona*	EPR	316 SS, *316 Acero inoxidable*	10K18
4			Viton		10K55
5	Silicon Carbide		EPR		10K81
6			Viton		10K62
8*			EPR		10K167
9	Carbon	Ceramic	Teflon		10K52

* This is a JC Type 2100 unitized seal ideal for glycol applications.

Impeller Option . . . No Adder Required — ***Código del Impulsor Opcional***
For optional impeller diameters modify catalog order no. with impeller code listed. Select optional impeller diameter from pump performance curve.
Para impulsores con diámetros opcionales modificar el número de orden del catálogo con el código del impulsor anotado. Escoger el impul con diámetro opcional de la curva de funcionamiento de la bomba.

Impeller Code, *Código del impulsor*	Pump Size, *Tamaño de la bomba*		
	1 x 1¼ - 6	1¼ x 1½ - 6	1½ x 2 - 6
	Diameter	Diameter	Diameter
A	6 1/8	6 1/8	5 1/8
B	5 3/4	5 15/16	5
C	5 3/16	5 3/4	4 3/4
D	4 3/4	5 11/32	4 1/2
E	4 7/16	5 1/16	4 3/8
F	4 1/16	4 7/8	4
G		4 5/8	3 5/8
H		4 1/4	
J		4	

Driver, *Conductor*
1 = 1 PH, ODP 7 = 3 PH, XP C = 3 PH, 575 TE PE
2 = 3 PH, ODP 8 = 575 V, XP D = 3 PH, XP PE
3 = 575 V, ODP 9 = 3 PH, TE PE E = 3 PH, WD PE
4 = 1 PH, TEFC 0 = 1 PH, XP F = 1 PH, ODP PE
5 = 3 PH, TEFC A = 3 PH, ODP PE G = 1 PH, TEFC PE
6 = 575 V, TEFC B = 3 PH, 575 ODP PE H = 1 PH, XP PE

HP Rating, *HP Potencia*
C = ½ HP E = 1 HP G = 2 HP J = 5 HP
D = ¾ HP F = 1½ HP H = 3 HP K = 7.5 HP

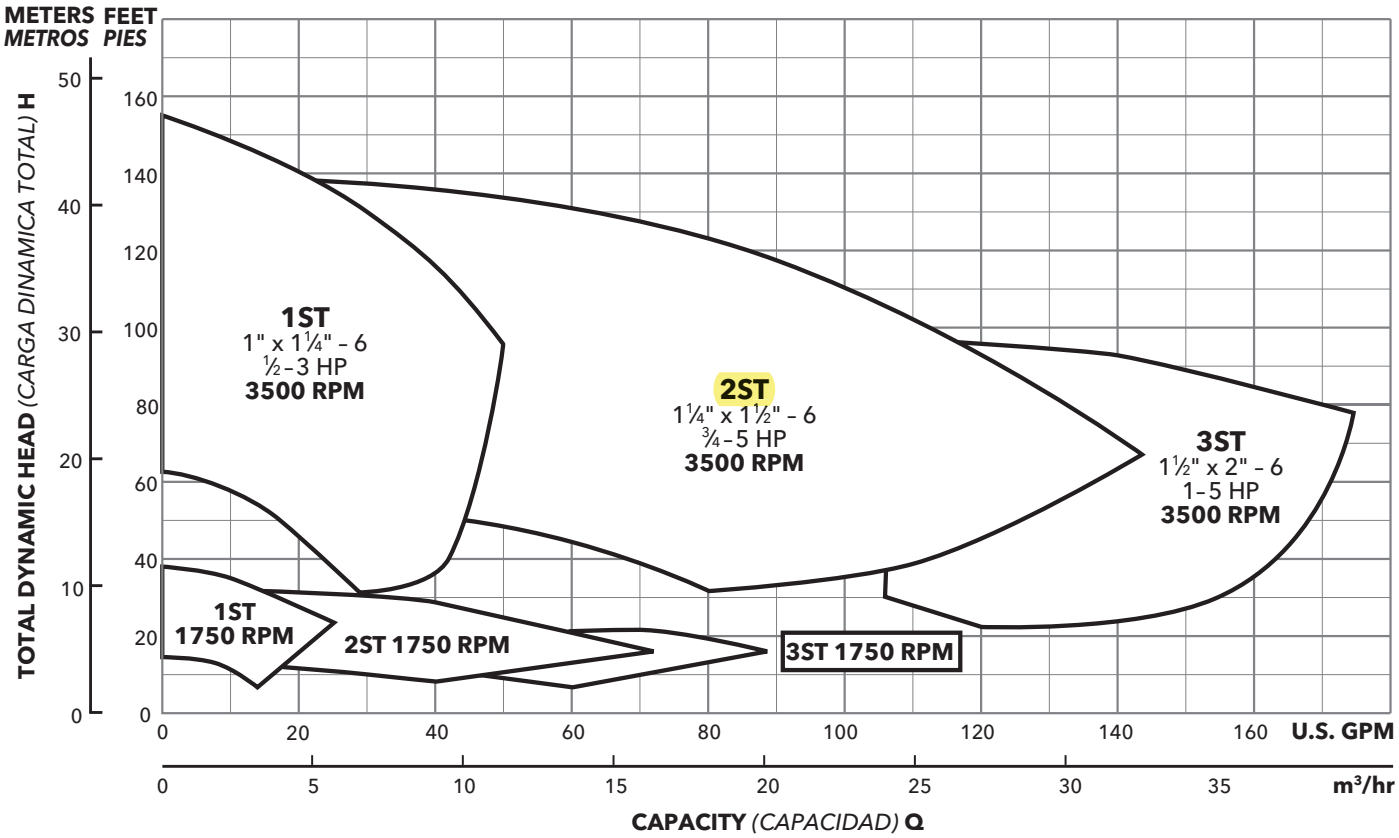
Driver: Hertz/Pole/RPM, *Conductor: Hercios/Polo/RPM*
1 = 60 Hz, 2 pole, 3500 RPM
2 = 60 Hz, 4 pole, 1750 RPM
3 = 60 Hz, 6 pole, 1150 RPM
4 = 50 Hz, 2 pole, 2900 RPM
5 = 50 Hz, 4 pole, 1450 RPM

For frame mounted version, substitute the letters "FRM" in these positions.
Para la versión con el armazón montado, sustituya las letras "FRM" en estas posiciones.

Material
ST = Stainless steel, *Acero inoxidable*

Pump Size, *Tamaño de la Bomba*
1 = 1 x 1¼ - 6 2 = 1¼ x 1½ - 6 3 = 1½ x 2 - 6

PERFORMANCE COVERAGE (60 HZ)
ALCANCE DE FUNCIONAMIENTO (60 HZ)



NOTES:

Not recommended for operation beyond printed H-Q curve.

For critical application conditions consult factory.

Not all combinations of motor, impeller and seal options are available for every pump model. Please check with G&L on non-cataloged numbers.

All standard 3500 RPM ODP* and TEFC* motors supplied by Goulds Water Technology, have minimum of 1.15 service factor. Standard catalog units may utilize available service factor. Any motors supplied other than Goulds Water Technology check available service factor.

* Premium efficiency where required by Department of Energy regulations.

NOTAS:

No se recomienda para funcionamiento superior al impreso en la curva H-Q.

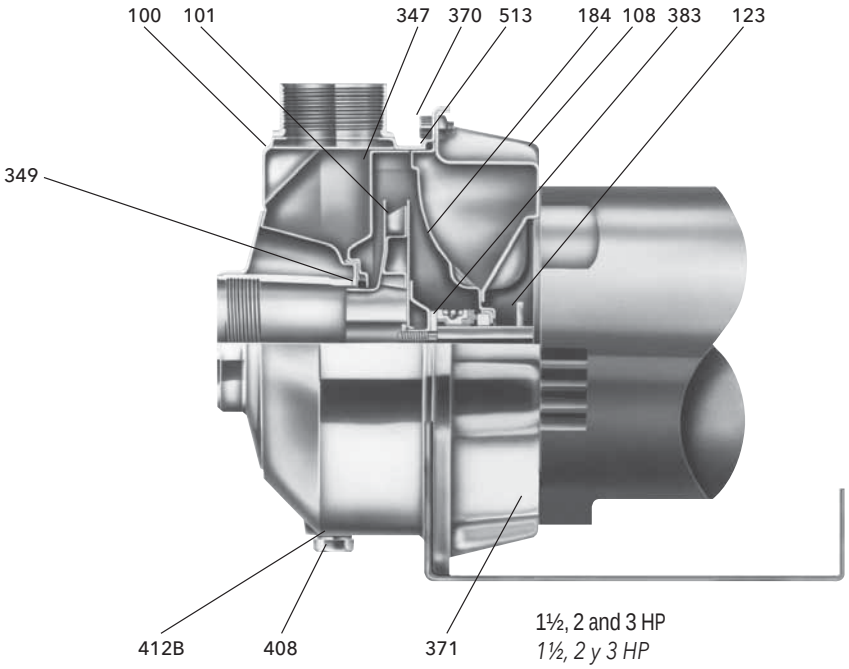
Para condiciones de aplicaciones críticas consultar con la fábrica.

No todas las combinaciones de las opciones de motor, impulsor y sello están disponibles para cada modelo de bombas. Por favor verifique con G&L en los números no catalogados.

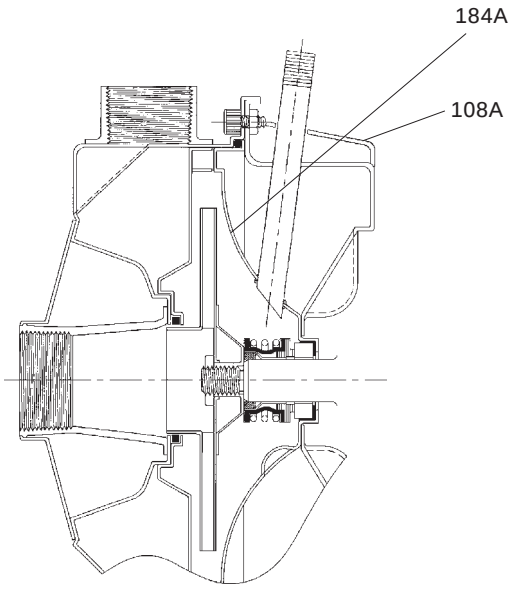
Todos los motores estándar de 3500 RPM, ODP (abiertos resguardados) y TEFC* (totalmente encerrados con enfriamiento forzado) provistos por Goulds Water Technology tienen un factor mínimo de servicio de 1,15. Las unidades estándar de catálogo pueden utilizar el factor de servicio disponible. Verificar el factor de servicio disponible de todo motor no provisto por Goulds Water Technology.*

** Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

NPE CLOSE COUPLED PUMP MAJOR COMPONENTS: MATERIALS OF CONSTRUCTION
BOMBA CERRADA ACOPLADA NPE COMPONENTES PRINCIPALES: MATERIALES DE CONSTRUCCIÓN

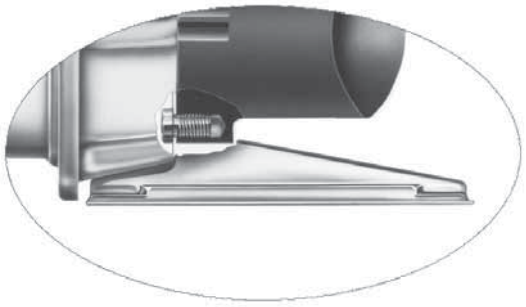


1½, 2 and 3 HP
1½, 2 y 3 HP



Seal Face Vent/Flush Option,
Opción Cara del Sello Válvula/Chorro

Item No., ***Parte No.***	**Description,** ***Descripción***	**Materials,** ***Materiales***
100	Casing; *Carcasa*	AISI 316L SS; *AISI 316L Acero inoxidable*
101	Impeller; *Impulsor*	
108	Motor adapter; *Adaptador del motor*	
108A	Motor adapter seal vent/flush; *Sello válvula/chorro del adaptador del motor*	
123	Deflector; *Deflector*	BUNA-N
184	Seal housing; *Alojamiento del sello*	AISI 316L SS; *AISI 316L Acero inoxidable*
184 A	Seal housing seal vent/flush; *Sello válvula/chorro del alojamiento del sello*	
347	Guidevane; *Difusor*	
349	Seal ring, guidevane; *Anillo del sello, difusor*	Viton
370 *able*	Socket head screws, casing; *Encajes cabezas de tornillos, carcasa*	AISI 410 SS; *AISI 410 Acero inoxid-*
371	Bolts, motor; *Tornillos, motor*	Plated steel; Acero chapeado
383	Mechanical seal; *Sello mecánico*	**see chart, *ver tabla*
408 *able*	Drain and vent plug, casing; *Enchufes de drenaje y válvula, carcasa*	AISI 316L SS; *AISI 316L Acero inoxid-*
412B	O-ring, drain and vent plug; *Anillo 'O', enchufe de drenaje y válvula*	Viton (Standard, *estándar*) EPR (Optional, *Opcional*)
513	O-ring, casing; *Anillo 'O', carcasa*	
Motor *Motor*	NEMA standard, 56J flange; *NEMA estándar, brida 56J*	



½, ¾ and 1 HP
½, ¾ y 1 HP

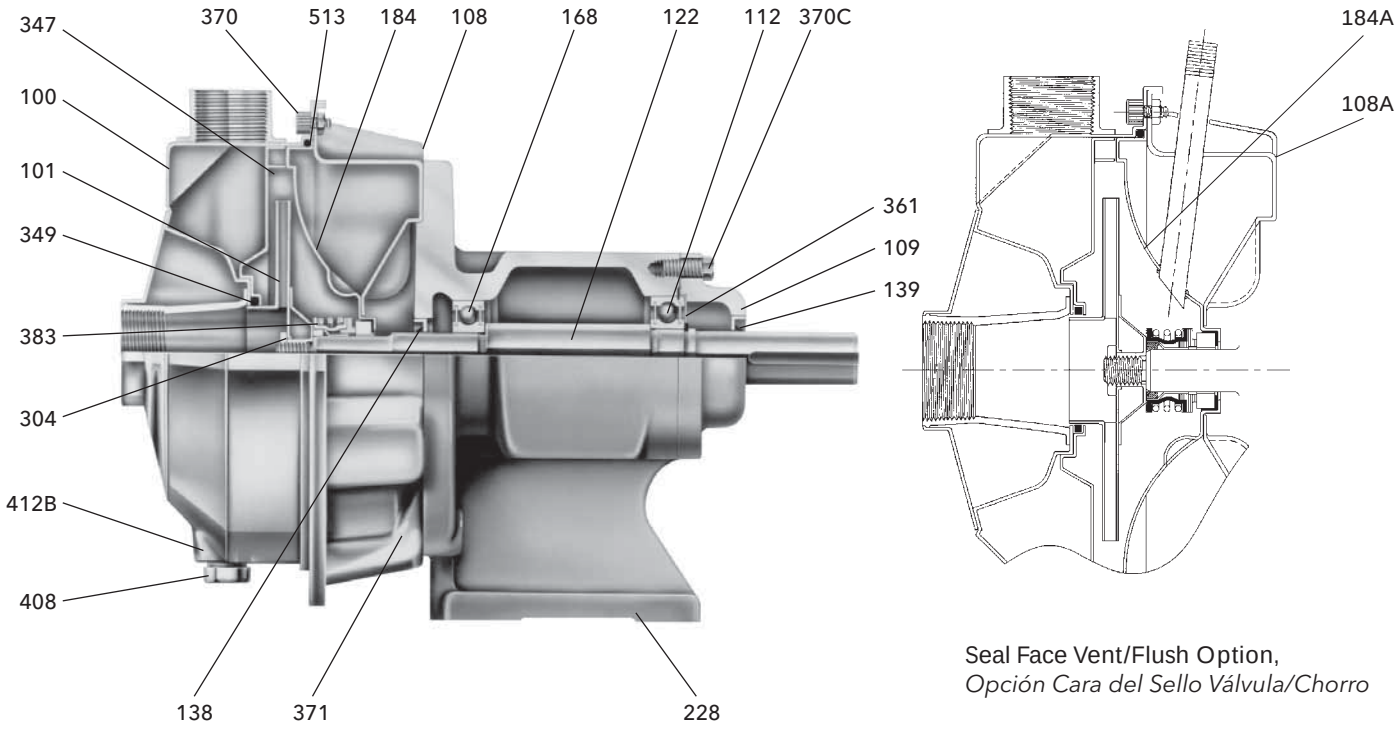
Footed motor for 5 & 7.5 HP ODP* and TEFC*, all explosion proof motors, see page 13.

Motor con pie para 5 y 7.5 HP ODP y TEFC*, a prueba de explosiones motores, en la página 13.*

* Premium efficiency where required by Department of Energy regulations.

Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.

NPE FRAME MOUNTED PUMP MAJOR COMPONENTS: MATERIALS OF CONSTRUCTION
BOMBA NPE DE ARMAZÓN MONTADO COMPONENTES PRINCIPALES: MATERIALES DE CONSTRUCCIÓN

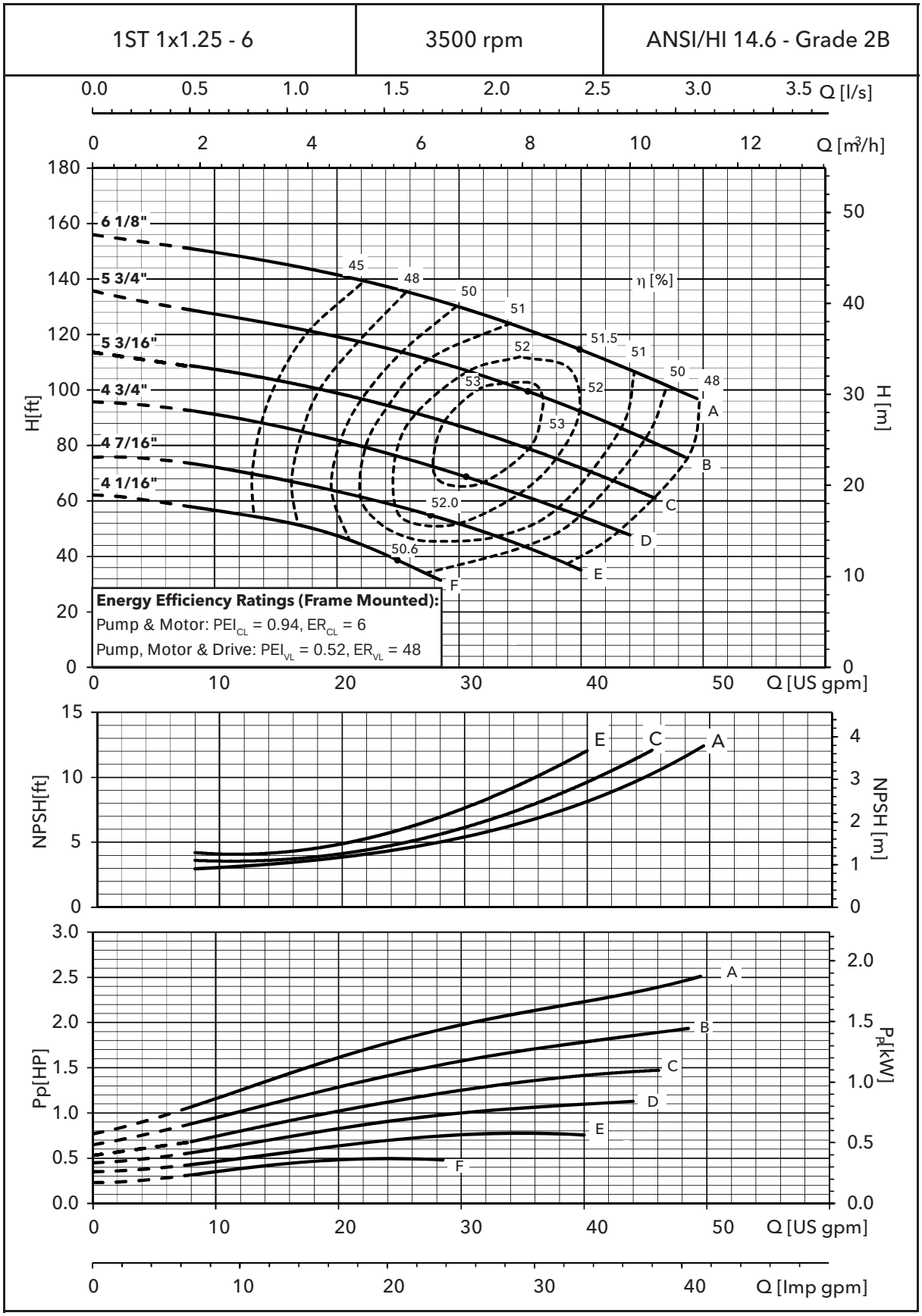


Seal Face Vent/Flush Option,
Opción Cara del Sello Válvula/Chorro

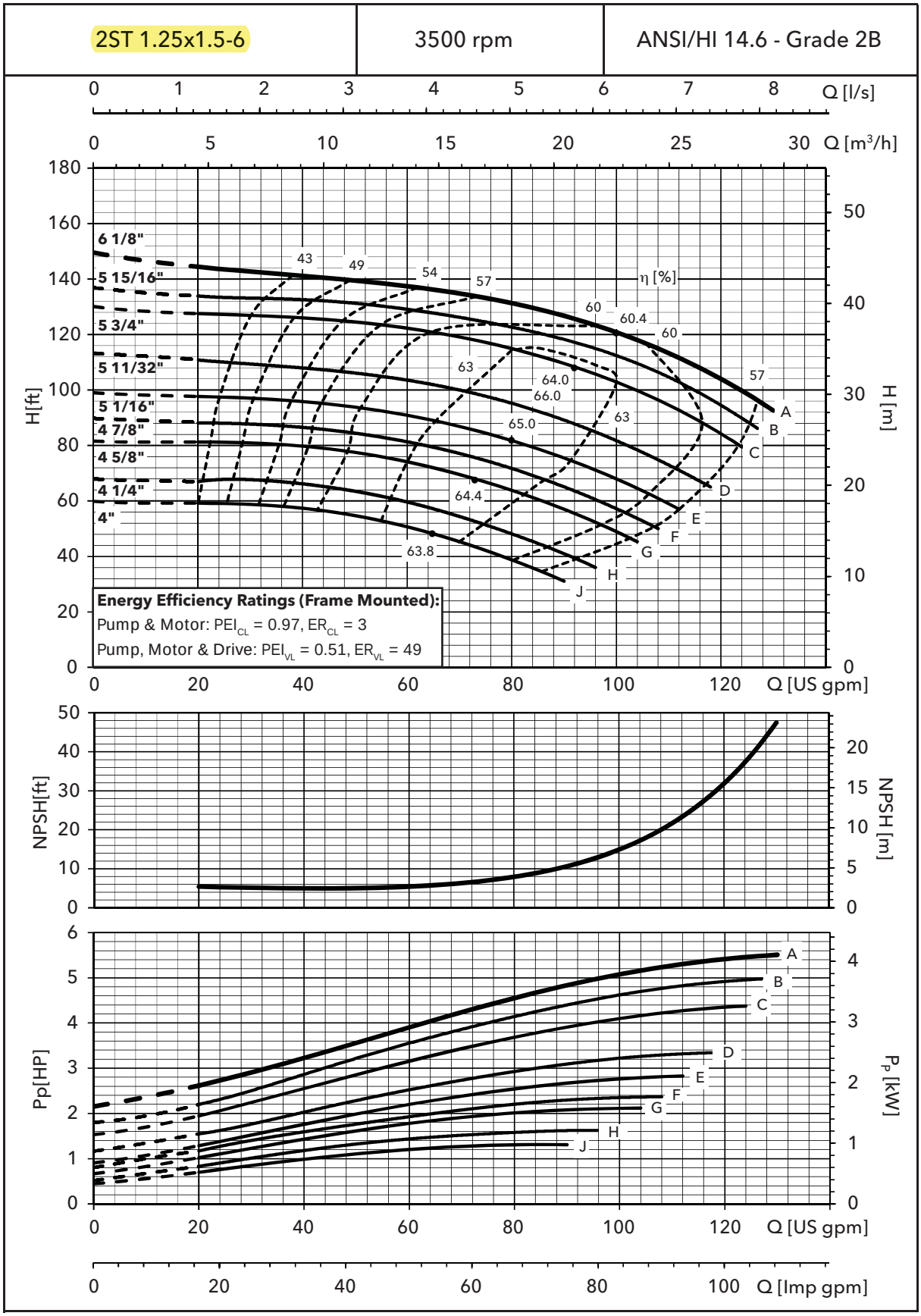
Item No., *Parte No.*	Description, *Descripción*	Materials, *Materiales*
100	Casing; *Carcasa*	AISI 316L SS; *AISI 316L Acero inoxidable*
101	Impeller; *Impulsor*	
108	Adapter; *Adaptador*	
108A	Motor adapter seal vent/flush; *Sello válvula/chorro del adaptador del motor*	
109	Bearing cover; *Cubierta de balineras*	Cast iron; *Hierro fundido*
112	Ball bearing (outboard); *Balineras de bolas (exterior)*	Steel; *Acero*
122	Shaft; *Eje*	AISI 316 SS; *AISI 316 Acero inoxidable*
138	Lip-seal (inboard); *Sello cubierto (interior)*	BUNA/steel; *BUNA/acero*
139	Lip-seal (outboard); *Sello cubierto (exterior)*	BUNA/steel; *BUNA/acero*
168	Ball bearing (inboard); *Balineras de bolas (interior)*	Steel; *Acero*
184	Seal housing; *Alojamiento del sello*	AISI 316L SS; *AISI 316L Acero inoxidable*
184 A	Seal housing seal vent/flush; *Sello válvula/chorro del alojamiento del sello*	
228	Bearing frame; *Armazón de balineras*	Cast iron, *Hierro fundido*

Item No., *Parte No.*	Description, *Descripción*	Materials, *Materiales*
304	Impeller locknut; *Contratuerca del impulsor*	AISI 316 SS; *AISI 316 Acero inoxidable*
347	Guidevane; *Difusor*	
349	Seal ring, guidevane; *Anillo del sello, difusor*	Viton
361	Retaining ring; *Anillo de retención*	Steel; Acero
370	Socket head screws, casing; *Encaje cabeza del tornillo, carcasa*	AISI 410 SS; *AISI 410 Acero inoxidable*
370C	Hex head screw, bearing cover; *Tornillo de cabeza hexagonal, cubierta de balineras*	Plated steel; *Acero chapeado*
371	Hex head screw, bearing frame; *Tornillo de cabeza hexagonal, armazón de balineras*	Plated steel; *Acero chapeado*
383	Mechanical seal; *Sello mecánico*	**see chart; ver tabla
400	Shaft key; *Llave del eje*	Steel; Acero
408	Drain and vent plug, casing; *Enchufes de drenaje y válvula, carcasa*	AISI 316 SS; *AISI 316 Acero inoxidable*
412B	O-ring, drain and vent plug; *Anillo 'O', enchufe de drenaje y válvula*	Viton (Standard, *estándar*) EPR (Optional, *Opcional*)
513	O-ring, casing; *Anillo 'O', carcasa*	

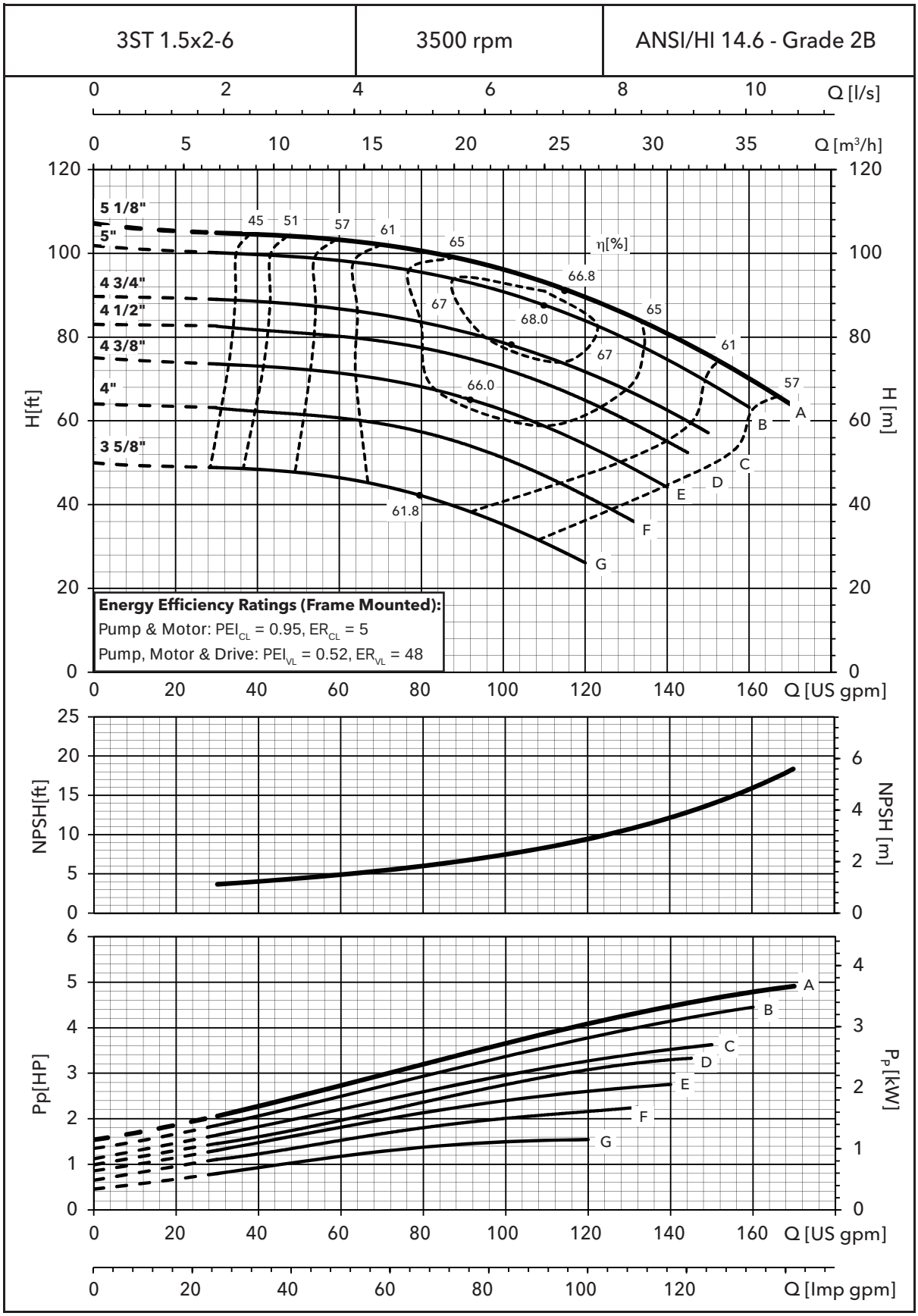
PERFORMANCE CURVES – 60 HZ, 3500 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 3500 RPM



PERFORMANCE CURVES – 60 HZ, 3500 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 3500 RPM

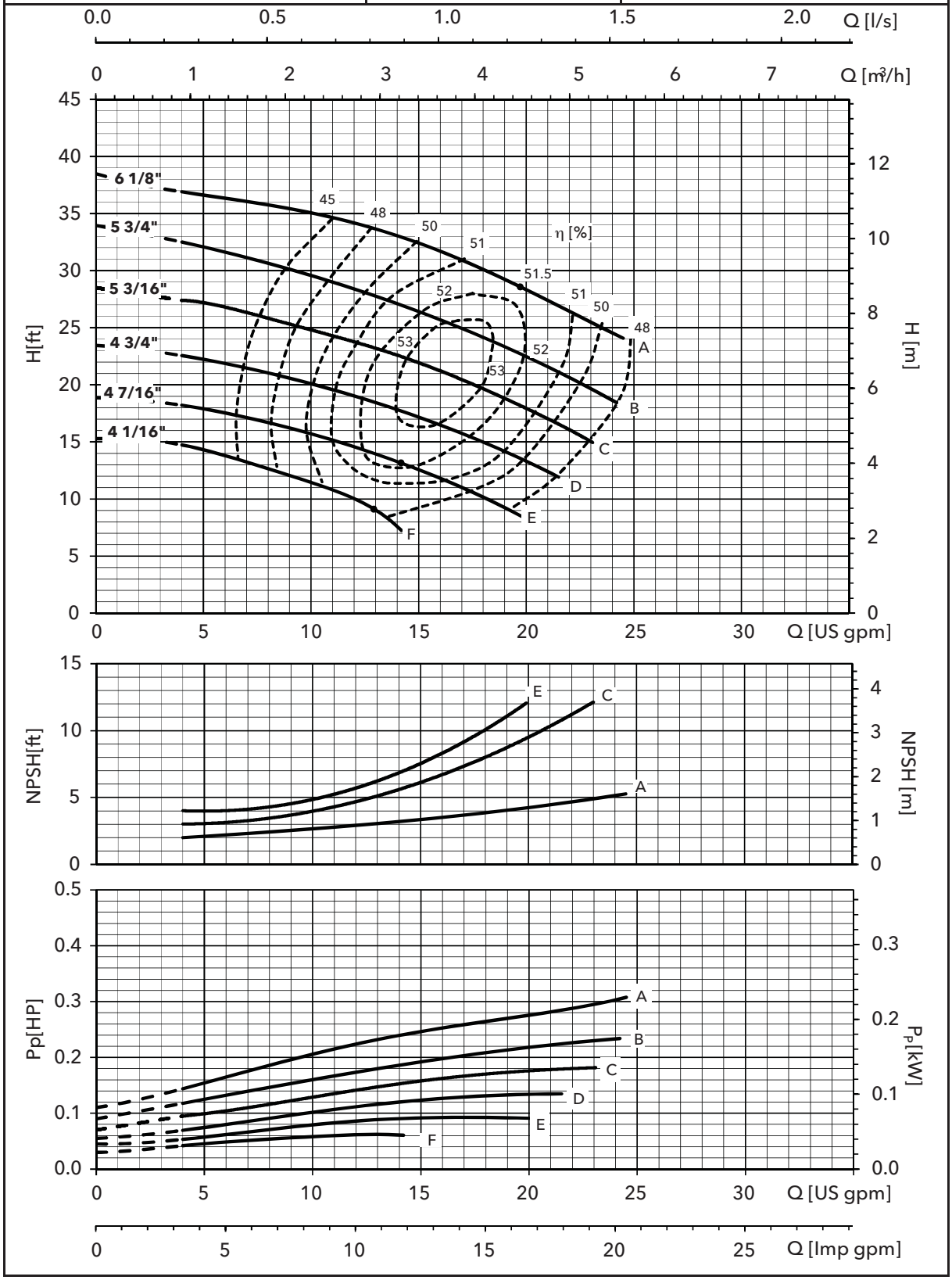


PERFORMANCE CURVES – 60 HZ, 3500 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 3500 RPM



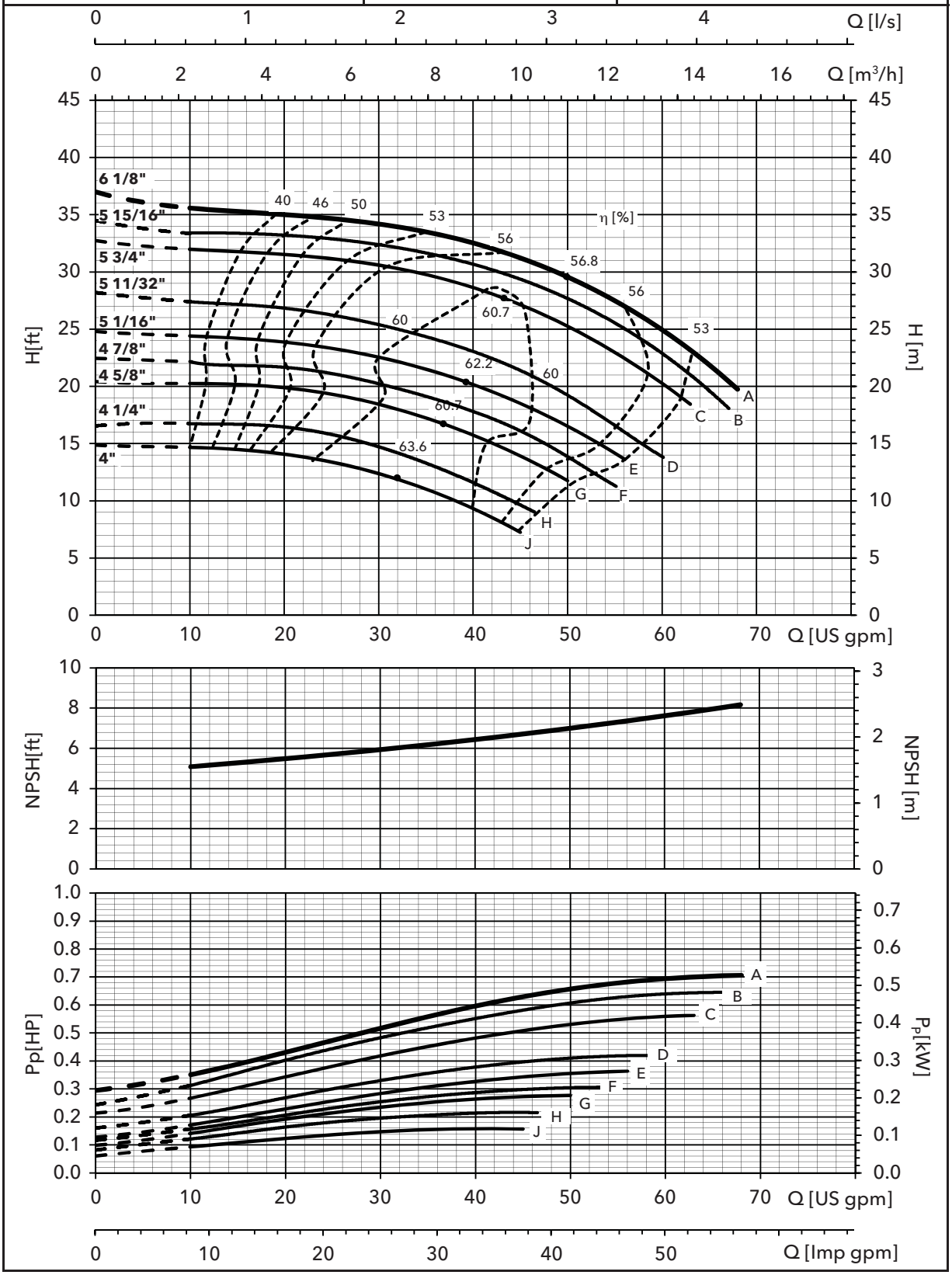
PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 1750 RPM

1ST 1x1.25-6	1750 rpm	ANSI/HI 14.6 - Grade 2B



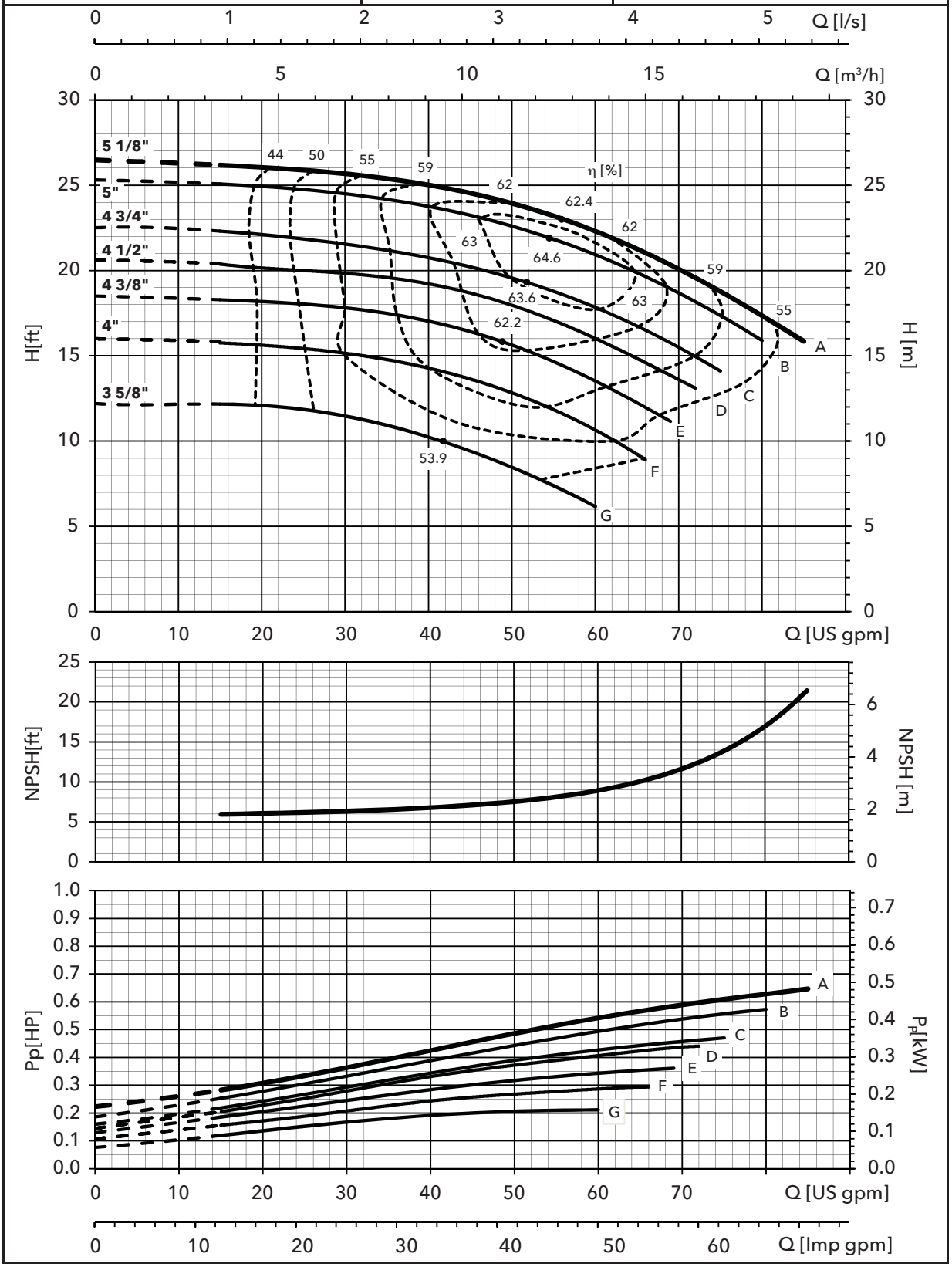
PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 1750 RPM

2ST 1.25x1.5-6	1750 rpm	ANSI/HI 14.6 - Grade 2B



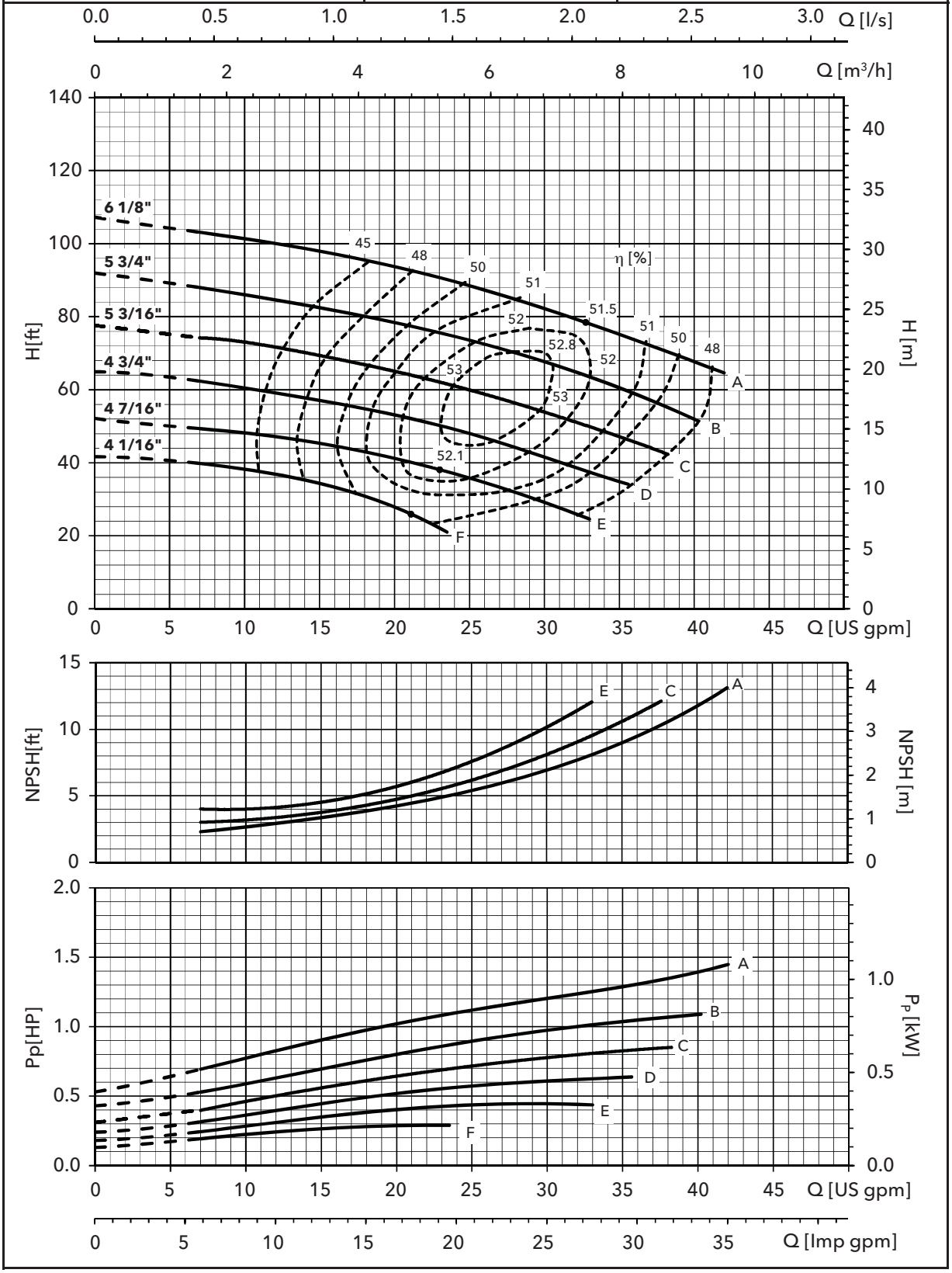
PERFORMANCE CURVES – 60 HZ, 1750 RPM
CURVAS DE FUNCIONAMIENTO – 60 HZ, 1750 RPM

3ST 1.5x2-6	1750 rpm	ANSI/HI 14.6 - Grade 2B



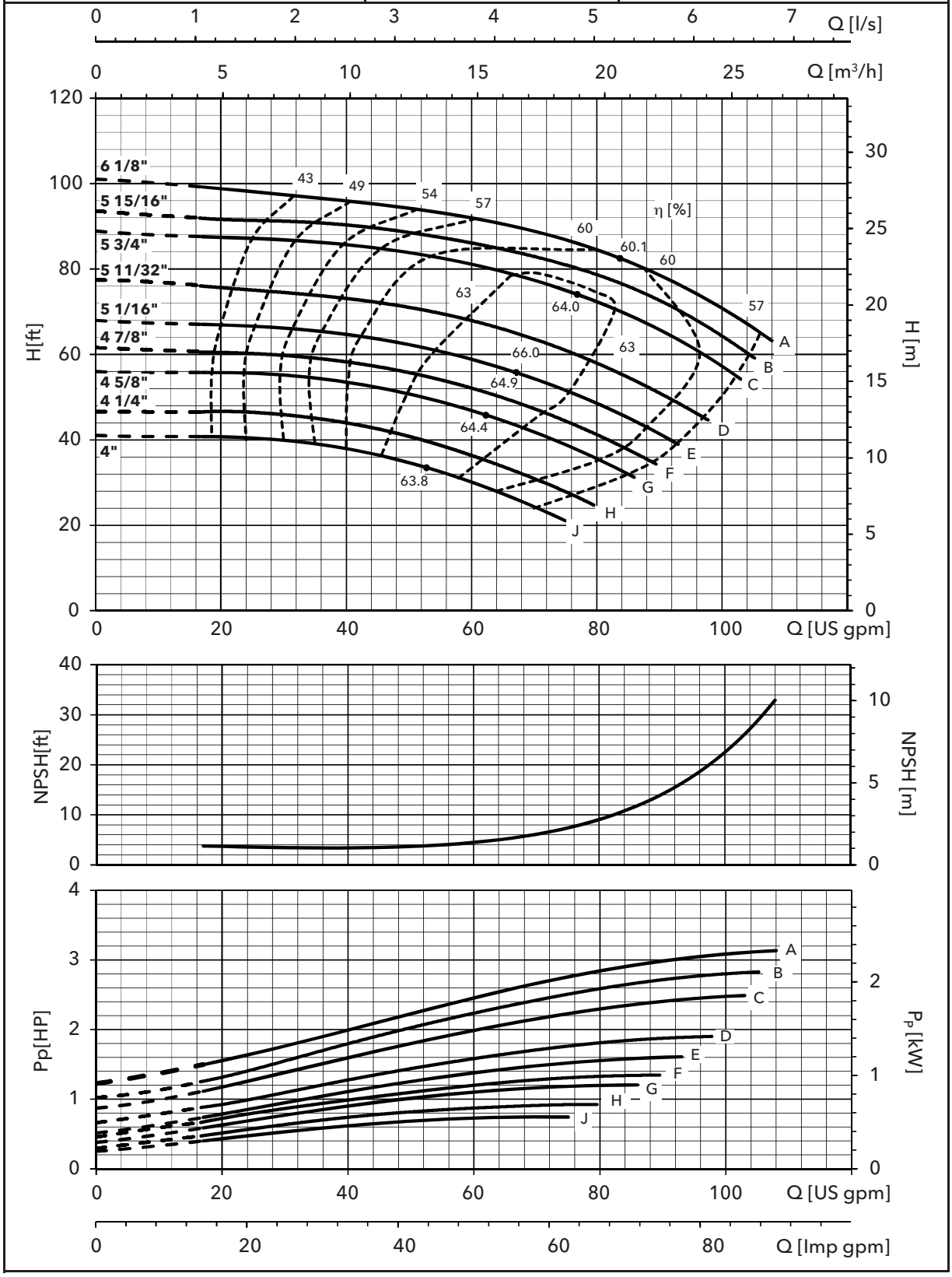
PERFORMANCE CURVES – 50 HZ, 2900 RPM
CURVAS DE FUNCIONAMIENTO – 50 HZ, 2900 RPM

1ST 1x1.25 - 6	2900 rpm	ANSI/HI 14.6 - Grade 2B



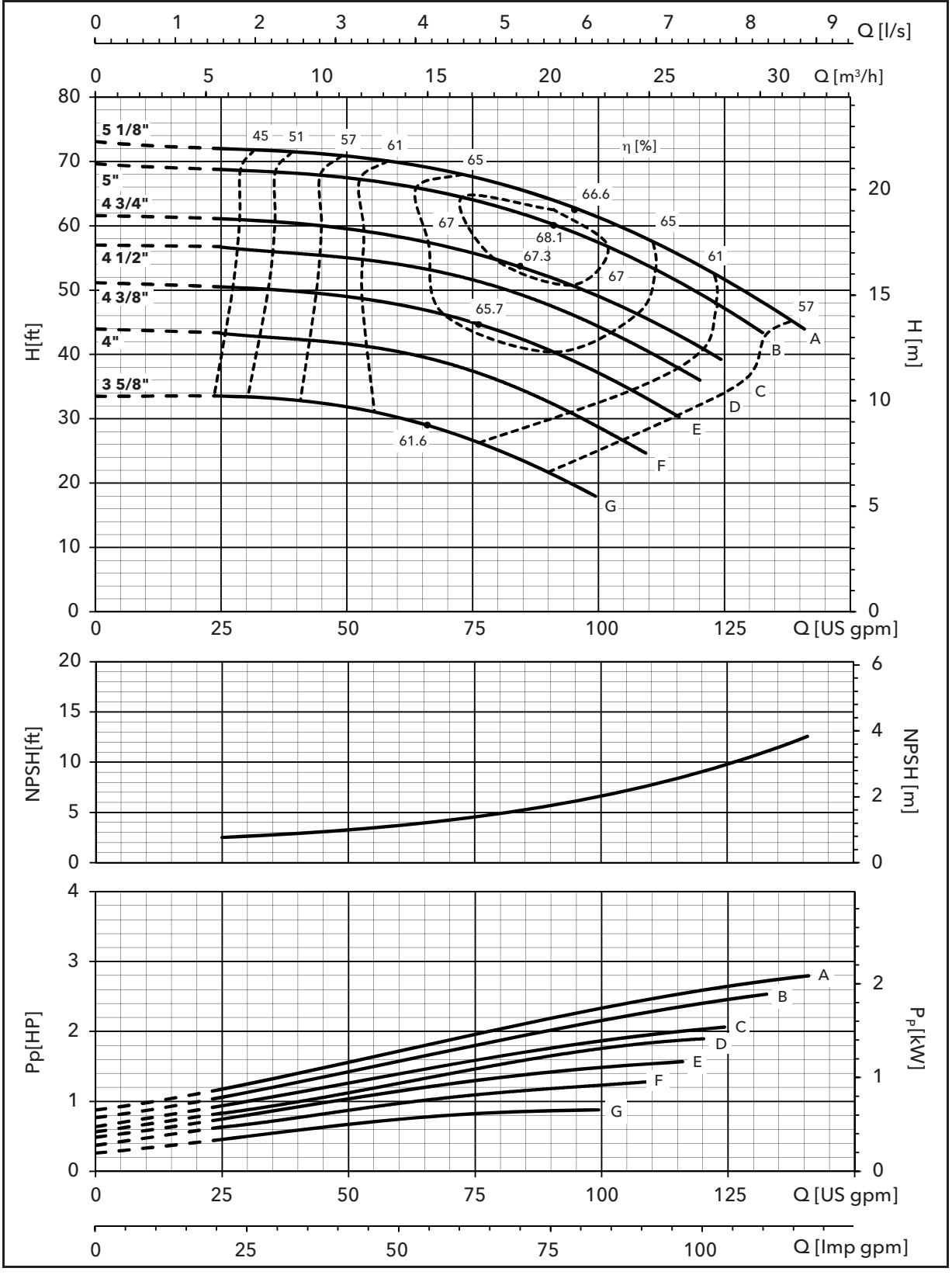
PERFORMANCE CURVES – 50 HZ, 2900 RPM
CURVAS DE FUNCIONAMIENTO – 50 HZ, 2900 RPM

2ST 1.25x1.5-6	2900 rpm	ANSI/HI 14.6 - Grade 2B



PERFORMANCE CURVES – 50 HZ, 2900 RPM
CURVAS DE FUNCIONAMIENTO – 50 HZ, 2900 RPM

3ST 1.5x2-6	2900 rpm	ANSI/HI 14.6 - Grade 2B



MOTOR SIZING TABLES
TABLAS DE DIMENSIONAMIENTO DE MOTORES

1ST MOTOR SIZING (2-POLE, 3500 RPM)

Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	6.13	2	2
B	5.75	1.5	2
C	5.19	1.5	1.5
D	4.75	1	1.5
E	4.44	0.75	1
F	4.06	0.50	0.50

1ST MOTOR SIZING (4-POLE, 1750 RPM)

Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	6.13	0.50	0.50
B	5.75	0.50	0.50
C	5.19	0.50	0.50
D	4.75	0.50	0.50
E	4.44	0.50	0.50
F	4.06	0.50	0.50

2ST MOTOR SIZING (2-POLE, 3500 RPM)

Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	6.13	5	7.5
B	5.94	5	5
C	5.75	5	5
D	5.34	3	5
E	5.06	2	3
F	4.88	2	3
G	4.63	2	3
H	4.25	1.5	2
J	4.00	1	1.5

2ST MOTOR SIZING (4-POLE, 1750 RPM)

Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	6.13	0.75	0.75
B	5.94	0.75	0.75
C	5.75	0.50	0.75
D	5.34	0.50	0.50
E	5.06	0.50	0.50
F	4.88	0.50	0.50
G	4.63	0.50	0.50
H	4.25	0.50	0.50
J	4.00	0.50	0.50

3ST MOTOR SIZING (2-POLE, 3500 RPM)

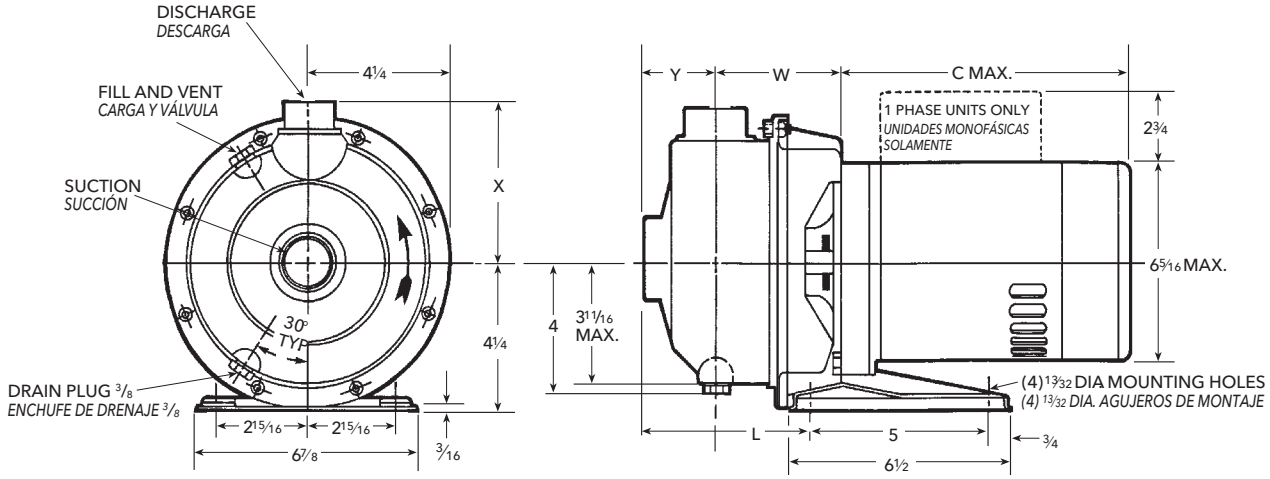
Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	5.13	5	5
B	5.00	5	5
C	4.75	3	5
D	4.50	3	5
E	4.38	2	3
F	4.06	2	2
G	3.63	1.5	1.5

3ST MOTOR SIZING (4-POLE, 1750 RPM)

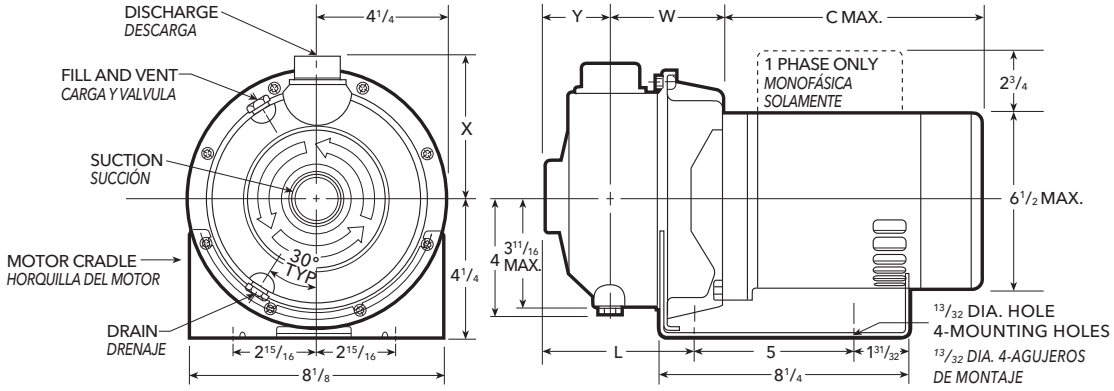
Impeller Code, *Código de impulsor*	Impeller Dia. (in), *Diá. del impulsor (pulg.)*	Motor Selection 1.15SF (HP), *Selección de motor*	Motor Selection 1.0SF (HP), *Selección de motor*
A	5.13	0.75	0.75
B	5.00	0.75	0.75
C	4.75	0.5	0.5
D	4.50	0.5	0.5
E	4.38	0.5	0.5
F	4.06	0.5	0.5
G	3.63	0.5	0.5

NPE CLOSE COUPLED – DIMENSIONS, WEIGHTS AND SPECIFICATIONS
NPE ACOPLE CERRADO – DIMENSIONES, PESOS Y ESPECIFICACIONES

Clockwise Rotation Viewed from Drive End
Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor



ODP* and TEFC* ½, ¾ and 1 HP (standard), *ODP* y TEFC* ½, ¾ y 1 HP (estándar)*



ODP* and TEFC* 1½, 2, 3 and 5 HP (standard), *ODP* y TEFC* 1½, 2, 3 y 5 HP (estándar)*

SPECIFICATIONS - *ESPECIFICACIONES*

Capacities to:
85 GPM (322L/min) at 1750 RPM
170 GPM (643L/min) at 3500 RPM

Heads to:
39 feet (12 m) at 1750 RPM
150 feet (46 m) at 3500 RPM

Working pressures to:
125 PSIG (9 bars)

Maximum temperatures to:
250° F (121° C)

Direction of rotation:
Clockwise when viewed from motor end.

Motor specifications:
NEMA 56J frame, 1750 RPM, ½ HP. 3500 RPM ½ through 5 HP. Open drip-proof, totally enclosed fan-cooled or explosion proof enclosures*. Stainless steel shaft with ball bearings.

Single phase: Voltage 115/230 ODP* and TEFC*. (3 and 5 HP model – 230 V only) Built-in overload with auto-reset provided.

Three phase: Voltage 208-230/460 ODP*, TEFC* and EX PROOF*.

NOTE: For three phase motors, overload protection must be provided in starter unit. Starter and heaters must be ordered separately.

* Premium efficiency where required by Department of Energy regulations.

Capacidades:
85 GPM (322L/min) a 1750 RPM
170 GPM (643L/min) a 3500 RPM

Cargas:
39 pies (12 m) a 1750 RPM
150 pies (46 m) a 3500 RPM

Presión de trabajo:
125 PSIG (9 baras)

Temperatura máxima:
250 ° F (121 ° C)

Dirección de rotación:
En dirección de las agujas del reloj visto desde el extremo final del motor.

Motores:
Armazón 56J NEMA, 1750 RPM ½ HP. 3500 RPM ½ a 5 HP. Cubiertas abiertas resguardadas, totalmente encerradas enfriadas por ventilador o a prueba de explosiones. Eje de acero inoxidable con balineras de bolas.*

Monofásicos: *Voltaje 115/230 ODP* y TEFC*. (modelo 3 y 5 HP – 230 voltios solamente) Se proporciona protección térmica contra sobrecarga construida con reseteo automático.*

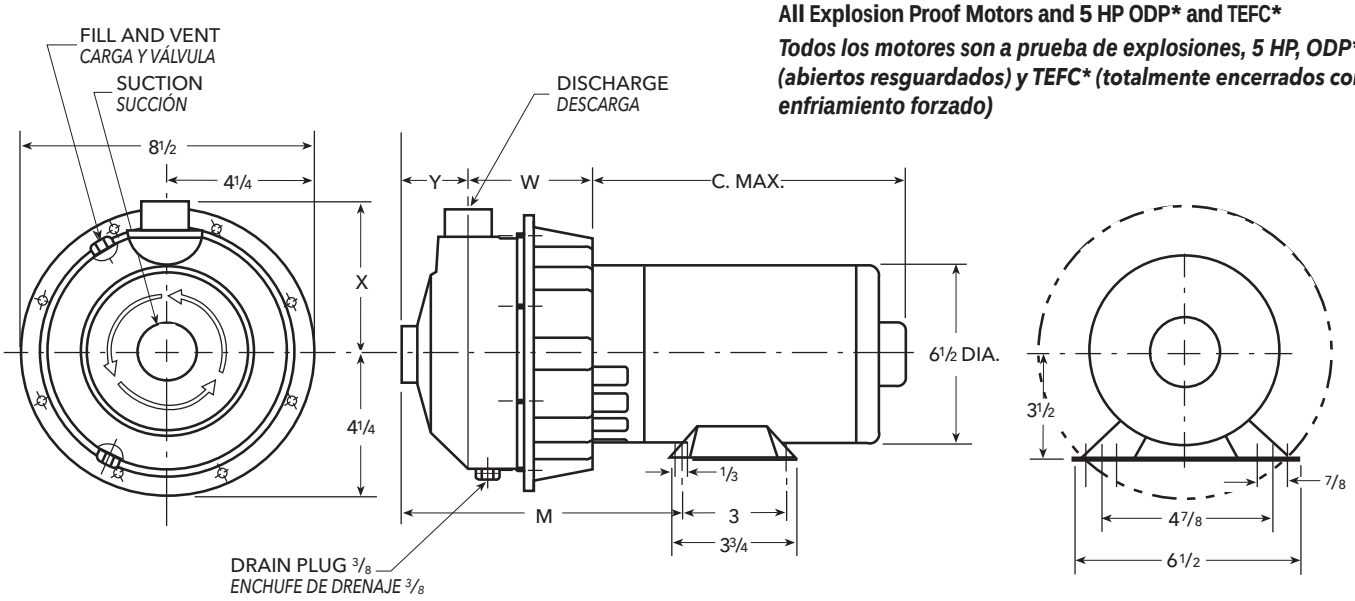
Trifásicos: *Voltaje 208-230/460 ODP*, TEFC* y EX PROOF*.*

NOTA: *Para motores trifásicos se debe de proporcionar la protección térmica contra sobrecarga en la unidad de arranque. El arrancador y los calentadores se deben pedir por separado.*

* *Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

NPE CLOSE COUPLED WITH FOOTED MOTOR, EXPLOSION-PROOF* AND 5 AND 7.5 HP MOTORS
NPE ACOPLE CERRADO CON MOTOR CON PATAS, MOTORES A PRUEBA DE EXPLOSIÓN Y 5 Y 7.5 HP

All Explosion Proof Motors and 5 HP ODP* and TEFC*
Todos los motores son a prueba de explosiones, 5 HP, ODP* (abiertos resguardados) y TEFC* (totalmente encerrados con enfriamiento forzado)



Dimensions – Determined by Pump,
Dimensiones - Determinadas por la Bomba

Pump, *Bomba*	Suction, *Succión*	Discharge, *Descarga*	HP	W	X	Y	L	M
1ST	1¼	1	½ – 3	3 5/16	4⅜	2	4 9/16	7 5/16
2ST	1½	1¼	¾ – 5	3¾	4½	2⅛	5⅛	8½
3ST	2	1½	1 – 5	3¾	4⅝	2⅛	5⅛	8½

Available Motor Weights and Dimensions
Pesos y Dimensiones Disponibles del Motor

HP	Motor Weights, *Pesos del Motor*						C Max. Length, *(Longitud)*	P Max.
	1 Phase, *Monofásicos*			3 Phase, *Trifásicos*				
	ODP*	TEFC*	EXP*	ODP*	TEFC*	EXP*		
½	23	29	45	24	23	27	11 3/16	7 7/16
¾	30	35	41	24	26	30	11 5/16	7
1	26	36	49	25	34	30	11 5/16	7 3/16
1½	28	51	56	29	34	37	13 7/16	7 3/16
2	34	46	60	35	34	44	13 7/16	7
3	42	51	–	39	45	44	13 13/16	7 3/16
5	48	–	–	45	48	–	12 5/16	6½

Dimensions in inches, weights in pounds.
Dimensiones en pulgadas, pesos en libras.

* Premium efficiency where required by Department of Energy regulations.

** Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

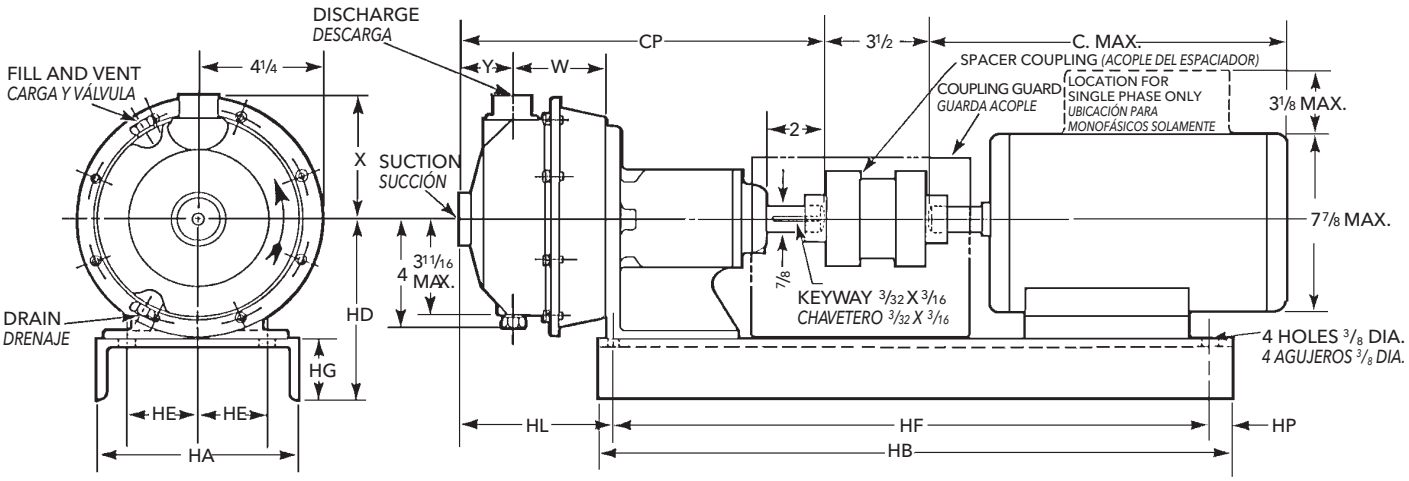
NOTES:

1. Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 – 6 lbs.-ft.
2. Motor dimensions may vary with motor manufacturers.
3. Dimensions in inches, weights in pounds.
4. For explosion proof* motor dimensions consult factory for information.
5. Not to be used for construction purposes unless certified.

NOTAS:

1. *Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 – 6 libras-pies.*
2. *Las dimensiones del motor puede que varíen con los fabricantes.*
3. *Dimensiones en pulgadas, pesos en libras.*
4. *Para las dimensiones de los motores a prueba de explosión* consultar con la fábrica para información.*
5. *No usar para propósitos de construcción sin certificar.*

NPE FRAME MOUNTED – DIMENSIONS, WEIGHTS AND SPECIFICATIONS
NPE ARMAZÓN MONTADO – DIMENSIONES, PESOS Y ESPECIFICACIONES



SPECIFICATIONS
ESPECIFICACIONES

Capacities to:
85 GPM (322L/min) at 1750 RPM
170 GPM (643L/min) at 3500 RPM

Heads to:
39 feet (12 m) at 1750 RPM
150 feet (47 m) at 3500 RPM

Working pressures to:
125 PSIG (9 bars)

Maximum temperatures to: 250°F (121°C)

Direction of rotation:
Clockwise when viewed from motor end.

Motor specifications:
T-frame single and three phase. Open drip-proof*, TEFC* or explosion proof* enclosures are available for 60 Hz, 3500 and 1750 RPM operation.

For three phase motors, overload protection must be provided in starter unit. Starter and heaters must be ordered separately.

* Premium efficiency where required by Department of Energy regulations.

Capacidades:
85 GPM (322L/min) a 1750 RPM
170 GPM (643L/min) a 3500 RPM

Cargas:
39 pies (12 m) a 1750 RPM
150 pies (47 m) a 3500 RPM

Presión de trabajo:
125 PSIG (9 baras)

Temperatura máxima:
250°F (121°C)

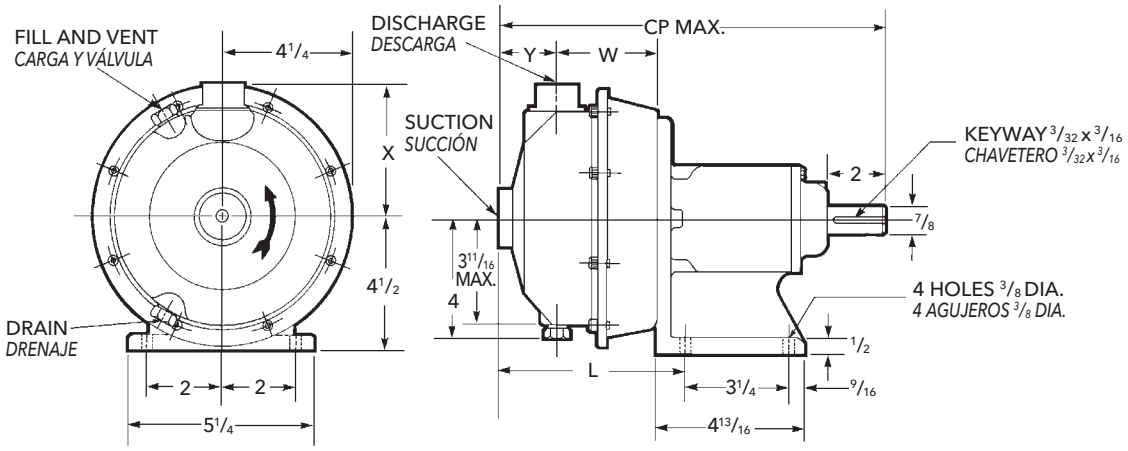
Dirección de rotación: *En dirección de las agujas del reloj visto desde el extremo final del motor.*

Motores:
Armazón T- monofásico y trifásico. A prueba de goteo, TEFC* o recintos a prueba de explosión* están disponibles para funcionamiento de 60 Hz, 3500 y 1750 RPM.*

Para motores trifásicos se debe de proporcionar la protección térmica contra sobrecarga en la unidad de arranque. El arrancador y los calentadores se deben pedir por separado.

** Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

NPE-F



NPE FRAME MOUNTED – DIMENSIONS, WEIGHTS AND SPECIFICATIONS
NPE ARMAZÓN MONTADO – DIMENSIONES, PESOS Y ESPECIFICACIONES

Dimensions and Weights
Dimensiones y Pesos

Dimensions and Weights – Determined by Pump,
Dimensiones y Pesos – Determinados por la Bomba

Pump, *Bomba*	Suct. NPT, *Succión NPT*	Disch. NPT, *Descarga NPT*	CP	L	W	X	Y	Wt., *Peso*	Dim. "HL" Determined by Pump and Motor, *Dim. "HL" Determinadas por la Bomba y el Motor* Frame, *Armazón*		
									56	140	180
1ST	1¼	1	12 15/16	6 7/16	3 5/16	4⅜	2	22½	4 9/16		6 7/16
2ST	1½	1¼	13½	7	3¾	4½	2 1/8	23	5⅛		7
3ST	2	1½				4⅝					

Available Motor and Bedplate Dimensions and Weights,
Pesos y Dimensiones Disponibles de la Fundación y del Motor

Motor Frame, *Armazón del Motor*	HA	HB	HD	HE	HF	HG	HP	Wt. Max., *Peso Máx*	Shims, *Deflector*
56 143T 145T	8	26	6⅞	3⅛	22⅜	2⅜	1	30	1"
182T 184T	10	26	7¼	3¾	24	2¾	⅞	43	–

Frame Size, *Tamaño del Armazón*	Horsepower, *Fuerza* 3500 RPM				C Max.	Wt. Max., *Peso Máx.*	P Max.
	Single Phase, *Monofásicos*		Three Phase, *Trifásicos*				
	ODP	TEFC	ODP	TEFC			
56	½ – 1½	½ – 1½	½ – 1	½ – 1	10 13/16	37	7 3/16
143T	–	–	1½	1½	9 13/16	41	7 3/16
145T	2	2	1½ – 3	1½ – 2	11 11/16	52	7 3/16
182T	3	3	5	3	12 3/16	76	7⅞
184T	5	5	–	5	15⅛	117	10¼

NOTES:

1. Pump will be shipped with top vertical discharge position as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten 6mm bolts to 5 – 6 lbs.-ft.
2. Motor dimensions may vary with motor manufacturers.
3. Dimensions in inches, weights in pounds.
4. For explosion proof* motor dimensions consult factory for information.
5. Not to be used for construction purposes unless certified.

NOTAS:

1. *Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y reemplazar y apretar los tornillos de 6mm a 5 – 6 libras-pies.*
2. *Las dimensiones del motor puede que varíen con los fabricantes.*
3. *Dimensiones en pulgadas, pesos en libras.*
4. *Para las dimensiones de los motores a prueba de explosión* consultar con la fábrica para información.*
5. *No usar para propósitos de construcción sin certificar.*

* Premium efficiency where required by Department of Energy regulations.

** Eficacia superior donde se requiera por el Ministerio de regulaciones de la Energía.*

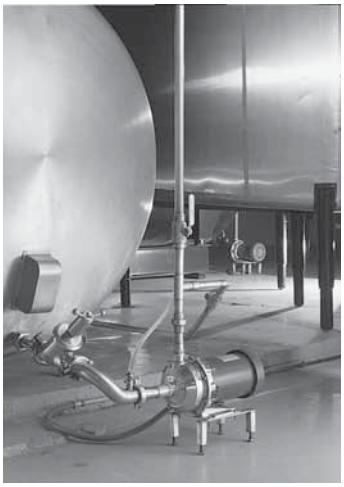
TYPICAL APPLICATIONS, *APLICACIONES TÍPICAS*

Specifically designed for a broad range of general applications traditionally requiring various materials such as all iron, bronze fitted or all bronze construction.

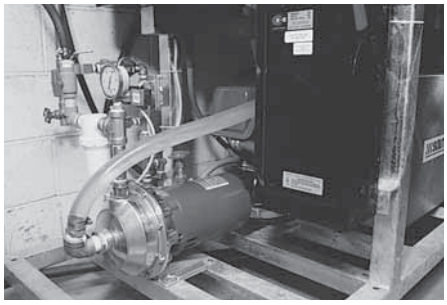
Diseñadas específicamente para una amplia variedad de aplicaciones generales, requiriendo tradicionalmente varios materiales, tales como hierro, bronce empotrado o todas las construcciones de bronce.

- Water circulation
- Booster service
- Liquid transfer
- Spray system
- Chillers
- Washing/cleaning systems
- Injection molding cooling
- Reverse osmosis
- Air scrubbers
- Heat exchangers
- Filtration systems
- Jockey pumps
- OEM applications
- General water services

- *Circulación de agua*
- *Aumento de presión*
- *Transferencia de líquidos*
- *Sistemas de aspersión*
- *Enfriadores*
- *Sistemas de lavado/ limpieza*
- *Enfriamiento con molde por inyección*
- *Osmosis reversa*
- *Depuradores de aire*
- *Termopermutadores*
- *Sistemas de filtración*
- *Bombas auxiliares*
- *Aplicaciones OEM*
- *Servicios generales de agua*

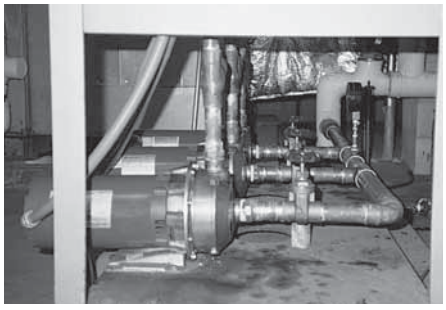


Brewery, *Fábrica de Cerveza*

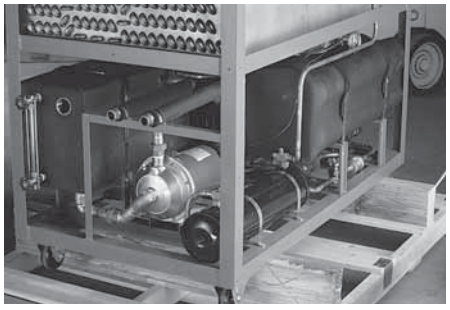


Car Wash, *Lavadero de Autos*

Pure Water/OEM, *Agua Pura/OEM*



Pressure Booster System, *Sistema de Aumento de Presión*



Chiller, *Enfriador*

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Let's Solve Water

Xylem Inc.
2881 East Bayard Street Ext., Suite A
Seneca Falls, NY 13148
Phone (*Teléfono*): (866) 673-0428
Fax: (888) 322-5877
www.xylem.com/goulds

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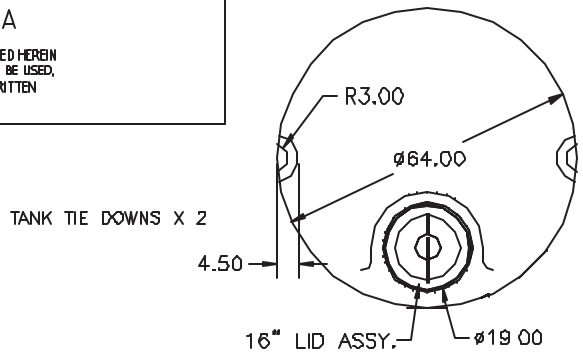
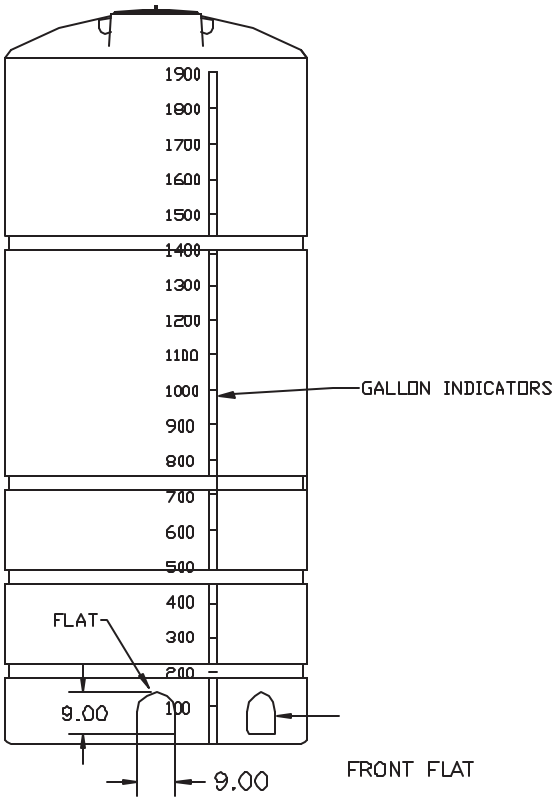
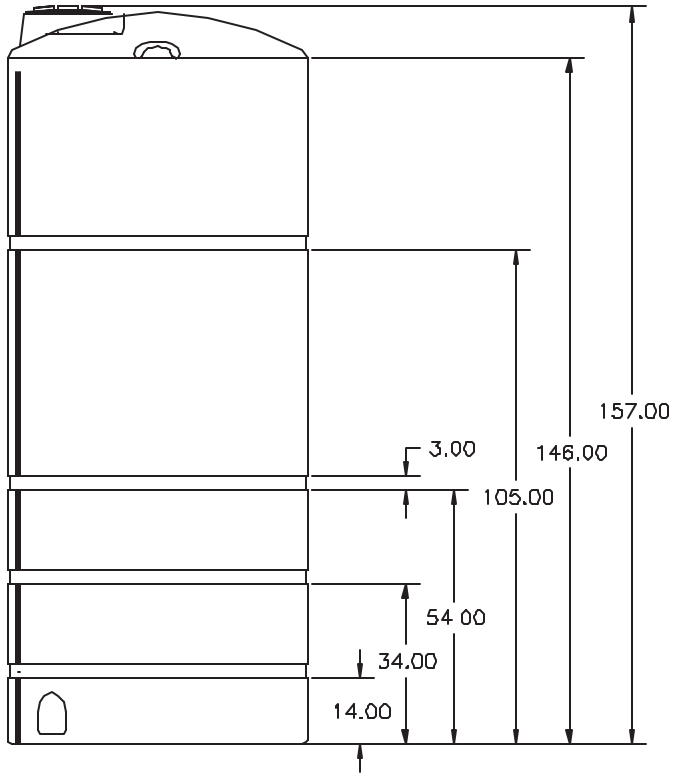


1. HEAVY DUTY POLYETHYLENE CONSTRUCTION
2. 1 PIECE ROTATIONALLY MOLDED
3. TRANSLUCENT
4. FDA APPROVED RESIN
5. CALIBRATED IN GALLONS
6. THREE YEAR WARRANTY
7. UV STABILIZED





REV	DESCRIPTION	DATE	APPRD

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± 1% @ 68° F

DRAWN / DATE
REH 5/8/98

APPRD. / DATE
REH 5/8/98

THIRD ANGLE PROJECTION
ANSI 14.5M

MATERIAL

HDPE OR EQUIVALENT
REFERENCE MATERIAL DATA SHEET
FOR SPECIFIC PROPERTIES.

NOTES:
1. 2.7 % SHRINK ALLOWANCE
2. SHOT WEIGHT 654 LBS.
3. BLUE, GREEN, BLACK, WHITE OR YELLOW COLOR

Ace Roto-Mold
A DIVISION OF DON HARTOG INDUSTRIES, INC.
4118 HWY. 61 BLVD., BOX 421, HOSPERS, IOWA 51238

CLIENT / DESCRIPTION
2000 GALLON VERTICAL TANK

SCALE
N.S.

PART NO.
VT2000-64

FLOAT SWITCH

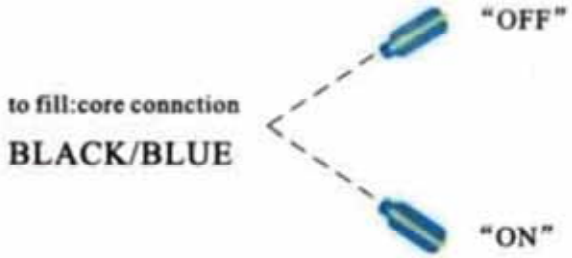
AUTOMATIC ADJUSTABLE
EASYTOINSTALL
RELIABLE
MAINTENANCE FREE
ENVIRONMENTALPROTECTION

WIRING CONNECTION

Blue=the "ON" switch action below is to fill

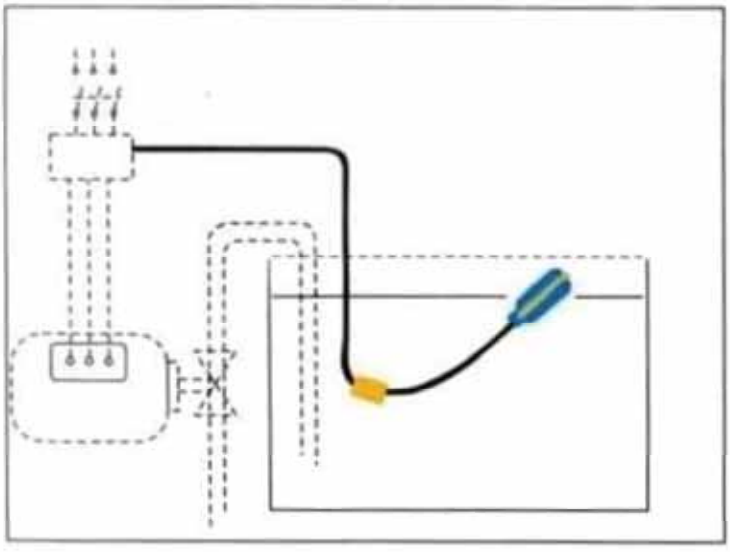
Black

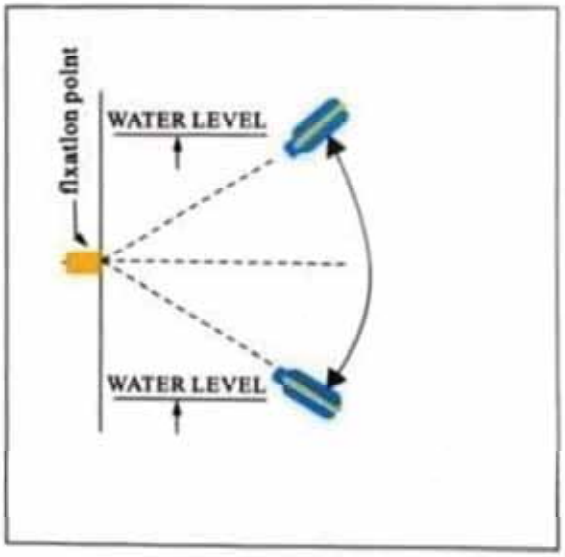
brown=the "ON" switch on high is to empty



TECHNICALCALDATES

Microswitch:	10(8)A250V~10（4）A380V
Switch currency:	⊣⊢
	≥50 000 switch workings
Protective connection:	□T70U" ⑧
Protection:	Waterproof"
Max.temperature:	70℃
Working pressure:	max.1bar
Circuitbreaking capacity:	directly 2KW with 250V





EASY OPERATION

The desired "ON"or"OFF"differential is obtained by simply lengthening or shortening the free cord fixation point. "ON"and"OFF"switch action may be adjusted to any desired liquid level by moving the cord fixation in up or down direction.

APPLICATION

The float switch "HUTO"is a switch which regulates fluid level in the tank or well etc, The float switch is resistant to water(sewage water),it is relative capable of being used for oil,most acids and alkalis.The float switch is not exploaion proof.

Submittal #6 Sump Pump #HDPS33W

Internet #308300779 Model #HDPS33W UPC Code #858001008736 Store SKU #1004118379 Store SO SKU #100403270

Live Chat
Feedback

Top Rated

Everbilt

1/3 HP Submersible Aluminum Sump Pump with Tethered Switch

★★★★☆ (298) Questions & Answers (31)

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Have a question?
Chat with a Home Depot expert.
CHAT NOW

$119.00

Pay **$94.00** after **$25 OFF** your total qualifying purchase upon opening a new card.
Apply for a Pro Xtra Credit Card

Maximum Horsepower (hp): **1/3**

~~1/4~~ **1/3** 1/2

Pickup at Bellport Delivering to 11980

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Unavailable

Delivery
Today
51 available

Get it as soon as today. Schedule your delivery in checkout.

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Get Expert Plumbing Repair

Need help fast? Call 1-855-466-3337

Request plumbing repair service

What to Expect

Protect This Item

Select a Home Depot Protection Plan by Allstate for:

2 Year / **$18.00**

No thanks

What to Expect

- 1 + Add to Cart

Add to List | Add to Quote

Product Details

Specifications

Dimensions: H 10.63 in, W 8.27 in, D 6.3 in

Dimensions

Product Depth (in.)	6.3 in
Product Height (in.)	10.63 in
Product Width (in.)	8.27 in
Switch-Off Height (in.)	3.94
Switch-On Height (in.)	11.81

Details

Amperage (amps)	15
Cord Length (ft.)	8.25

Live Chat Feedback

Live Chat

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Discharge Flow @ 0 ft. (gallons/hour)	2580
Discharge Flow @ 0 ft. (gallons/min)	43
Discharge Flow @ 10 ft. (gallons/hour)	2160
Discharge Flow @ 10 ft. (gallons/min)	36
Discharge Flow @ 15 ft. (gallons/min)	33
Features	Bottom/End Suction, Non-Clogging, Self-Priming, Solids Handling, Submersible, Thermal Overload Protection
Housing Material	Aluminum
Impeller Material	Plastic
Maximum Horsepower (hp)	1/3
Maximum Pressure (psi)	9.96
Maximum Working Temperature (F)	100
Minimum Sump Basin Diameter	18 or More
Minimum working temperature (F)	35
Outlet Diameter Connection (in.)	1-1/2 FPT
Pack Size	1
Power Type Required	AC
Product Weight (lb.)	8.49 lb
Pump Switch Type	Tethered
Returnable	90-Day
Vertical Lift (ft.)	23
Voltage	115v

Warranty / Certifications

Certifications and Listings	CSA Certified
Manufacturer Warranty	1 year

How can we improve our product information? Provide feedback.

Questions & Answers

31 Questions

Customer Reviews

4.2 out of 5 ★★★★☆ (298)

Frequently Bought Together

Select Select Select

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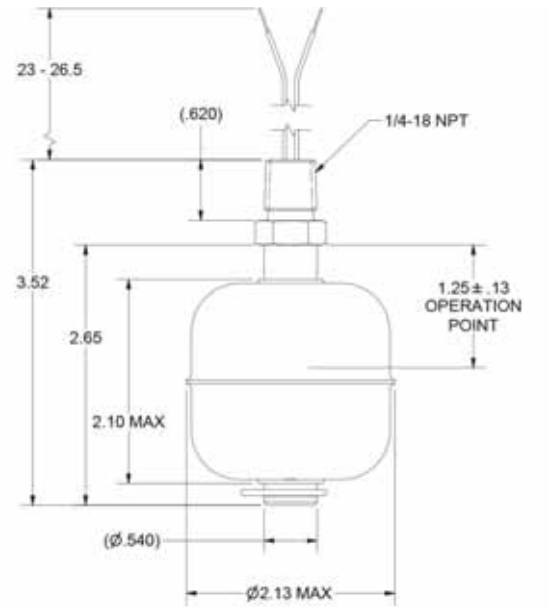
Sensing Solutions since 1959

Model # M5600 Technical Data Sheet

Float switch, stainless steel, 1/4" NPT, 60 watt



Applications:

- Detects high/low levels in a container
- 316 SS is frequently used in food processing
- Ideal for high-temperature, medical and petrochemical applications, as well as plating processes
- Suitable in applications where superior corrosion resistance is required
- All NPT vertical switches can be extended with pipe to meet custom tank depths

Madison Company, Inc.
27 Business Park Drive
Branford, CT 06405

203-488-4477 or 800-466-5383
info@madisonco.com
www.madisonco.com

MADE IN THE USA

Sensing Solutions since 1959

Model # M5600 Technical Data Sheet

Float switch, stainless steel, 1/4" NPT, 60 watt

Specifications:

Approvals	CE, UL Haz. Loc., CSA Haz. Loc., NSF
Electrical Ratings	240 VAC, 0.40A; 120 VAC, 0.50A; 120 VDC, 0.20A; 24 VDC, 0.50A
Float Material	316 Stainless Steel
Float SG	0.55
Lead Wires	24", 22 AWG, Teflon Insulated
Max Pressure	200 PSI
Max Temperature	392°F (200°C)
Mounting	1/4" NPT
Note	Electrical Switch Ratings are shown for resistive loads as tested by UL at different voltages. See our Electrical Considerations for typical inductive or capacitive load considerations. The wire clips are made to be removed and replaced up to 10 times, while maintaining a holding force of 3 lb.
Stem Material	316 Stainless Steel
Switch Rating	60 Watt, SPST
Type	Full Size Switch

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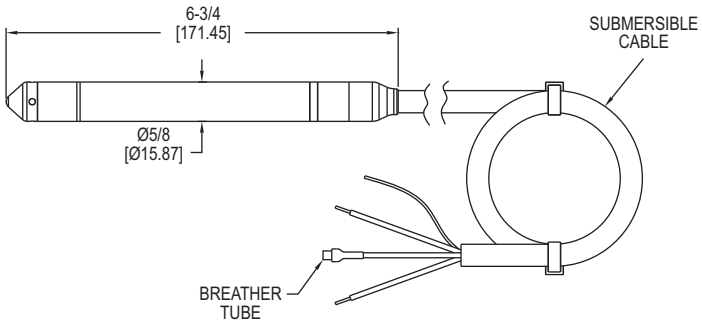
MADE IN THE USA

Dwyer

SERIES MBLT

MINIATURE SUBMERSIBLE LEVEL TRANSMITTER

Only 0.63″ (16 mm) in Diameter, Perfect for Wells and Boreholes, Low Power Models for Telemetry Systems



The **Series MBLT Miniature Submersible Level Transmitter** measures the height of liquid above the position in the tank referenced to atmospheric pressure. The transmitter consists of a piezoresistive sensing element, encased in a 0.63″ (16 mm) diameter 316 SS housing.

BENEFITS/FEATURES
- Fits narrow installation openings with slender 0.63″ (16 mm) diameter design
- Constructed for years of trouble free service with welded 316 SS body and 316 SS nose cap
- Prevents damage or snares when removing the unit from the installation with tapered 316 SS body top
- More precise than BFSL or BSL rated output with ±0.10% or ±0.25% FS accuracy output
- Eliminates particulate or water droplets from entering the transducer using maintenance-free filter
- Excellent chemical compatibility with choice of polyether polyurethane or ETFE cable materials
- Eliminate both power supply surges and lightning ground strike transients with incorporated lightning and surge protection, (surge protection is not guaranteed and is not covered by warranty)

APPLICATIONS
- Ballast tanks
- Ground water monitoring
- Surface water monitoring
- Dewatering
- Down hole
- Remote telemetry
- Remote flood monitoring
- Narrow conduit or pipe installations
- Remediation and environmental monitoring

SPECIFICATIONS

Service: Compatible liquids.
Wetted Materials: Body and nose: 316 SS; Cable: Polyether polyurethane or ETFE; Seals: Fluoroelastomer; Label: Polyolefin.
Accuracy: ±0.25% or ±0.10% FS**.
Temperature Limits: -4 to 176°F (-20 to 80°C).
Compensated Temperature Limits: 0.25%: (0 to 70°C); 0.10%: (0 to 60°C).
Thermal Effect: 0.25%: ±0.45% FS TEB; 0.10%: ±0.30% FS TEB.
Pressure Limit: 2x FS.
Power Requirements: Current output: 10-33 VDC; Voltage output: 8-33 VDC; 5 mA max (no load).
Output Signal: 4-20 mA DC 2-wire or 0-5 V* (model depending).
Response Time: < 50 ms.
Max Loop Resistance: 1000 Ω @ 30 VDC (current output).
Voltage Output Impedence: 10 Ω + 4.4 Ω / 100´ cable (voltage output).
Electrical Connections: Wire pigtail.
Mounting Connection: Suspended below point being monitored.
Electrical Protection: Surge/lightning protected per EN61000-4-5, Class 5.
Weight: Body: 0.235 lb (0.107 kg); Cable: 0.037 lb (0.017 kg) per foot.
Compliance: CE.

*Consult factory for additional outputs.
**4.3 to 4.9 psi (10 to 11.54 in w.c.) configured ranges ±0.30% FS accuracy.

MODEL CHART

4-20 mA output Model ±0.10%	4-20 mA output Model ±0.25%**	0-5 V output Model ±0.25%**	Range psi (´ w.c.) [m w.c.]	Cable Length	Cable Type
-	MBLT-2SC-IVPP-5-40	MBLT-2SC-VVPP-5-40	5 (11.54) [3.52]	40´	Polyether polyurethane
-	MBLT-2SC-IVPF-15-40	MBLT-2SC-VVPF-15-40	6.50 (15) [4.57]	40´	Polyether polyurethane
-	MBLT-2SC-IVPM-5-12.2	MBLT-2SC-VVPM-5-12.2	7.10 (16.40) [5]	12.2 m	Polyether polyurethane
-	MBLT-2SC-IVPM-10-30**	MBLT-2SC-VVPM-10-30**	14.22 (32.84) [10]	9.14 m	Polyether polyurethane
MBLT-2SB-IVPF-20-40	MBLT-2SC-IVPF-20-40	MBLT-2SC-VVPF-20-40	8.66 (20) [6.10]	40´	Polyether polyurethane
MBLT-2SB-IVPF-30-50	MBLT-2SC-IVPF-30-50	MBLT-2SC-VVPF-30-50	12.99 (30) [9.14]	50´	Polyether polyurethane
MBLT-2SB-IVPM-10-15.2	MBLT-2SC-IVPM-10-15.2	MBLT-2SC-VVPM-10-15.2	14.21 (32.81) [10]	15.2 m	Polyether polyurethane
MBLT-2SB-IVPF-50-70	MBLT-2SC-IVPF-50-70	MBLT-2SC-VVPF-50-70	21.65 (50) [15.24]	70´	Polyether polyurethane
MBLT-2SB-IVPM-20-26	MBLT-2SC-IVPM-20-26	MBLT-2SC-VVPM-20-26	28.42 (65.62) [20]	26 m	Polyether polyurethane
MBLT-2SB-IVPM-30-36	MBLT-2SC-IVPM-30-36	MBLT-2SC-VVPM-30-36	42.63 (98.43) [30]	36 m	Polyether polyurethane
MBLT-2SB-IVPF-100-120	MBLT-2SC-IVPF-100-120	MBLT-2SC-VVPF-100-120	43.31 (100) [30.48]	120´	Polyether polyurethane
MBLT-2SB-IVPM-40-46	MBLT-2SC-IVPM-40-46	MBLT-2SC-VVPM-40-46	56.83 (131.23) [40]	46 m	Polyether polyurethane
MBLT-2SB-IVPF-150-170	MBLT-2SC-IVPF-150-170	MBLT-2SC-VVPF-150-170	64.96 (150) [45.72]	170´	Polyether polyurethane
MBLT-2SB-IVPM-60-66	MBLT-2SC-IVPM-60-66	MBLT-2SC-VVPM-60-66	85.25 (196.85) [60]	66 m	Polyether polyurethane
MBLT-2SB-IVPF-200-220	MBLT-2SC-IVPF-200-220	MBLT-2SC-VVPF-200-220	86.62 (200) [60.96]	220´	Polyether polyurethane
MBLT-2SB-IVPF-350-370	MBLT-2SC-IVPF-350-370	MBLT-2SC-VVPF-350-370	151.58 (350) [106.68]	370´	Polyether polyurethane
MBLT-2SB-IVPM-100-106	MBLT-2SC-IVPM-100-106	MBLT-2SC-VVPM-100-106	142.09 (328.08) [100]	106 m	Polyether polyurethane
MBLT-2SB-IVPM-200-206	MBLT-2SC-IVPM-200-206	MBLT-2SC-VVPM-200-206	284.18 (656.17) [200]	206 m	Polyether polyurethane
MBLT-2SB-IVPF-690-710	MBLT-2SC-IVPF-690-710	MBLT-2SC-VVPF-690-710	298.83 (690) [210.31]	710´	Polyether polyurethane

**4.3 to 4.9 psi (10 to 11.54 in w.c.) configured ranges ±0.30% FS accuracy.

OPTIONS

For custom ranges, cable lengths, or ETFE cable, contact the website.

ACCESSORIES

Model	Description
A-297	Dessicant filter for vent tube. Removes humidity for protection of the sensor. Changes color to show saturation

A-297

ProSense® SPT25 Series Pressure Transmitters

The ProSense SPT25 pressure transmitter series is engineered to meet many industrial, commercial, and OEM pressure measurement applications. The all stainless steel welded thin film sensing element provides very fast response time and is compatible with many different media sensing applications. With a robust design resistant to vibration, shock, and EMI/RFI, the SPT25 series provides high accuracy over a wide compensated temperature range. Pressure sensing ranges from vacuum to 5000 psig are available along with a ¼ inch NPT male threaded process connection. Choose from linear outputs of 4-20 mA or 0-10VDC with electrical connections of either a DIN 175301-803C L-connector or 6.6 foot (2 m) integral shielded cable.

Applications

- Process control & automation
- Pump & compressor control
- Hydraulic systems
- Pneumatic systems
- Engine monitoring
- Refrigeration equipment
- Presses
- Machine tools

Features

- All stainless steel welded sensing element
- Fast response time
- Pressure sensing ranges from vacuum to 5000 psig
- 1/4 inch NPT male threaded process connection
- Output options: 4-20 mA or 0-10 VDC
- Integral 6.6 foot shielded cable or DIN form C electrical connections
- Made in the USA
- CE marked
- 3-year warranty

Click on the thumbnail or go to https://www.automationdirect.com/VID-PR-0001 for a short video on ProSense Air Differential and Pressure Transmitters

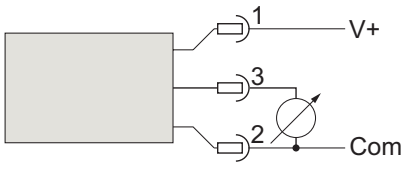
ProSense SPT25 Series Pressure Transmitters (Shielded Cable)

Part Number	Description	Electrical Connection	Input Voltage	Wt(lb)	Price
SPT25-20-V30A	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	Integral 6.6 ft (2m) shielded cable	9 - 36 VDC	0.38	$153.00
SPT25-20-0030A	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-20-0060A	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-20-0100A	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-20-0150A	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-20-0200A	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-20-0300A	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-20-0500A	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-20-1000A	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-20-1500A	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-20-2000A	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-20-3000A	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-20-5000A	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$153.00
SPT25-10-V30A	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$153.00
SPT25-10-0030A	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-10-0060A	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-10-0100A	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-10-0150A	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-10-0200A	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-10-0300A	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-10-0500A	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-10-1000A	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-10-1500A	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-10-2000A	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-10-3000A	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-10-5000A	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$153.00

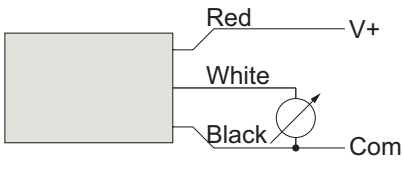
ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series Pressure Transmitters (DIN Connector)					
Part Number	**Description**	**Electrical Connection**	**Input Voltage**	**Wt(lb)**	**Price**
SPT25-20-V30D	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	DIN 175301-803C L-connector	9 - 36 VDC	0.30	$147.00
SPT25-20-0030D	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-20-0060D	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-20-0100D	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-20-0150D	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-20-0200D	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-20-0300D	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-20-0500D	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-20-1000D	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-20-1500D	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-20-2000D	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-20-3000D	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-20-5000D	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$147.00
SPT25-10-V30D	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$147.00
SPT25-10-0030D	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-10-0060D	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-10-0100D	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-10-0150D	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-10-0200D	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-10-0300D	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-10-0500D	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-10-1000D	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-10-1500D	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-10-2000D	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-10-3000D	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-10-5000D	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$147.00

0 to 10 VDC Output Wiring Diagram

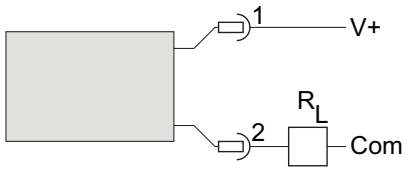


With DIN Connector

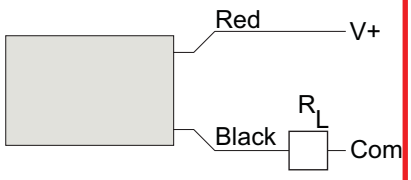


With Integral Cable

4 to 20 mA Output Wiring Diagrams



With DIN Connector



With Integral Cable

Shielded Cable Models Wire Designation		
Wire Color	**0 - 10 VDC Output**	**4 - 20 mA Output**
Red	V +	V +
Black	Com	Output
White	Output	None
Bare*	Shield Drain Wire	Shield Drain Wire

** Where shielded wiring is being used; Connect the drain wire to the guard terminal on the read out device or measuring instrument if available. In all other cases connect to the power supply negative terminal.*

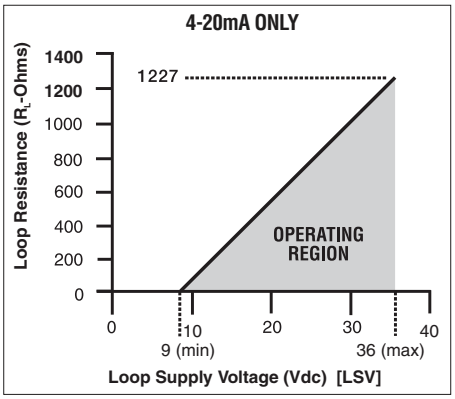
DIN Form C Models Pin Designation		
Pin No.	**0 - 10 VDC Output**	**4 - 20 mA Output**
1	V+	V+
2	Com	Output
3	Output	None
4	Case Ground	Case Ground

ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series General Specifications	
Housing Material	20% Glass Reinforced Nylon, Fire retardant to UL94 V1 / 304 Series Stainless steel
Materials (wetted parts)**	304 Series Stainless steel / 17-4PH Stainless Steel
Operating Temperature	–40 to 257°F (–40 to 125°C)
Medium Temperature	–40 to 257°F (–40 to 125°C)
Storage Temperature	–40 to 257°F (–40 to 125°C)
Protection	IP 67 for cabled models IP 65 For DIN connector models
Accuracy*	± 0.50% of full range
Temperature Coefficient	0.15% of full range / 10°F (0.25% of full range / 10°C)
Reference Temperature	70°F ± 1°F (21°C ± 1°C)
Compensated Temperature	–4 to 185°F (–20 to 85°C)
Insulation Resistance	Greater than 100 megohms at 100 VDC
Shock Resistance	100 gs, 6 ms
Vibration Resistance	Random vibration (20 g) over temperature range (-40° to 125°C). Exceeds typical MIL. STD. requirements
Drop Test	Withstands 1 meter on concrete 3 axis
Response Time	Less than 1 msec
Warm-up time	Less than 500 msec
Position Effect	Less than ±0.01% span, typical
Insulation Breakdown Voltage	100 VAC
Reverse Polarity & Miswired Protected	Yes
Durability	Tested to 50 million cycles
Humidity	0 to 100% R.H., no effect
Stability	Less than ±0.25% full range / year
Agency Approvals	CE
**Note - Includes non-linearity, hysteresis & non-repeatability.*	
*** Not cleaned for oxygen service*	

ProSense SPT25 Series Technical Specifications	
Technical Specifications SPT25-20-xxxx	
Operating Voltage	9 – 36 VDC
Analog Output	4 – 20 mA
Maximum Load	Determine Maximum Loop Resistances $\frac{V_L - 9\ VDC}{0.022\ amps} = R_L$ For example [(24 VDC – 9 VDC) / 0.022 amps] = 681Ω
Technical Specifications SPT25-10-xxxx	
Operating Voltage	14 – 36 VDC
Current Consumption	4 mA
Minimum Load	10 kΩ

Power Supply Voltage vs Loop Resistance



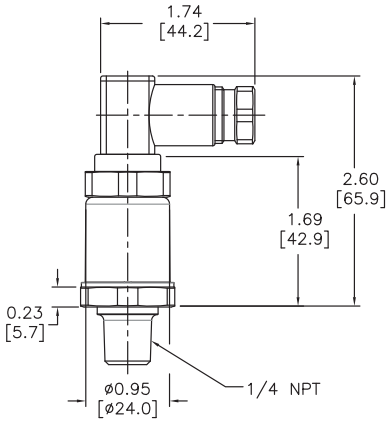
DIN Connector Specifications	
Number of contacts	3 + PE
Cable glands	PG 7
Conductor size max.	0.75 mm² / 18AWG
Type of termination	Screw
Suitable cables	4.5 mm to 6mm
Standard DIN	EN 175 301-803-C

ProSense SPT25 Proof & Burst Pressures		
	Proof	***Burst***
500 psig & below	200% full scale	1000% full scale
1000 – 2000 psig	200% full scale	500% full scale
3000 psig	200% full scale	500% full scale
5000 psig	150% full scale	500% full scale

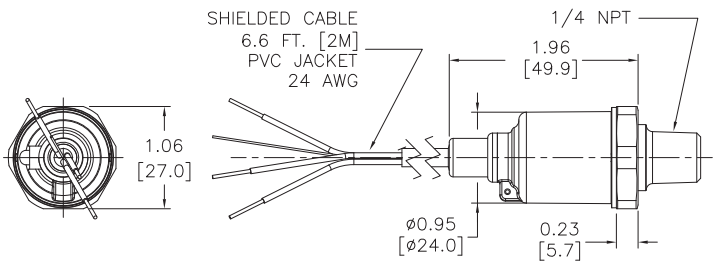
See our website www.AutomationDirect.com for complete Engineering drawings.

Dimensions

inches [mm]



DIN Connector Models



Shielded Cable Models

3 Inch Totalizing Water Meter with Pulse Output

Cast Iron Flanged Water Meters for indicating flow totalization of water with pulse output. Woltmann Helix style water meter for industrial use. Designed for long service life and maintenance-free operation, even under harsh conditions.

Features:

- Pulse Output Components
- All Meters have Hydrocarbon Resistant Seals and will not be damaged by dissolved amounts of free product
- Sealed Dry Dial for Clear Readings

Specifications:

- Woltmann Helix Style Water Meter
- 150# Flange
- Pulse Rate: 100 gal/pulse
- Accuracy Class: B
  Transitional Flow: ± 5%
  Nominal Flow: ± 2%
- 6 Digit Mechanical Roller Counter
- Maximum Water Temperature: 86°F
- Maximum Water Pressure: 150 psi
- Mounting Orientation: Horizontal

Materials:

- Body: Cast Iron Body, Epoxy Coated
- Measuring Components: Polyethylene
- Seals: Viton

PRM meters are ideal for Environmental and Industrial companies to measure process water for environmental treatment, manufacturing, or irrigation. These meters are for any application that does not require potable water measurement and are excluded from federal Lead Free Standards for drinking water.

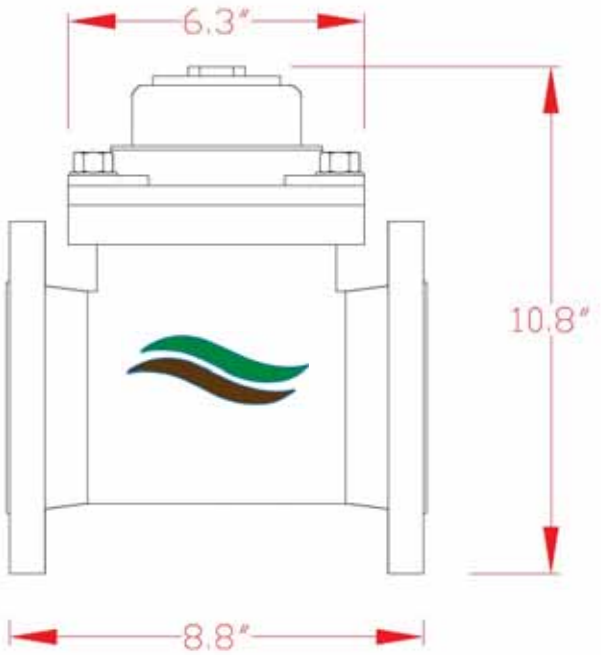
PRM Part Number:

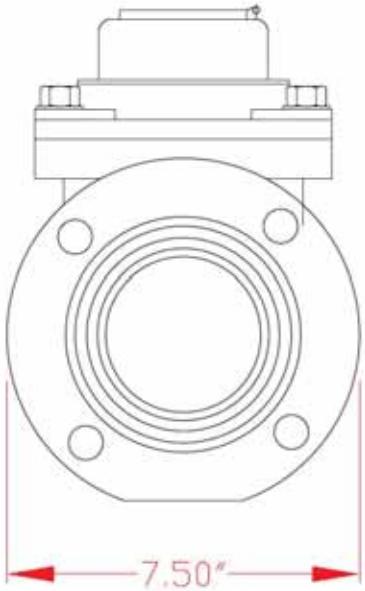
WM300PVX: 3” Flanged Multi-Jet Water Meter

(888-TREAT-IT) • www.prmfiltration.com • sales@prmfiltration.com

3 Inch Totalizing Water Meter with Pulse Output

Information in this drawing is provided for reference only.





WM300PVX:

Materials:
Body: Cast Iron
Measuring Chamber: Polyethylene
Paint: Epoxy Coated
Seal: Viton
Mounting Orientation: Horizontal

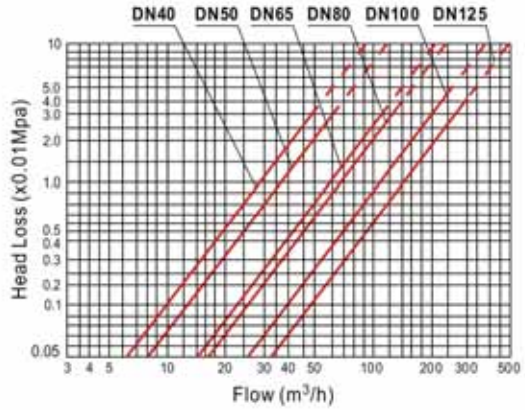
Not for use with Potable Water

Connection: 3 Inch 150# Flange
Pulse Rate: 100 gallons/pulse

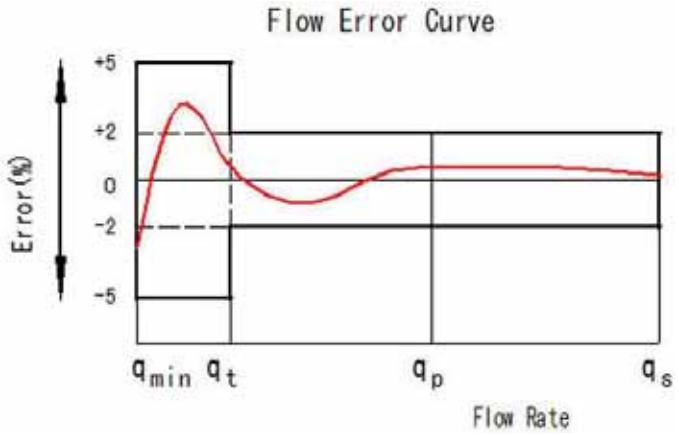
Height: 10.8 Inches
Length: 8.8 Inches
Weight: 31 lbs.

Flow Specifications:
Qmin: 5.3 GPM
Qt: 35 GPM
Qp: 176 GPM
Qmax: 352 GPM

Head Loss Curve



Flow Error Curve



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ProSense® FMM Series (-1002) Magnetic-Inductive Flow Meters

Part No.FMM75-1002

Part No. FMM200-1002

Overview

AutomationDirect's ProSense FMM Series (-1002) Magmeters are designed to reliably detect the flow rate of conductive media up to 158.5 gallons per minute. The stainless steel, mechanically-robust design mounts directly in-line providing a compact, low-profile installation for process control. A 4-digit numeric display with pushbutton setup indicates flow rate and fluid temperature with selectable engineering units. Two outputs are available to remotely monitor the analog status of flow rate and temperature parameters. Simple to set up, easy to install and with no moving parts, the FMM series is a reliable alternative to traditional flow meters and mechanical flow switches.

Features

- 1/2 to 2" NPT female process connections
- Measure up to 158.5 GPM
- Measure fluid temperature in addition to flow
- 4-digit numeric display with pushbutton setup
- Selectable engineering units: GPM, GPH, LPM, m^3/h, °F, °C
- Two analog output signals
- 4-pin M12 quick disconnect
- 5-year warranty

#E320431

See the end of the section for a series of Overview and Setup Videos

Output Function Selections

Output 1:
Analog temperature

Output 2:
Analog flow rate

ProSense FMM Series (-1002) Magnetic Flow Meters					
Model	***FMM50-1002***	***FMM75-1002***	***FMM100-1002***	***FMM150-1002***	***FMM200-1002***
Weight	1.14 lb	1.23 lb	1.36 lb	6.76 lb	6.76 lb
Range	0 to 6.6 GPM	0 to 13.2 GPM	0 to 26.4 GPM	0 to 79.3 GPM	0 to 158.5 GPM
Process Connection	1/2" FNPT	3/4" FNPT	1" FNPT	1-1/2" FNPT	2" FNPT
Application	Conductive liquids: ≥ 20 µS/cm (micro Siemens per centimeter) liquids / viscosity: < 70cSt (centiStoke) at 104°F				
Pressure Rating	232PSIG [16bar]				
Medium Temperature	14 to 158°F [-10 to 70°C]				
Operating Voltage	20 to 30VDC			18 to 32VDC	
Current Consumption	120mA			< 150mA	
Insulation Resistance	> 100MΩ (500VDC)				
Protection Class	III				
Reverse Polarity Protection	YES				
Output Functions					
Output Type / Function	OUT1: analog signal / temperature OUT2: analog signal / flow				
Analog Output	4-20 mA max 22mA Max. load: 500Ω (4-20 mA) Overload protection: Yes				
Flow Rate Monitoring					
Measuring Range	0.030 to 6.600 GPM	0.020 to 13.200 GPM	0.100 to 26.400 GPM	1.300 to 79.300 GPM	1.300 to 158.500 GPM
Display Range	-7.920 to 7.920 GPM	-15.860 to 15.860 GPM	-31.700 to 31.700 GPM	-95.100 to 95.100 GPM	-190.200 to 190.200 GPM
Resolution	0.010 GPM	0.020 GPM	0.050 GPM	0.100 GPM	0.100 GPM
Analog Start Point, ASP	0.000 to 5.280 GPM	0.000 to 10.580 GPM	0.000 to 21.100 GPM	0.000 to 63.400 GPM	0.000 to 126.800 GPM
Analog End Point, AEP	1.320 to 6.600 GPM	2.640 to 13.220 GPM	5.300 to 26.400 GPM	15.900 to 79.300 GPM	31.700 to 158.500 GPM
In Steps Of	0.010 GPM	0.020 GPM	0.050 GPM	0.100 GPM	0.100 GPM

ProSense® FMM Series (-1002) Magnetic-Inductive Flow Meters

ProSense FMM Series (-1002) Magnetic Flow Meters					
Model	**FMM50-1002**	**FMM75-1002**	**FMM100-1002**	**FMM150-1002**	**FMM200-1002**
Temperature Monitoring					
Measuring Range	-4 to 176°F [-20 to 80°C]				
Resolution	0.5°F [0.2°C]				
Analog Start Point, ASP	-4.0 to 140°F [-20 to 60°C]				
Analog End Point, AEP	32 to 176.0°F [0.0 to 80°C]				
In Steps Of	0.5°F [0.28°C]				
Accuracy / Deviations					
Flow Monitoring					
Accuracy[1]	± (2% MW + 0.5% VMR)			± (0.8% MW + 0.5% VMR)	
Repeatability[1]	± 0.2% VMR				
Temperature Monitoring					
Accuracy	± 2.5°K (Q > 0.26 GPM)			± 1°K (Q > 4.00 GPM)	
Reaction Times					
Power-On Delay Time	5s				
Flow Monitoring					
Response Time	< 0.150s (dAP = 0)			< 0.350s (dAP = 0)	
Display Damping, dAP	0.0 to 3.0s			0.0 to 5.0s	
Temperature Monitoring					
Response Time	T09 = 3s (Q > 4.00 GPM)				
Environment					
Ambient Temperature	14 to 140°F [-10 to 60°C]				
Storage Temperature	-13 to 176°F [-25 to 80°F]				
Protection	IP 67			IP 65, IP 67	
Mechanical Data					
Process Connection	1/2" NPT female	3/4" NPT female	1" NPT female	1-1/2" NPT female	2" NPT female
Materials (wetted parts)	Stainless steel 316L / 1.4404; PEEK (polyether ether ketone); FKM			Stainless steel 316L / 1.4404; stainless steel 316Ti / 1.4571; PEEK (polyether ether ketone); Hastelloy C-4 (2.4610); Cetellen: FKM	
Housing Materials	Stainless steel 316L / 1.4404; PBT-GF 20; PC; EPDM/X			Stainless steel 316L / 1.4404; stainless steel 316Ti / 1.4571; PEI; FKM; PBT-GF 20; elastolan	
Displays / Operating Elements					
Display	Display unit: 6 x LED green (l/min, m³/h, GPM, GPH, °C, °F) Measured values: 4-digit alphanumeric display (7.5 mm) Programming: 4-digit alphanumeric display (7.5 mm)			Display unit: 6 x LED green (l/min, m³/h, GPM, GPH, °C, °F) Function display: 1 x LED yellow (10³) Measured values: 4-digit alphanumeric display (7.5 mm) Programming: 4-digit alphanumeric display (7.5 mm	
Electrical Connection					
Connection	M12 connector; gold-plated contacts				
Tests / Approvals					
EMC	EN 61000-4-2: 4kV CD / 8kV AD EN 61000-4-3 HF radiated: 10 V/m EN 61000-4-4 Burst: 2kV EN 61000-4-5 Surge: 0.5 kV EN 61000-4-6 HF conducted: 10V				
Shock Resistance	DIN IEC 68-2-27: 20g (11ms)				
Vibration Resistance	DIN IEC 68-2-6: 5g (10 to 2,000Hz)				
Approvals*	UL (E320431), CE, RoHS				

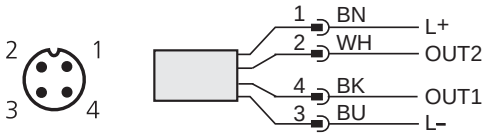
**** To obtain the most current agency approval information, see the Agency Approval Checklist section on the specific part number's web page at www.automationdirect.com***

[1] MW = Measured value; VMR = Final value of the measuring range

NOTE: CHECK THE CHEMICAL COMPATIBILITY OF THE SENSOR'S WETTED PARTS WITH THE MEDIUM TO BE MEASURED.

ProSense® FMM Series (-1002) Magnetic-Inductive Flow Meters

Wiring Diagram



Cable Assembly Wiring Colors:
Pin 1 - Brown
Pin 2 - White
Pin 3 - Blue
Pin 4 - Black

Colors to DIN EN 60947-5-2

For additional wiring details see individual product manuals.
Use FMM-GND1 if meter is installed in ungrounded pipe system.

Output Function Selections

Models:
FMM50-1002, FMM75-1002, FMM100-1002, FMM150-1002, FMM200-1002

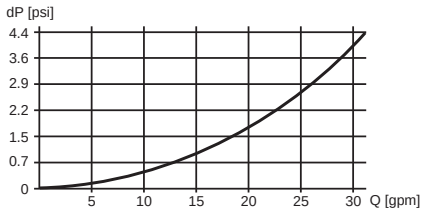
Output 1:
Analog temperature

Output 2:
Analog flow rate

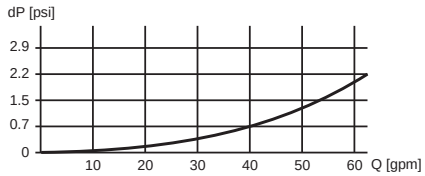
Note: Wiring colors are based on AutomationDirect CD12L and CD12M 4-pole cable assemblies.

Pressure Loss/Flow Rate*

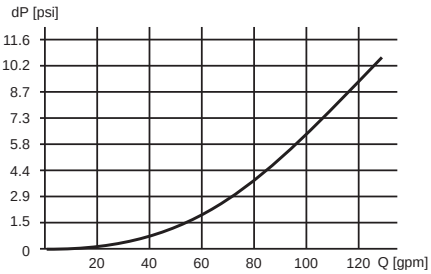
FMM50-1002



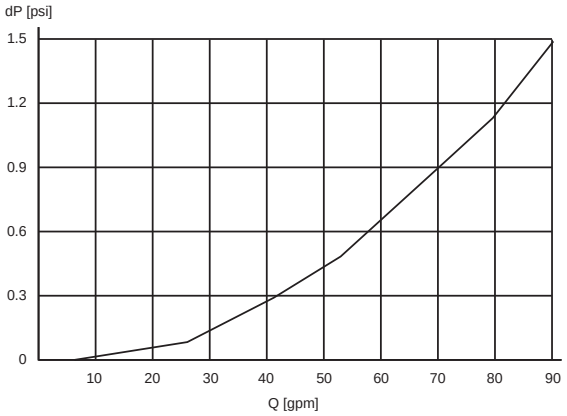
FMM75-1002



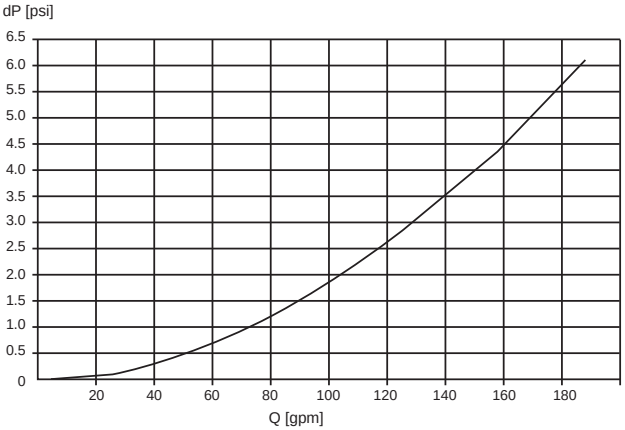
FMM100-1002



FMM150-1002



FMM200-1002



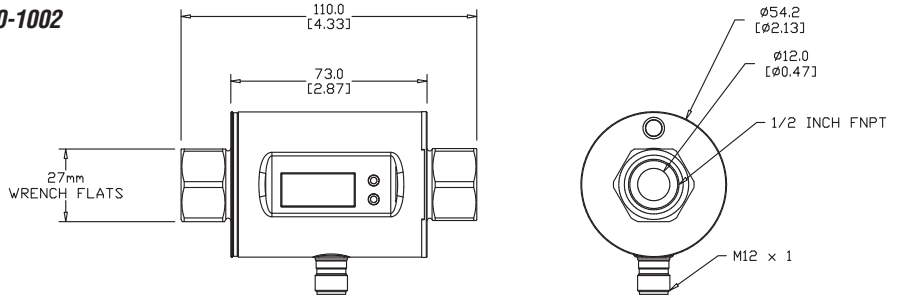
**** when used with water @ 68˚F [20˚C]***

ProSense® FMM Series (-1002) Magnetic-Inductive Flow Meters

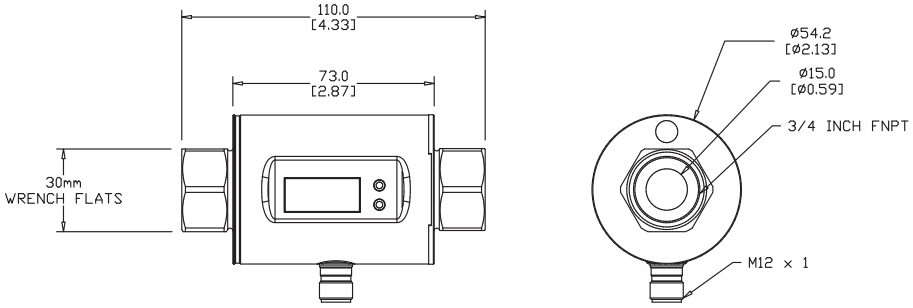
Dimensions

mm [inches]

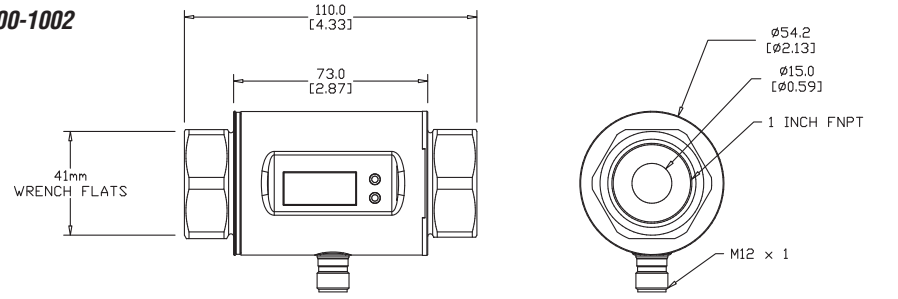
Part No. FMM50-1002



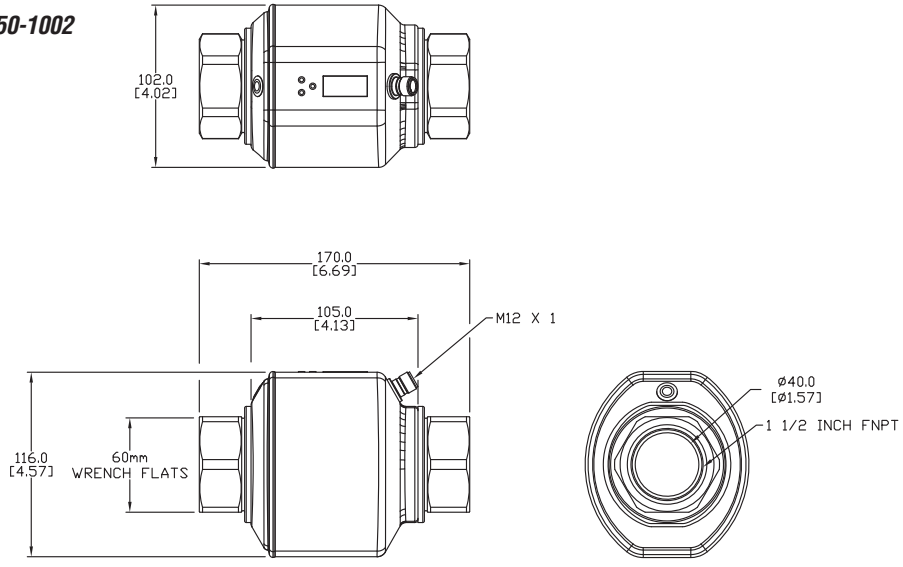
Part No. FMM75-1002



Part No. FMM100-1002



Part No. FMM150-1002



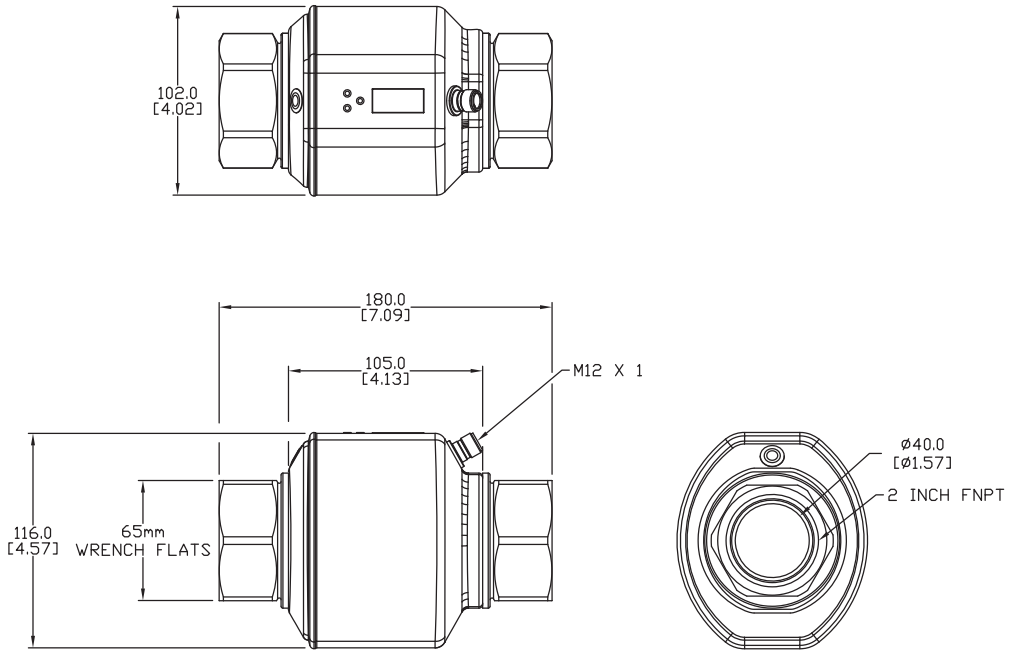
See our website www.AutomationDirect.com for complete Engineering drawings.

FMM Series (-1002) Magnetic-Inductive Flow Meters

Dimensions

Part No. FMM200-1002

mm [inches]



See our website www.AutomationDirect.com for complete Engineering drawings.

Video Links

Click on the thumbnail or go to https://www.automationdirect.com/VID-FL-0003 for a short Quick Start video for the 0.5", 0.75 and 1" FMM Series Magnetic-Inductive Flow Meters

Click on the thumbnail or go to https://www.automationdirect.com/VID-FL-0004 for a short Quick Start video for the 1.5" and 2.0" FMM Series Magnetic-Inductive Flow Meters

Click on the thumbnail or go to https://www.automationdirect.com/VID-FL-0005 for a short Parameter Setup video of the FMM Series Magnetic-Inductive Flow Meters using live demos.

ProSense® Magnetic-Inductive Flow Meter Accessories

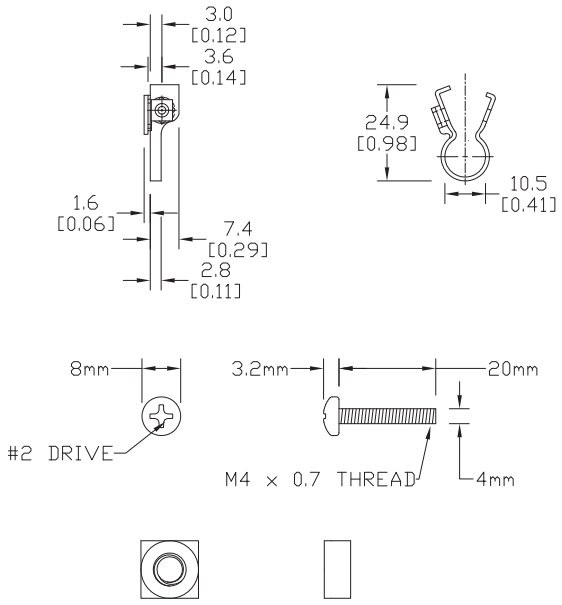
The FMM-GND1 Grounding Clamp is used when an FMM series Magnetic-Inductive Flow Meter is installed in an ungrounded pipe system (e.g. PVC pipe).
Simply place the FMM-GND1 Grounding Clamp around the base of the M12 connector and attach a grounded wire to FMM-GND1 Grounding Clamp with the supplied machine screw and nut.
Note: Improper grounding may cause inaccurate readings

ProSense Magnetic Flow Meter Accessories			
Part No.	***Description***	***Price***	***Weight***
FMM-GND1	ProSense 316 stainless steel grounding clamp for magnetic flow meters with an M12 connector.	$6.25	0.015 lb

Dimensions

mm [inches]

Part No. FMM-GND1



See our website www.AutomationDirect.com for complete Engineering drawings.

Grounding Clamp Installation

The ProSense magnetic flow meter grounding clamp is installed as shown above.
Note: the ground wire shown above is not included.

ProSense® FMM Series Magnetic-Inductive Flow Meters

Magnetic-Inductive Flow Meter Application

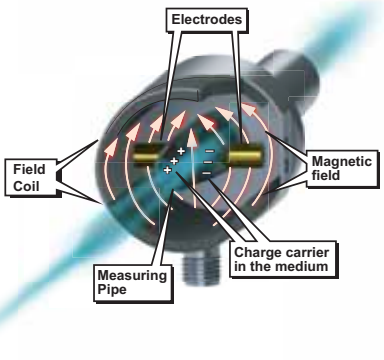
Magnetic-inductive flow meters (Magmeters) are one of the most widely used technologies for liquid flow monitoring in industrial process markets such as wastewater, mining and minerals, utilities, food and beverage, and pharmaceuticals. To ensure reliable and accurate operation, some important application requirements should be considered. Meeting the minimum conductivity of the liquid and properly installing with a full pipe are required in order to avoid significant error or the meter not functioning at all. Additionally, the presences of air bubbles should be avoided as they will affect the accuracy of the meter's measurements. Installation location in the piping is important because disturbances in the flow caused by bends in the pipe, valves, reductions, etc. can cause inaccuracies. Refer to the magmeter's specifications and operating instruction documents for specific information regarding application and installation requirements.

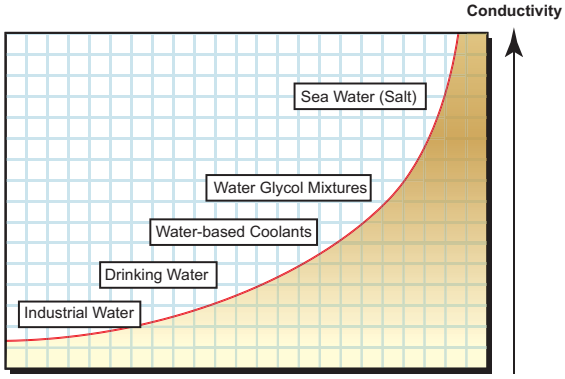
Click on the thumbnail or go to https://www.automationdirect.com/VID-FL-0002 for a short overview video of the FMM Series Magnetic-Inductive Flow Meters

Magnetic-Inductive Flow Meter Measuring Principle

Magmeters operate by using the magnetic-inductive measuring principle in which a magnetic field is generated in the specified measuring pipe by current-carrying coils. When the media flows through the pipe, the ions of the conductive media are diverted perpendicularly to the magnetic field with the positive and negative charge carriers flowing in opposite directions. The two electrodes that are in contact with the medium then measure the voltage that is induced. The measured signal voltage is proportional to the average flow velocity. By knowing the inside pipe diameter of the unit, the volumetric flow rate is determined. Magmeters are suitable for use with a variety of conductive liquids in industrial process applications such as those in the following graph:

Click on the thumbnail or go to https://www.automationdirect.com/VID-FL-0006 for a short video to learn how Magnetic Inductive Flow Meters works





Types of medium with electrical conductivity

ProSense FMM Series Magnetic Flow Meter Selection Guide

Model	Process Connection	Flow Range	Temperature Range	Display Units	Output 1	Output 2	Empty Pipe Detection
FMM50-1001	1/2" FNPT	0 to 6.6 GPM	-4 to 176°F [-20 to 80°C]	GPM, GPH, GAL, or °F	Switch or pulse (flow)	Switch, analog or reset input (flow or temperature)	No
FMM75-1001	3/4" FNPT	0 to 13.2 GPM					
FMM100-1001	1" FNPT	0 to 26.4 GPM					
FMM150-1001	1-1/2" FNPT	0 to 80 GPM			Switch, pulse or frequency (flow)		Yes
FMM200-1001	2" FNPT	0 to 160 GPM					
FMM50-1002	1/2" FNPT	0 to 6.6 GPM		GPM, GPH, LPM, m³/h, °F, °C	Analog 4-20 mA (temperature)	Analog 4-20 mA (flow)	No
FMM75-1002	3/4" FNPT	0 to 13.2 GPM					
FMM100-1002	1" FNPT	0 to 26.4 GPM					
FMM150-1002	1-1/2" FNPT	0 to 79.3 GPM					Yes
FMM200-1002	2" FNPT	0 to 158.5 GPM					

Sensorex

TX100 pH/ORP TRANSMITTER

PRODUCT SPECIFICATION SHEET

- Displays readings in pH or mV alongisde temperature
- Mounts on wall, panel, pipe or DIN-rail
- Simple, easy to read user interface
- Probe cleaning reminder for easy maintenance
- Stores calibration and other data in case of power loss
- Water resistant case included

PARTS COVERED BY THIS SPECIFICATION SHEET:

- TX100

The TX100 pH/mV transmitter is a loop-powered 4-20mA transmitter with a wide range of useful features and programmable options. Five buffer choices are available in two-point calibration mode. The 4-20mA output is scaleable in pH or mV units and has 500V input to output isolation. Temperature is always displayed and is selectable in °C or °F. All stored parameters and calibration data are retained in the non-volatile memory during transmitter power down or power loss. A useful probe clean reminder icon flashes when it is time to clean the probe. Probe cleaning interval is user programmable from 1 to 250 days. The TX100 can be used for wall mounting, panel mounting, pipe mounting and DIN-rail mounting. Cable grips for inlet/outlet to box are included as well as all mounting hardware. The case meets NEMA and IP ratings for water resistance.

RECOMMENDED APPLICATIONS INCLUDE:

- Swimming pool control
- Industrial water treatment
- Potable water systems
- Boiler feedwater
- Municipal wastewater plants

SPECIFICATIONS:

Measuring Range (pH)	0.00 to 14.00 pH, 0.01 pH resolution, ± 0.01 accuracy
Measuring Range (ORP/mV)	-1999mV to 1999mV, 1mV resolution, ± 2mV accuracy
Temperature Range	-20°C (-4°F) to 110°C (230°F), 0.1° C/F resolution
Current Output Range	2.00mA to 24mA, .01mA resolution, ±0.005mA accuracy, 500V input/output isolation
Enclosure	NEMA 4X IP65, ABS case with push-button control pad HWD: 3.9" (99.1 mm) x 3.9" (99.1mm) x 2.9" (74.7mm)
Weight	approx. 1lb (0.45 kg)
Mounting Options	Wall, panel, din rail, and pipe
Conduit Openings	2 each 3/8" NPT openings (cordgrips included)
Ambient Temperature	Transmitter Service, 0°C (32°F) to 60°C (140°F)
Ambient Humidity	0-95%, non-condensing
Location	Designed for non-hazardous areas
Temperature Input	2-wire Pt1000 RTD with automatic compensation
Max Sensor to Transmitter Distance	30 feet (9.1 meters)
Power Requirement	12-24 VDC, max 600 Ohm load

DESIGNED AND ASSEMBLED IN CALIFORNIA, USA
11751 MARKON DRIVE • GARDEN GROVE, CA 92841 • 714.895.4344 • WWW.SENSOREX.COM
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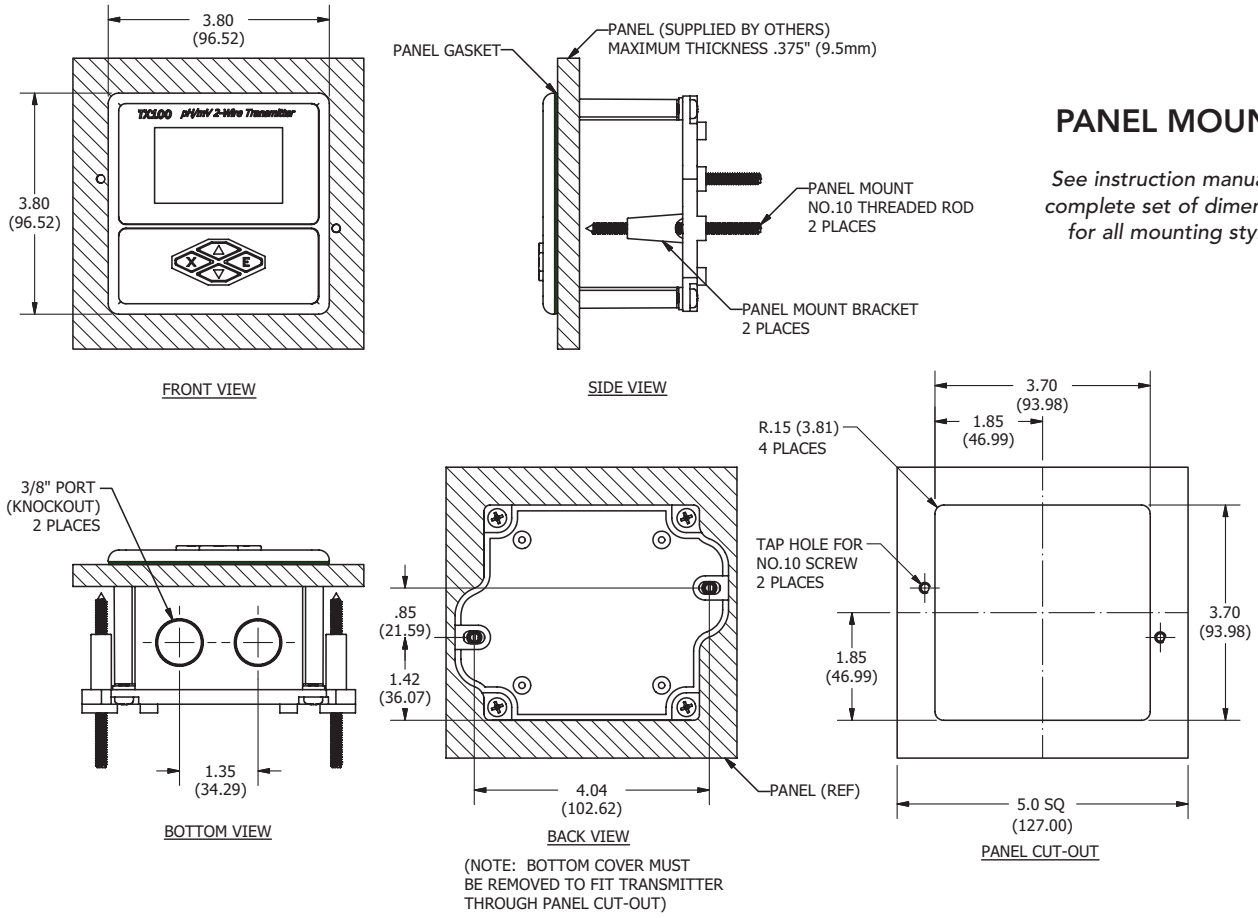
TX100 TRANSMITTER

PRODUCT SPECIFICATION SHEET

OUTLINE AND DIMENSIONS



PANEL MOUNT

See instruction manual for complete set of dimensions for all mounting styles.

Wall Mount, DIN Rail Mount and Pipe Mount Hardware are all included.

ORDERING INFORMATION

The TX100 2-wire isolated pH/ORP transmitter is supplied complete with mounting hardware for panel, wall, din rail and pipe mounting with instructions. *Power supply is not included.*

Part Number	Description
Model:	
TX100	Isolated pH/ORP 2-wire transmitter in 1/4 DIN case, requires 24V DC power supply (customer supplied)
Accessories:	
B225	Zobell ORP calibration solution, 473 mL
B104	pH 4.01 buffer solution, 473mL
B107	pH 7.00 buffer solution, 473mL
B110	pH 10.00 buffer solution, 473mL
B125	ORP Calibration Kit - incl. B104, B107, B115 quinhydrone powder (20g), 3 plastic beakers, stir sticks

Doc. #450000 Revision A: Published 3/29/16

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Submittal #13 pH Sensor #S271CD

Low Cost Submersion and In-Line pH Electrodes

S270 Series Ryton Sensors

S260 Series Ryton Sensors

S222 Series Quick Disconnect Models

Economical design for in-line or submersion use

Choose from single or double junction models

Threaded 1/2" or 3/4" NPT connections

Choose from spherical or flat pH measuring surfaces

Special models for low ionic and other specialty applications available

This series of electrodes is designed to provide an economical multi-purpose solution for in-line or submersion pH measurements. Based on our proven S200C bulb and S350CD flat surface pH glass technology, these rugged and durable electrodes are available in Ryton nipples with 1/2" or 3/4" NPT threads; or in our durable epoxy body with or without quick disconnect top caps. Choose from single or double junction designs, flat or recessed measuring surface configurations and cable lengths and connectors as required. For special configurations such as low ionic models, fluoride resistant pH glass and other specialty sensors, please contact the Sensorex sales or technical support department.

Specifications

Measuring Range	0-14 pH (Sodium ion error >12.3pH)
Body material	Epoxy (S200,S222, S353, S354 Series) or Ryton (S265-S269 Series, S271CD, S272CD & S273CD)
Max Temp/Pressure	S265-S269 Series : 32-176 deg F (0-80 deg C))/70 psig S271CD,S272CD & S273CD : 170 deg F (75 de C))/100 psig, 180 deg F (81 deg C)/85 psig, 212 deg F (100 deg C)/50 psig
Connector	BNC, tinned wires (other connectors available for an addi tional charge), S353CD AND S353CD have DIN Cap and require DIN-EL mating connector
Cable length	30" or longer for S200 Series lengths at additional cost user specified (Cap-cable S653 required for S222 Series). 10ft length for S265-S269 series, 10ft waterproof cable for S271CD, S272CD & S273CD
Process Connection	1/2" or 3/4" MNPT for submersion or in-line, S354CD has DIN 13.5mm threads

Parts covered by this product data sheet include:
S200C, S200CD, S222C, S222CD, S223C, S223CD, S224C, S224CD, S265C-S269CD, S271CD, S272CD, S272CDTC, S273CD, S273CDTC, S353CD, S354CD

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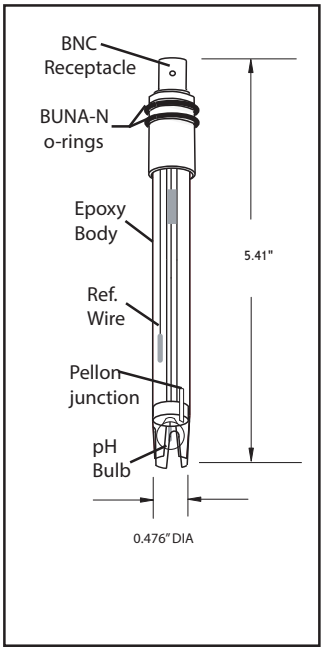
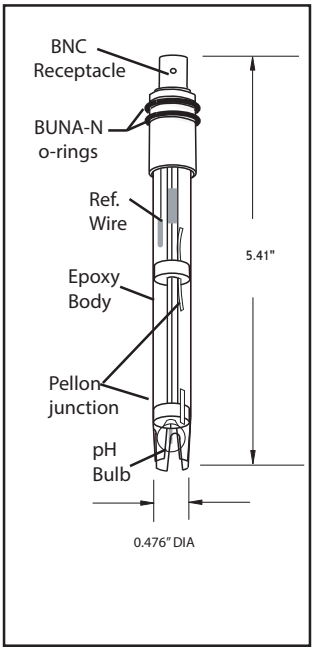
Low Cost Submersion and In-Line pH Electrodes

Designed to provide an economical multi-purpose solution for in-line or submersion pH measurements.

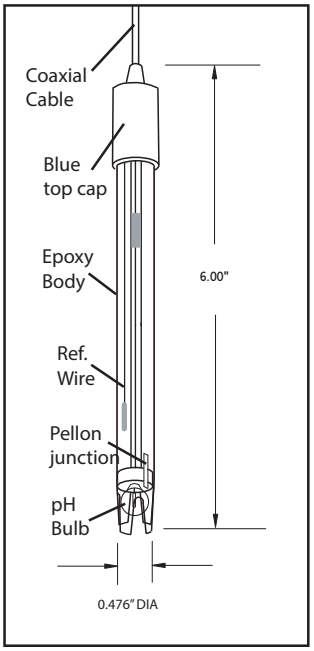
S222C



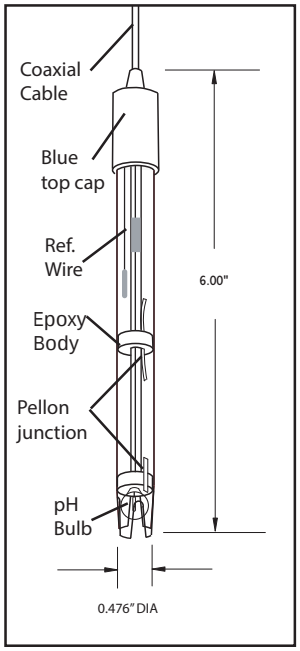
S222CD



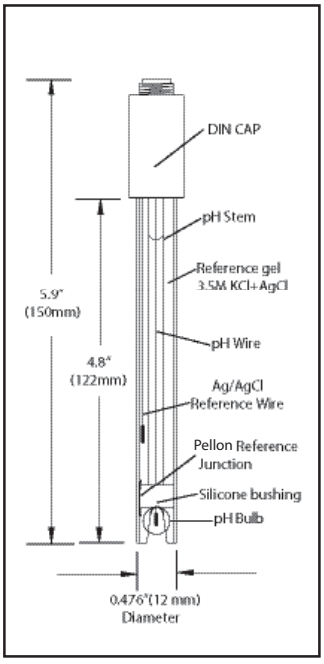
S200C



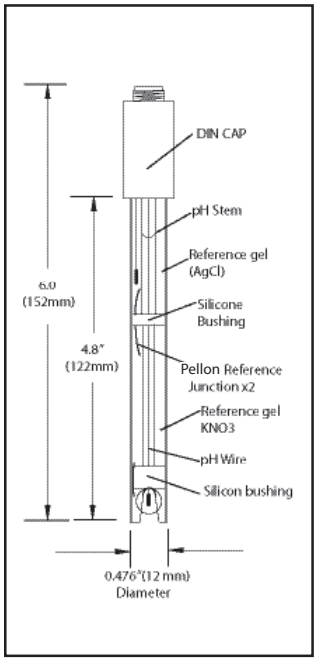
S200CD & S200CD-LC



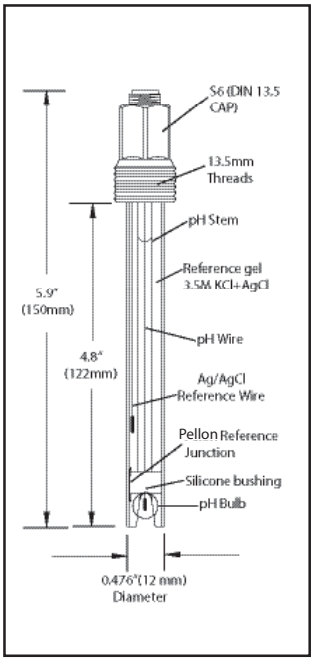
S223C



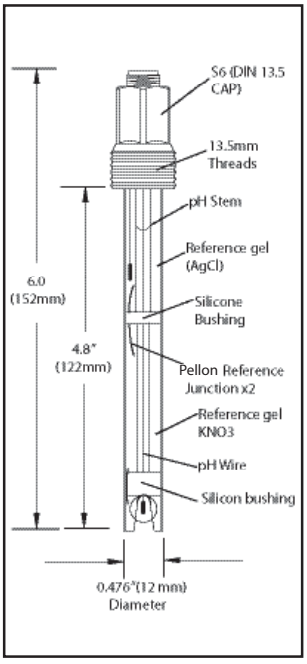
S223CD



S224C



S224CD



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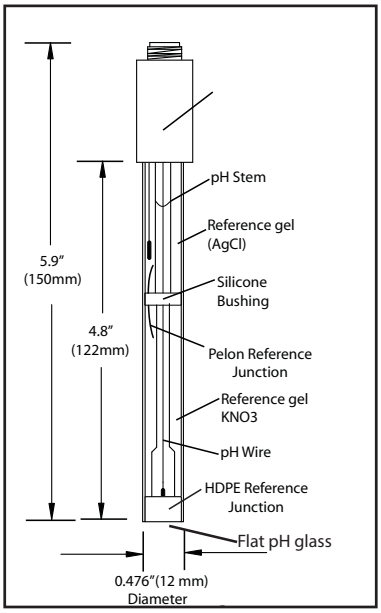
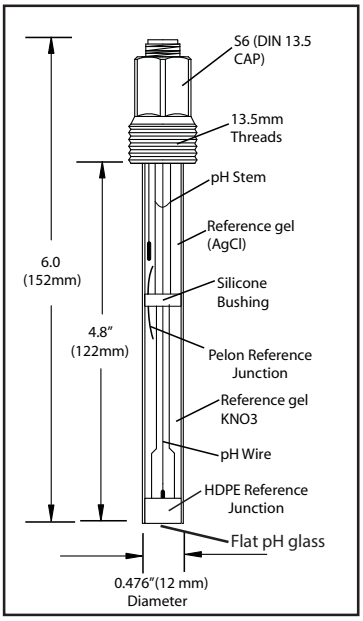
Low Cost Submersion and In-Line pH Electrodes

Designed to provide an economical multi-purpose solution for in-line or submersion pH measurements.

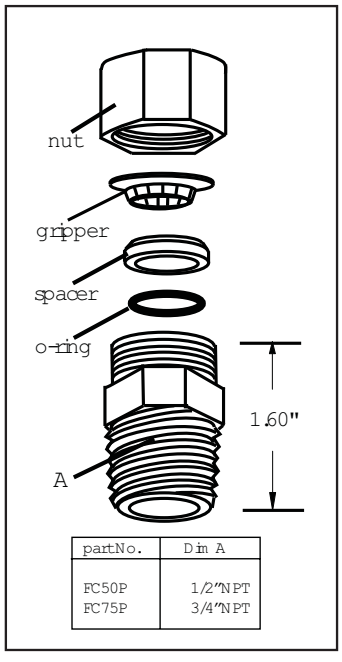
S353CD



S354CD

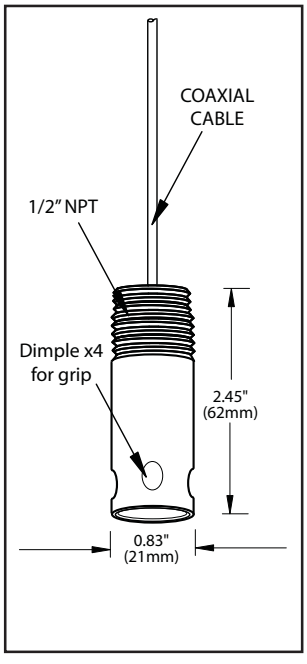


FC50P and FC75P

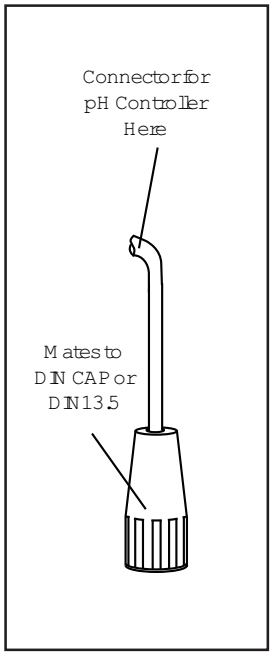


partNo.	Dim A
FC50P	1/2"NPT
FC75P	3/4"NPT

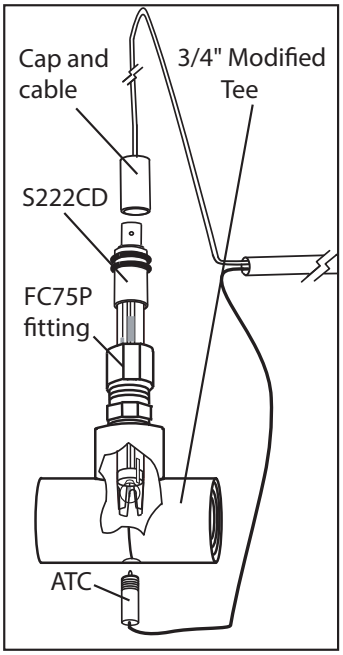
S653 Cap and Cable for Conduit use



DIN-EL Ext. Cable for DIN Cap Models



FC75TC Installation



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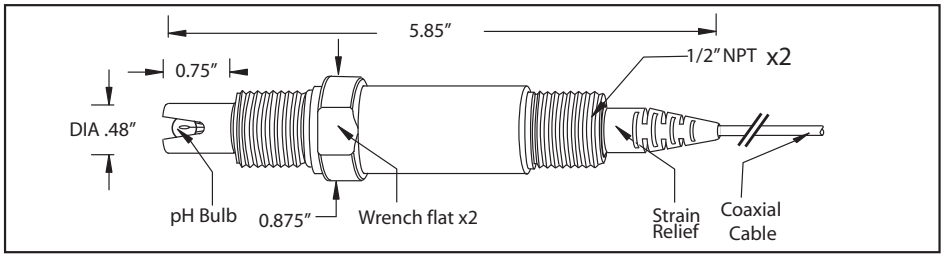
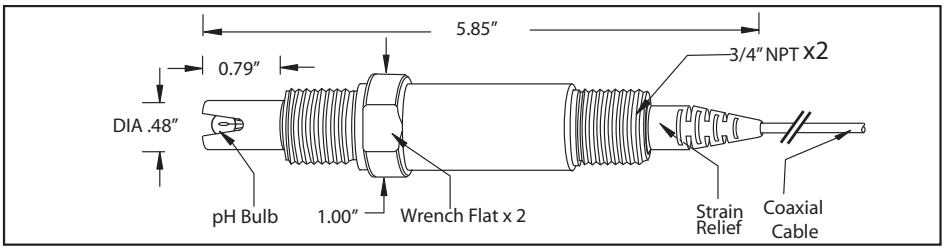
Low Cost Submersion and In-Line pH Electrodes

Designed to provide an economical multi-purpose solution for in-line or submersion pH measurements.

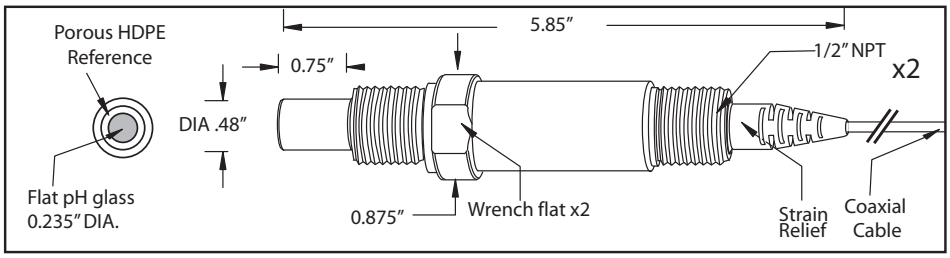
S265C/CD



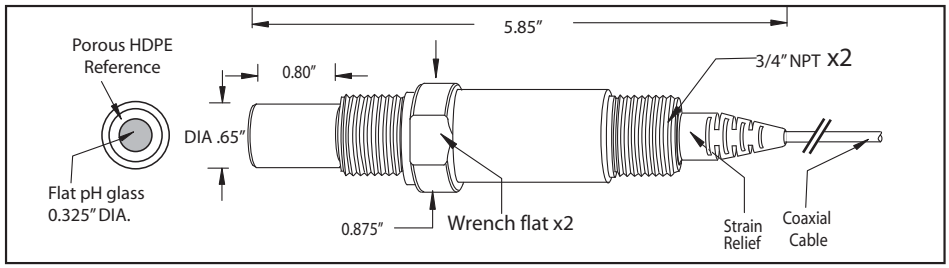
S267C/CD



S268CD



S269CD



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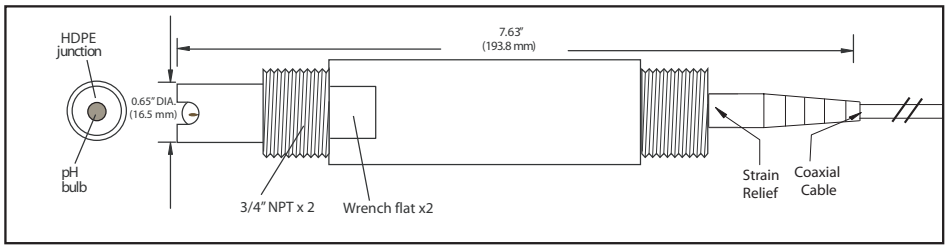
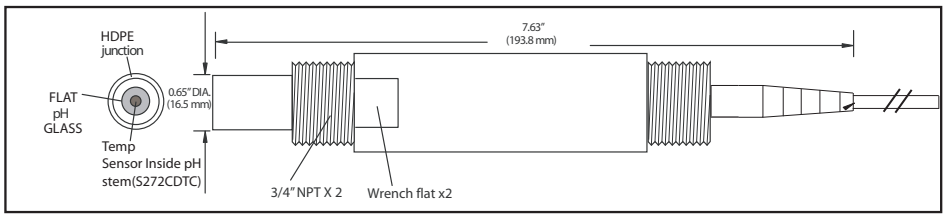
Low Cost Submersion and In-Line pH Electrodes

Designed to provide an economical multi-purpose solution for in-line or submersion pH measurements.

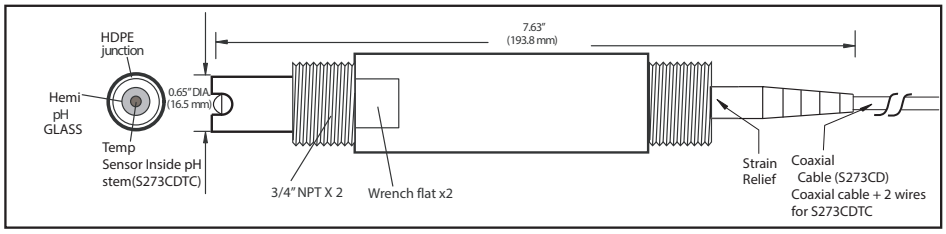
S271CD



S272CD & S272CDTC



S273CD & S273CDTC



Ordering Information

These economical sensors are submersion and in-line ready by utilizing the 1/2" or 3/4" MNPT threads on the sensor. 10ft cable length is standard. Special lengths available upon request.

pH Sensors	Body Material	Key Features
(To order an ORP model instead of pH, simply add - ORP to the model numbers below.)		
S265C	PPS	Single junction 1/2" NPT spherical bulb
S265CD	PPS	Double junction 1/2" NPT spherical bulb
S267C	PPS	Single junction 3/4" NPT spherical bulb
S267CD	PPS	Double junction 3/4" NPT spherical bulb
S268CD	PPS	Double junction 1/2" NPT flat surface
S269CD	PPS	Double junction 3/4" NPT flat surface
S271CD	PPS	Double junction 3/4" NPT spherical bulb, heavy duty
S272CD	PPS	Double junction 3/4" NPT flat surface , heavy duty
S272CDTC	PPS	Double junction 3/4" NPT flat surface , heavy duty with Temperature Sensor, Pt100 or Pt1000RTD
S273CD	PPS	Double junction 3/4" NPT hemi pH glass surface , heavy duty
S273CDTC	PPS	Double junction 3/4" NPT hemi pH glass surface , heavy duty with Temperature Sensor, Pt100 or Pt1000RTD

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Low Cost Submersion and In-Line pH Electrodes

Designed to provide an economical multi-purpose solution for in-line or submersion pH measurements.

Mounting glands

Color coded pH buffers

TX100 2-wire pH transmitter

Ordering Information

These economical sensors can be used for submersion or in-line use. Mounting is accomplished by ordering the appropriate mounting gland listed below.

Sensor	Type
S200C	Single junction spherical style bulb
S200CD	Double junction spherical style bulb
S200CD-LC	Low ionic, double junction, spherical style bulb
S222C	Single junction spherical style bulb-Quick disconnect
S222CD	Double junction spherical style bulb-Quick disconnect
970796	Double junction flat pH glass-Quick disconnect
S223C	Single junction spherical style bulb- DIN Cap
S223CD	Double junction spherical style bulb-DIN Cap
S353CD	Double junction flat pH glass-DIN Cap

DIN 13.5 Threaded Cap Sensors - (Do not require mounting fitting. Mount via DIN 13.5 thread)

Sensor	Type
S224C	Single junction spherical style bulb- DIN 13.5 Cap(S6)
S224CD	Double junction spherical style bulb-DIN 13.5 Cap(S6)
S354CD	Double junction flat pH glass-DIN 13.5 Cap(S6)

Accessories

FC50P	1/2 " NPT mounting gland for 12mm electrodes
FC75P	3/4 " NPT mounting gland for 12mm electrodes
FC75TC	3/4 "flow cell, mounting gland and ATC cable for 12mm electrodes
S653	Cap Cable assembly for S222 series (Specify cable length and connector termination when ordering)
EXT Cable - DIN EL/"X"	Extension cable for DIN cap and DIN 13.5 electrodes (Series S223, S224, S354)
TX100	4-20mA loop-powered pH transmitter
B104	1 pint 4.01 pH Buffer
B107	1 Pint 7.00 pH Buffer
B110	1 Pint 10.00 pH Buffer

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PIC GAUGES Industrial Pressure Gauge: 0 to 60 psi, 2 1/2 in Dial, Liquid-Filled, 1/4 in NPT Male

Item 20TV21

Mfr. Model PRO-201L-254D

Compare

Your Price
$21.42 / each

Qty 1

Add to Cart

Setup Auto Reorder

Ship | Pickup

Expected to arrive
Mon. May 01.

Ship to 11980 | Change

Shipping Weight 0.47 lbs

Ship Availability Terms

Add to List

Product Details

Catalog Page N/A

Pressure Gauge Type	Industrial Pressure Gauge
Pressure Range Type	Pressure
Nominal Dial Size	2-1/2 in
Pressure Range	0 to 60 psi
Vibration Resistance	Liquid-Filled
Gauge Case	Liquid Glycerin
Process Connection	1/4 in NPT Male
Process Connection Location	Bottom
Secondary Pressure Range	0 to 4
Secondary Scale Units	bar
Gauge Case Material	Stainless Steel
Case Material	Stainless Steel
Dial Face Color	White
Dial Color	White
Accuracy	±2-1-2%
Gauge Accuracy Grade	Grade A - Industrial
Accuracy Scale	Mid-Scale
Accuracy Grade	ASME B40.100 Grade A
Includes Calibration Certificate	No
Scale Type	Dual

Compliance & Restrictions

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

Chat with an Agent

Gauge Wetted Parts	Copper
Wetted Parts Material	Copper Alloy
Socket Material	Copper Alloy
Sensor Material	Copper Alloy
Hazardous Location Rating	Not Rated
IP/NEMA Rating	Not Rated
Includes Vent Plug	Yes
Blowout Safety Back	No
Lens Material	Polycarbonate
Lens Material - Gauge	Plastic
Bezel Material	Stainless Steel
Bezel Mounting Type	Fixed
Removable Bezel	No
Dry Dampening Feature	None
Field Fillable	No
Liquid-Filled Case	Yes
Primary Scale Minor Graduations	0.5
Mounting Type	Stem-Mount
Primary Pressure Range	0 to 60
Primary Scale Units	psi
Process Connection Gender	Male
Process Connection Size	1/4 in
Process Connection Type	NPT
Ambient Operating Temperature Range	-30° to 180°F
Application	General Purpose
Case Color	Metallic
Case Depth	1.2 in
Case Diameter	2.65 in
Cleaned for Oxygen Service	No
Freeze Resistant Movement	No
Includes	Vent Plug
Includes Mounting Hardware	No
Manufacturer Part Number	PRO-201L-254D

Chat with an Agent

Manufacturer Warranty Length	1 yr
Non-Sparking	No
Panel-Mountable	No
Pointer Color	Black
Pointer Material	Aluminum
Brand	PIC GAUGES
Series	201L
Standards	ASME
UNSPSC	23151820
Country of Origin	China (subject to change)

Product Description

These dial pressure gauges have heavy-duty construction for many industrial applications. They have non-ferrous sockets or process connections for applications where all-stainless construction is not necessary. They are available with liquid-filled cases that are good for applications where there is significant vibration and pulsation. Select gauges are built with a proprietary dry case that also dampens the impact of vibration and pulsation.

Chat with an Agent

Electric Unit Heater

HVAC/R fact sheet

shown with optional
Outlet Mesh (Bird Screen)

c UL us

One Product, Multiple Solutions

- The perfect solution for factories, warehouses, garages, power stations and similar areas
- Mounts horizontally or vertically
- Primary or supplementary heat
- Summer fan kit are available to adapt heater into a fan for cooling

Multi Wattage Units

- 3 to 50 kW heating output
- 208, 240, 277, and 480V
- 10,000 to 170,500 BTU/hr

Durable Heavy Duty

- Rugged, light weight construction
- Enclosed fan motor, offers protection against the elements

Safe and Reliable

- Meets all UL, NEC, and OSHA requirements
- 5 Year Element Warranty
- Auto Thermal Cut-out protects from overheating

Control Your Comfort

- Custom designed venturi outlet for added throw
- Fan delay to eliminates cold drafts.
- Individually adjustable discharge louvers to control air flow

Exclusively from Grainger.
Call or visit your local branch or go to **grainger.com/dayton** for complete product line information

Specifications

Catalog Number	kW Rating	BTU/HR (1,000's)	Heater/ Motor Voltage	Phase	Control Voltage	Amps Per Phase	-Fan Motor- HP	-Fan Motor- RPM	CFM at Outlet	FPM at Outlet	Air Temp. Rise (°F)	Air Throw (Horiz)
2YU58*	3.0/2.2	10.2/7.5	240/208	1	240/208	12.5/11.0	1/100	1600	350	800	27	12'
2YU59	3.0	10.2	480	3	24	3.6	1/100	1600	350	800	27	12
2YU60*	3.0	10.2	277	1	277	11.0	1/100	1600	350	800	27	12
2YU61*	3.0	10.2	208	1	208	14.5	1/100	1600	350	800	27	12
2YU62*	5.0/3.7	17.0/12.6	240/208	1-3	240/208	21.0/18.0	1/100	1600	350	800	45	12
2YU63	5.0	17.0	480	3	24	6.0	1/100	1600	350	800	45	12
2YU64*	5.0	17.0	277	1	277	18.0	1/100	1600	350	800	45	12
2YU65*	5.0	17.0	208	1-3	208	24.0	1/100	1600	350	800	45	12
2YU66	7.5/5.6	25.6/19.1	240/208	1-3	24	31.3/27.0	1/30	1600	650	970	37	18
2YU67	7.5	25.6	480	3	24	9.0	1/30	1600	650	970	37	18
2YU68	7.5	25.6	208	1-3	24	36.0	1/30	1600	650	970	37	18
2YU69	10.0/7.5	34.1/25.6	240/208	1-3	24	42.0/36.0	1/30	1600	650	970	49	18
2YU70	10.0	34.1	480	3	24	12.0	1/30	1600	650	970	49	18
2YU71	10.0	34.1	208	1-3	24	48.0	1/30	1600	650	970	49	18
2YU72	15.0/11.2	51.2/38.2	240/208	3	24	36.1/33.3	1/20	1530	910	1640	52	35
2YU73	15.0	51.2	480	3	24	18.0	1/20	1530	910	1640	52	35
2YU74	15.0	51.2	208	1-3	24	72.0	1/20	1530	910	1640	52	35
2YU75	20.0/15.0	68.2/51.2	240/208	3	24	48.0/41.2	1/10	1500	1320	2060	48	41
2YU76	20.0	68.2	480	3	24	24.0	1/10	1500	1320	2060	48	41
3END3	25	85.2	480	3	24	30	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU77	30.0/22.5	102/77	240/208	3	24	72.0/63.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU78	30.0	102.3	480	3	24	36.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU79	30.0	102.3	208	3	24	84.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
3END4	40	136.4	480	3	24	48	1/2	1524/1420	3000/2600	3260/2900	49/42	60
2YU80	50.0/37.5	170/127	240/208	3	24	120.4/104.2	1/2	1525/1420	3000/2600	3260/2900	53/61	60
2YU81	50.0	170.5	480	3	24	60.2	1/2	1525/1420	3000/2600	3260/2900	53/61	60

Accessories

Grainger Sku #	Description
25D242	Universal Wall-Ceiling Mount 3-10KW
25D243	Universal Wall-Ceiling Mount 15-20KW
25D244	Dust Shield for 3-10KW units
25D245	Dust Shield for 15-20KW units
25D246	Thermostat 40 to 80 temp range
25D247	Summer/Winter Fan Switch
25D248	3pole disconnect switch 25A
25D249	Radial Diffuser for 3-5KW units
25D250	Radial Diffuser for 7.5 to 15KW units

Universal Wall Ceiling Mount

Radial Diffuser

Exclusively from Grainger.
Call or visit your local branch or go to **grainger.com/dayton** for complete product line information

C-more Operator Panels Overview

Getting started

Installing the software and configuring the *C-more* panel is simple. You will need the following to successfully connect, configure and send a project to the panel:

- ***C-more*** HMI - 6in, 7in wide, 8in, 10in, 10in wide, 12in, 15in or EA9-RHMI
- ***C-more*** Programming Software, p/n EA9-PGMSW
- ***C-more*** programming cable, USB or Ethernet
- 12-24 VDC switching power supply or the optional ***C-more*** AC Power Adapter, p/n EA-AC
- Personal Computer - to run ***C-more*** programming software
- PLC communications cable (serial or Ethernet) to connect the ***C-more*** HMI to your controller

Part Number	Description	Price
EA9-T6CL-R	*C-more* EA9 series touch screen HMI, 6in color TFT LCD, analog resistive, 320 x 240 pixel, QVGA, LED backlight, (1) serial, (2) USB ports and (1) memory card slot.	$691.00
EA9-T6CL	*C-more* EA9 series touch screen HMI, 6in color TFT LCD, analog resistive, 320 x 240 pixel, QVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (1) memory card slot and (1) audio line out.	$965.00
EA9-T7CL-R	*C-more* EA9 series touch screen HMI, 7in color TFT LCD, analog resistive, widescreen, 800 x 480 pixel, WVGA, LED backlight, (1) serial, (1) Ethernet, (2) USB ports and (1) memory card slot.	$668.00
EA9-T7CL	*C-more* EA9 series touch screen HMI, 7in color TFT LCD, analog resistive, widescreen, 800 x 480 pixel, WVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (1) memory card slot and (1) audio line out.	$771.00
EA9-T8CL	*C-more* EA9 series touch screen HMI, 8in color TFT LCD, analog resistive, 800 x 600 pixel, SVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (1) memory card slot and (1) audio line out.	$1,343.00
EA9-T10CL	*C-more* EA9 series touch screen HMI, 10in color TFT LCD, analog resistive, 800 x 600 pixel, SVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (1) memory card slot and (1) audio line out.	$1,726.00
EA9-T10WCL	*C-more* EA9 series touch screen HMI, 10in color TFT LCD, analog resistive, widescreen, 1024 x 600 pixel, WSVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (1) memory card slot and (1) audio line out.	$939.00
EA9-T12CL	*C-more* EA9 series touch screen HMI, 12in color TFT LCD, analog resistive, 800 x 600 pixel, SVGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (2) memory card slots, (1) HDMI video out and (1) audio line out.	$1,500.00
EA9-T15CL-R	*C-more* EA9 series touch screen HMI, 15in color TFT LCD, analog resistive, 1024 x 768 pixel, XGA, LED backlight, (1) serial, (1) Ethernet, (2) USB ports and (2) memory card slots.	$1,777.00
EA9-T15CL	*C-more* EA9 series touch screen HMI, 15in color TFT LCD, analog resistive, 1024 x 768 pixel, XGA, LED backlight, (3) serial, (1) Ethernet, (2) USB ports, (2) memory card slots, (1) HDMI video out and (1) audio line out.	$2,722.00
EA9-RHMI	*C-more* EA9 series headless HMI, (2) serial, (1) Ethernet and (2) USB ports, (1) HDMI audio/video out and (1) memory card slot.	$506.00
EA9-PGMSW	*C-more* Windows programming software, CD or free download. For use with *C-more* EA9 series touch panels. Requires USB or Ethernet connection to touch panel.	$13.00 on CD, or FREE download
USB-CBL-AB3	AutomationDirect programming cable, USB A to USB B, 3ft cable length. For use with *C-more* HMIs, Do-more and Productivity series CPUs and most USB devices.	$12.00
USB-CBL-AB6	AutomationDirect programming cable, USB A to USB B, 6ft cable length. For use with *C-more* HMIs, Do-more and Productivity series CPUs and most USB devices.	$16.00
USB-CBL-AB10	AutomationDirect programming cable, USB A to USB B, 10ft cable length. For use with *C-more* HMIs, Do-more and Productivity series CPUs and most USB devices.	$36.50
USB-CBL-AB15	AutomationDirect programming cable, USB A to USB B, 15ft cable length. For use with *C-more* HMIs, Do-more and Productivity series CPUs and most USB devices.	$42.50

C-more Selection Guide & Specifications

Specification \ Model	6" TFT color w/ base features	6" TFT color w/ full features	7" TFT color w/ base features	7" TFT color w/ full features
Part Number	EA9-T6CL-R	EA9-T6CL	EA9-T7CL-R	EA9-T7CL
Price	$691.00	$965.00	$668.00	$771.00
Display Actual Size and Type	5.7" TFT color		7.0" TFT color	
Display Viewing Area	4.54" x 3.40" [115.2 mm x 86.4 mm]		6.00" x 3.60" [152.4 mm x 91.4 mm]	
Weight	1.56 lb [710g]	1.59 lb [720g]	1.46 lb [660g]	1.48 lb [670g]
Screen Pixel	320 x 240 (QVGA)		800 x 480 (WVGA)	
Display Brightness	280 nits (typ)		350 nits (typ)	
LCD Panel Dot Pitch	0.18 mm x 0.18 mm		0.190 mm x 0.190 mm	
Color Scale	65,536 colors			
Backlight Average Lifetime*	50,000 hours @ 25°C			
Touch Panel Type **	Four-wire analog resistive, single touch			
Project Memory	26MB			
Number of Screens	Up to 999 screens – limited by project memory			
Realtime Clock	Realtime clock built into panel, backed up for 30 days at 25°C			
Calendar – Month / Day / Year	Yes - monthly deviation 60sec (Reference)			
Serial Port 1	15-pin D-sub female – RS232C, RS-422/485			
Serial Port 2	N/A	3-wire terminal block – RS-485	N/A	3-wire terminal block – RS-485
Serial Port 3	N/A	RJ-12 modular jack – RS-232C	N/A	RJ-12 modular jack – RS-232C
USB Port – Type B	USB 2.0 High speed (480 Mbps) Type B – Download/Program – Max. cable length 15-feet			
USB Port – Type A	USB 2.0 High speed (480 Mbps) Type A – for USB device options – Max. cable length 15-feet – Bus Power – Less than 200mA at 5VDC			
Ethernet Port	N/A	10/100 Base-T, auto MDI/MDI-X		
Ethernet Port - Expansion Module	N/A	EA-ECOM	N/A	EA-ECOM
Audio Line Out	N/A	3.5 mm mini jack – requires amplifier and speaker(s)	N/A	3.5 mm mini jack – requires amplifier and speaker(s)
Mic In (Future)	N/A	3.5 mm mini jack	N/A	3.5 mm mini jack
SD Card Slot	1 slot supports max 2GB (SD,) max 32GB (SDHC)			
HDMI Video Out	N/A			
HDMI Supported Resolution	N/A			
Supply Power	10.2-26.4 VDC Class 2 or SELV (Safety Extra-Low Voltage) Circuit or Limited Energy Circuit (LEC), or use the AC/DC Power Adapter, EA-AC, to power the touch panel from a 100-240 VAC, 50/60 Hz power source. Reverse Polarity Protected			
Power Consumption	16.0 W 1.30 A @ 12VDC 0.66 A @ 24VDC			
Internal Fuse (non-replaceable)	4.0 A			
Altitude	Up to 2000m (6562ft)			
Operating Temperature	0 to 50°C (32 to 122°F) Maximum surrounding air temperature rating: 50°C (122°F) IEC 60068-2-14 (Test Nb, Thermal Shock)			
Storage Temperature	–20 to +60°C (–4 to +140°F) IEC 60068-2-1 (Test Ab, Cold) IEC 60068-2-2 (Test Bb, Dry Heat) IEC 60068-2-14 (Test Na, Thermal Shock)			
Humidity	5-95% RH (non-condensing)			
Environment	For use in Pollution Degree 2 environment, no corrosive gases permitted			
Noise Immunity	(EN61131-2), EN61000-4-2 (ESD), EN61000-4-3 (RFI), EN61000-4-4 (FTB), EN61000-4-5 (Serge), EN61000-4-6 (Conducted) EN61000-4-8 (Power frequency magnetic field immunity) (Local Test) RFI, (145MHz, 440Mhz 10W @ 10cm), Impulse 1000V @ 1µs pulse			
Withstand Voltage	1000VAC, 1min. (FG to Power supply)			
Insulation Resistance	> 10M ohm @ 500VDC (FG to Power supply)			
Vibration	IEC60068-2-6 (Test Fc)			
Shock	IEC60068-2-27 (Test Ea)			
Emission	EN55011 Class A (Radiated RF emission)			
Enclosure	NEMA 250 type 4/4X indoor use only UL50 type 4X indoor use only IP-65 indoor use only (When mounted correctly)		NEMA 250 type 4/4X indoor use only UL50 type 4X indoor use only IP-65 (not tested by UL) (When mounted correctly)	
Agency Approvals	UL508, E157382, Class 1, Div 2, Groups A, B, C CE (EN61131-2), RoHS (2011/65/EU) CUL Canadian C22.2		UL61010, E157382 CE (EN61131-2), RoHS (2011/65/EU) CUL Canadian C22.2	

NOTES: ****The backlight average lifetime is defined as the average usage time it takes before the brightness becomes 50% of the initial brightness. The lifetime of the backlight depends on the ambient temperature. The lifetime will decrease under low or high temperature usage.***
*****The touchscreen is designed to respond to a single touch. If it is touched at multiple points at the same time, an unexpected object may be activated.***

C-more 7” TFT Color Touch Panel - Full Model

EA9-T7CL

C-more EA9 series touch screen interface panel, 7-inch color TFT (7.0 inch viewable screen), 64K colors, 800 x 480 pixel WVGA screen resolution, 800MHz CPU, 12-24 VDC powered, NEMA 4/4X, IP65 (when mounted correctly; for indoor use only)(not tested by UL), non-replaceable LED backlight. Includes (3) serial ports, USB 2.0 Type A and B ports and Ethernet port; supports SD memory card. Compatible with EA9-PGMSW programming software version 6.3 or later.

$771.00

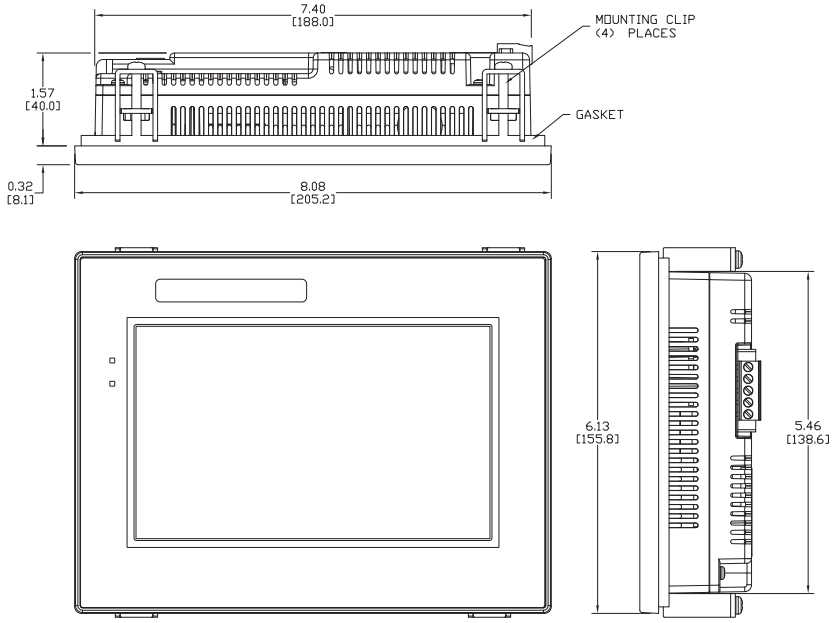
Features

- 7.0” diagonal color TFT (Thin Film Transistor) LCD display with 64K colors
- 800 x 480 pixel resolution
- 350 NITS display brightness
- 50,000 hour average backlight half-life
- Analog resistive (1024 X 1024) touch screen allowing unlimited touch areas
- USB port B (program/download) and USB port A (USB device options)
- Ethernet 10/100 Base-T port (program/download & PLC communication)
- Expansion Module Support
- Use EA-ECOM for second Ethernet Port
- Remote Internet access
- Serial PLC interface (RS-232/422/485)
- One built-in SD memory card slot
- 12–24 VDC powered, 110VAC power adapter (optional)
- Audio Line Out, stereo - requires amplifier and speaker(s)
- 26MB project memory
- Data logging
- 0 to 50°C [32 to 122°F] operating temperature range
- NEMA 4/4X, IP65(not tested by UL) when mounted correctly, indoor use only
- Slim design saves panel space
- UL, cUL & CE agency approvals
- 2-year warranty from date of purchase

Function	*Available*
Ethernet	Yes
USB	Yes
SD Card	Yes
Audio Out	Yes
HDMI Video Out	No
Expansion Module	Yes

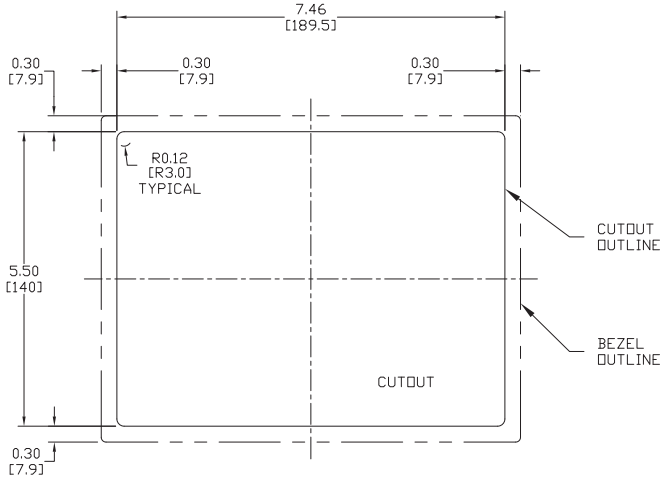
Dimensions

Units: inches [mm]

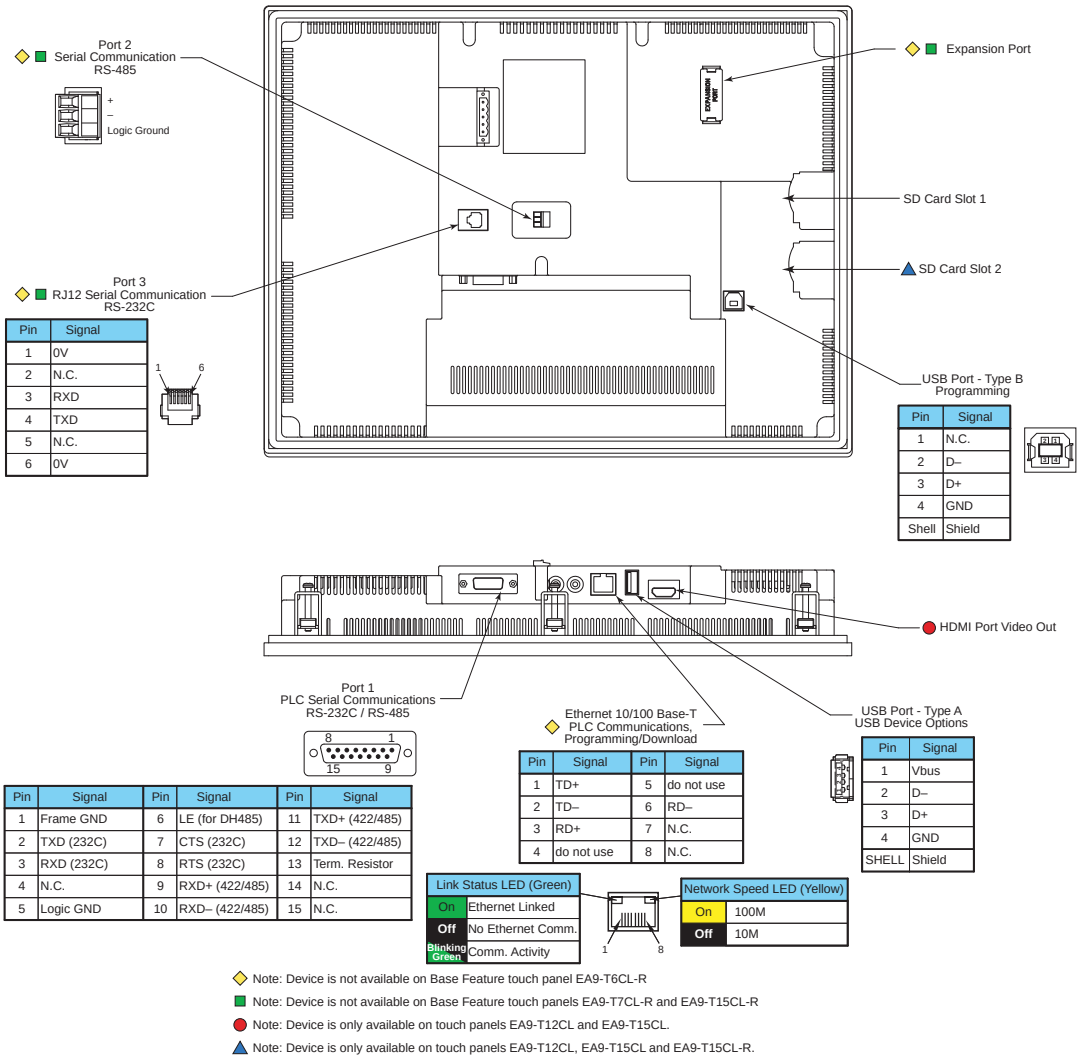


See our website www.AutomationDirect.com for complete engineering drawings.

Mounting Cutout



C-more Communication Ports



Pin	Signal
1	0V
2	N.C.
3	RXD
4	TXD
5	N.C.
6	0V

Pin	Signal
1	N.C.
2	D–
3	D+
4	GND
Shell	Shield

Pin	Signal	Pin	Signal	Pin	Signal
1	Frame GND	6	LE (for DH485)	11	TXD+ (422/485)
2	TXD (232C)	7	CTS (232C)	12	TXD– (422/485)
3	RXD (232C)	8	RTS (232C)	13	Term. Resistor
4	N.C.	9	RXD+ (422/485)	14	N.C.
5	Logic GND	10	RXD– (422/485)	15	N.C.

Pin	Signal	Pin	Signal
1	TD+	5	do not use
2	TD–	6	RD–
3	RD+	7	N.C.
4	do not use	8	N.C.

Pin	Signal
1	Vbus
2	D–
3	D+
4	GND
SHELL	Shield

Link Status LED (Green)	
On	Ethernet Linked
Off	No Ethernet Comm.
Blinking Green	Comm. Activity

Network Speed LED (Yellow)	
On	100M
Off	10M

◇ Note: Device is not available on Base Feature touch panel EA9-T6CL-R

■ Note: Device is not available on Base Feature touch panels EA9-T7CL-R and EA9-T15CL-R

● Note: Device is only available on touch panels EA9-T12CL and EA9-T15CL.

▲ Note: Device is only available on touch panels EA9-T12CL, EA9-T15CL and EA9-T15CL-R.

Ethernet Port

The Ethernet port has several uses:

- Download program to panel
- Communicate to PLCs/PCs
- Send e-mail
- Access FTP server
- Act as a Web server
- Remote Internet access

The Ethernet port has an RJ-45 8-wire modular connector with green and yellow LEDs.

- The yellow LED indicates network speed – off for a 10 Mbps connection and illuminated for a 100 Mbps connection.
- The green LED indicates link status and illuminates when a link is established.

Note: EA6-T6CL-R does not include an Ethernet port, and does not have these capabilities.

Expansion Port

The expansion port supports the EA-ECOM module to provide a second Ethernet Port for all full featured models.

USB Port B

Program *C-more* via the USB programming port. It's fast and easy, with no baud rate settings, parity, or stop bits to worry about. We stock standard USB cables for your convenience. USB Port B can be used to upload or download projects to and from a PC.

USB Port A

The Universal Serial Bus (USB) Port A is a standard feature on all models and can be used to connect various USB HID (Human Input Device) devices to the panel, such as the following:

- USB flash drives (USB-FLASH)
- USB keyboards
- USB barcode scanners
- USB card scanners

C-more can log data to the USB flash drive as well as load projects to the panel from the pen drive. You can also back up project files and panel firmware.

Sound Interface (Audio Line Out)

When attached to an amplifier and speaker(s), *C-more* can play warning sounds or pre-recorded messages such as: "conveyor is jammed". *C-more* supports WAV type files. The output is stereo.

Serial Port

Port 1 - Connect to your serial controller network via Port 1. Port 1 is a 15-pin port that supports RS-232 or RS-422/485.

Port 2 - Connect your RS-485 network via Port 2. Port 2 is provided with a 3-wire removable terminal block.

Port 3 - Connect to your RS-232C device via Port 3. Port 3 is an RJ12 connection.

HDMI Video Out

EA9-T12CL and EA9-T15CL include an HDMI Type A port to provide video output to a projector or remote monitor.

C-more Communication Protocols & Cables

Compatibility Table

PLC Family	Model		Protocols
Allen-Bradley	MicroLogix 1000, 1100, 1200, 1400, 1500, SLC 5-/01/02/03		DH485/AIC/AIC+
	MicroLogix 1000, 1100, 1200, 1400 and 1500		DF1 Half Duplex; DF1 Full Duplex
	SLC 5-/03/04/05		
	ControlLogix™, CompactLogix™, FlexLogix™		
	PLC-5		DF1 Full Duplex
	ControlLogix, CompactLogix, FlexLogix - Tag Based		DF1 Half Duplex; DF1 Full Duplex
	ControlLogix, CompactLogix, FlexLogix - Generic I/O Messaging		EtherNet/IP Server
	ControlLogix, CompactLogix, FlexLogix - Tag Based		EtherNet/IP Client
	Micrologix 1100, 1400 & SLC5/05, all via native Ethernet port		
	MicroLogix 1000, 1100, 1200, 1400,1500 & SLC 5-03/04/05, all via ENI Adapter		
	Micro 800 series		Modbus RTU
			Modbus TCP
	Micro 800 series - Tag Based		DF1 Full Duplex
			EtherNet/IP Client
Modbus RTU	Modbus RTU devices		Modbus RTU
Modbus TCP/IP	Modbus TCP/IP devices		Modbus TCP/IP
GE	90/30, 90/70, Micro 90, VersaMax Micro		SNPX
	90/30, Rx3i		SRTP Ethernet
Mitsubishi	FX Series		FX Direct
	Q02, Q02H, Q06H, Q12H, Q25H		Q CPU
	Q, QnA Serial		QnA Serial
	Q, QnA Ethernet		QnA Ethernet
Omron	C200 Adapter, C500		Host Link
	CJ1/CS1 Serial, CJ1/CS1 Ethernet		FINS
Modicon	984 CPU, Quantum 113 CPU, AEG Modicon Micro Series 110 CPU: 311-xx, 411-xx, 512-xx, 612-xx		Modbus RTU
Siemens	S7-200 CPU, RS-485 Serial		PPI
	S7-200 CPU, S7-300 CPU, S7-400, S7-1200 CPU, S7-1500; Ethernet		Ethernet ISO over TCP
Productivity Series	all		Productivity Serial
			Productivity Ethernet
Do-more	all		Do-more Serial
			Do-more Ethernet
CLICK	all		Modbus (CLICK addressing)
			Modbus TCP (CLICK addressing)
Direct LOGIC	DL05/DL06	all	K-Sequence
			DirectNET
			Modbus (Koyo addressing)
		H0-ECOM/H0-ECOM100	Direct LOGIC Ethernet
	DL105	all	K-Sequence
	DL205	D2-230	K-Sequence
		D2-240	K-Sequence
			DirectNET
		D2-250/D2-250-1/D2-260/ D2-262	K-Sequence
			DirectNET
			Modbus (Koyo addressing)
		D2-240/D2-250-1/D2-260 using D2-DCM	DirectNET
			Modbus (Koyo addressing)
		H2-ECOM/H2-ECOM100	Direct LOGIC Ethernet
	DL305	D3-330/330P (Requires the use of a Data Communications Unit)	DirectNET
		D3-340	DirectNET
		D3-350	K-Sequence
			DirectNET
			Modbus (Koyo addressing)
		D3-350 using D3-DCM	DirectNET
			Modbus (Koyo addressing)
	DL405	D4-430	K-Sequence
			DirectNET
		D4-440	K-Sequence
			DirectNET
		D4-450/D4-454	K-Sequence
			DirectNET
			Modbus (Koyo addressing)
		All with D4-DCM	DirectNET
			Modbus (Koyo addressing)
		H4-ECOM/H4-ECOM100	Direct LOGIC Ethernet
	H2-WinPLC (Think & Do) Live V5.2 or later and Studio any version		Think & Do Modbus RTU (serial port)
	H2-WinPLC (Think & Do) Live V5.5.1 or later and Studio V7.2.1 or later		Think & Do Modbus TCP/IP (Ethernet port)

Cable Description	Cable Part Number	Price
AutomationDirect communication cable, 15-pin male D-sub to 6-pin RJ12, shielded, 9.8ft/3m cable length. For use with *C-more* or *C-more* Micro panel and AutomationDirect PLCs with RJ12 ports.	***EA-2CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 15-pin D-sub HD15 male, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a DL06, D2-250(-1), D2-260 or D2-262 (bottom port) CPU.	***EA-2CBL-1***	$31.50
AutomationDirect communication cable, 15-pin male D-sub to 4-pin RJ11, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a D3-340 CPU top or bottom port.	***EA-3CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 15-pin male D-sub, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a DL405 (top port) CPU.	***EA-4CBL-1***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 25-pin male D-sub, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a D2-DCM, D3-232-DCU, D3-350 (bottom port) or DL405 (bottom port) CPU.	***EA-4CBL-2***	$32.00
AutomationDirect communication cable, 15-pin male D-sub to 8-pin male mini DIN, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and an Allen-Bradley Micrologix CPU.	***EA-MLOGIX-CBL***	$47.50
AutomationDirect communication cable, 15-pin male D-sub to 9-pin female D-sub, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and an Allen-Bradley SLC 5/03, 5/04 or 5/05 CPU with DF-1 port.	***EA-SLC-232-CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 25-pin male D-sub, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and an Allen-Bradley PLC-5 CPU with a DF1 port.	***EA-PLC5-232-CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 6-pin RJ45, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and an Allen-Bradley SLC 5/01, 5/02 or 5/03 CPU with a DH485 port cable.	***EA-DH485-CBL***	$30.50
AutomationDirect communication cable, 15-pin male D-sub to 15-pin male D-sub, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro and GE Fanuc Series 90/30 or 90/70 serial port.	***EA-90-30-CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 25-pin male D-sub, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a Mitsubishi FX Series CPU.	***EA-MITSU-CBL***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 8-pin male mini DIN, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and a Mitsubishi FX Series CPU.	***EA-MITSU-CBL-1***	$31.00
AutomationDirect communication cable, 15-pin male D-sub to 25-pin male D-sub, shielded, 3m/9.8ft cable length. For use with *C-more* or *C-more* Micro panel and an Omron C200 or C500 CPU.	***EA-OMRON-CBL***	$31.00

Example Cables:

EA-2CBL

EA-2CBL-1

CLICK PLC Family Overview

CLICK PLUS PLC Units and Option Slot Modules

CLICK PLUS PLC Units										
PLC	Number of Option Slots	Communication Ports						MicroSD Slot	Battery Backup	Run-Time Edit	Price
		USB	Ethernet (Port 1)	RS-232 (Port 2)	RS-485 (Port 3)	Bluetooth	WLAN				
C2-01CPU	1	Yes (MicroB)	Yes (10/100)	Yes	None	None	None	None	Yes	Yes	$97.00
C2-01CPU-2	2										$136.00
C2-02CPU	1		None	None	None	Yes (external antenna required)	Yes (external antenna required)	None			$151.00
C2-02CPU-2	2										$193.00
C2-03CPU	1		Yes (10/100)	Yes	Yes			Yes			$205.00
C2-03CPU-2	2										$255.00

C2-01CPU

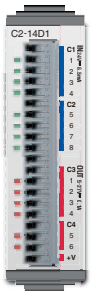
C2-01CPU-2

C2-02CPU

C2-02CPU-2

C2-03CPU

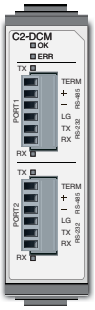
C2-03CPU-2


C2-14xx

C2-08xx-4VC

C2-08xx-6C

C2-08xx-6V



C2-DCM

CLICK PLUS Option Slot I/O Modules					
Part Number	Discrete Input Types	Discrete Output Types	Analog Input Types	Analog Output Types	Price
C2-14D1	8 DC (sink/source) 8 points high-speed**	6 DC (sink) 3 points high-speed**	None	None	$58.00
C2-14D2		6 DC (source) 3 points high-speed**			$58.00
C2-14DR		6 relay			$70.00
C2-14AR	8 AC				$70.00
C2-08D1-4VC*	4 DC (sink/source) 4 points high-speed**	4 DC (sink) 2 points high-speed**	2 channel; voltage (0–5 VDC) / current (4–20 mA); selectable separately per channel, 12-bit	2 channel; voltage (0–5 VDC) / current (4–20 mA); selectable separately per channel, 12-bit	$90.00
C2-08D2-4VC*		4 DC (source) 2 points high-speed**			$90.00
C2-08DR-4VC*		4 relay			$103.00
C2-08AR-4VC*	4 AC				$103.00
C2-08D1-6C	4 DC (sink/source) 4 points high-speed**	4 DC (sink) 2 points high-speed**	4 channel; current (0–20 mA), 12-bit	2 channel; current (4–20 mA), 12-bit	$90.00
C2-08D2-6C		4 DC (source) 2 points high-speed**			$90.00
C2-08DR-6C		4 relay			$103.00
C2-08AR-6C	4 AC				$103.00
C2-08D1-6V	4 DC (sink/source) 4 points high-speed**	4 DC (sink) 2 points high-speed**	4 channel; voltage (0–10 VDC), 12-bit	2 channel; voltage (0–10 VDC), 12-bit	$90.00
C2-08D2-6V		4 DC (source) 2 points high-speed**			$90.00
C2-08DR-6V		4 relay			$103.00
C2-08AR-6V	4 AC				$103.00

* -4VC Option Slot modules require that you select analog I/O type (voltage or current) in the CLICK programming software.
** High-speed Inputs and Outputs are only available when the Option Slot I/O Module is installed in Slot 0.

CLICK PLUS Option Slot Intelligent Modules		
Part Number	Description	Price
C2-DCM	Communications module, 2x RS-232/RS-485 ports, supports Modbus RTU and ASCII protocols	$118.00

CLICK PLUS PLC Specifications

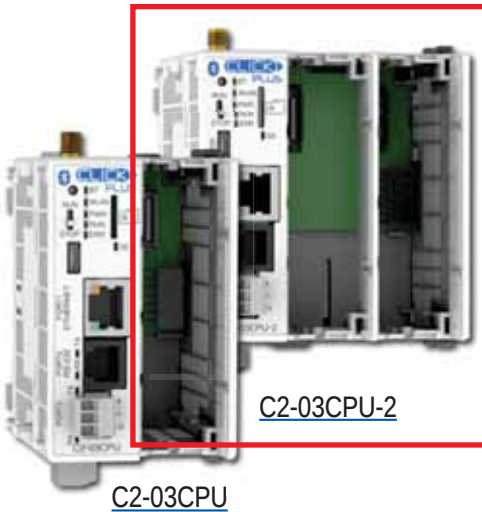
PLC Unit Specifications (continued)

C2-01CPU-2

C2-01CPU

C2-02CPU-2

C2-02CPU



C2-03CPU-2

C2-03CPU

CLICK PLUS PLC Unit Specifications				
		C2-01CPU C2-01CPU-2	C2-02CPU C2-02CPU-2	C2-03CPU C2-03CPU-2
Control Method		Stored Program/Cyclic execution method		
I/O Numbering System		Fixed in Decimal		
Ladder Memory (steps)		8000		
Total Data Memory (words)		8000		
Contact Execution (boolean)		< 0.2 µs		
Typical Scan (1k boolean)		< 1ms		
RLL Ladder Style Programming		Yes		
Run Time Edits		Yes		
Scan		Variable / fixed		
PLC Mode Switch		1 (RUN/STOP)		
FLASH Memory		Standard on PLC		
Protocol	***Modbus RTU (master/slave)***	Yes	No	Yes
	ASCII (in/out)	Yes	No	Yes
	Modbus TCP (client server)	Yes	Yes	Yes
	EtherNet/IP Implicit and Explicit (adapter server)	Yes	No	Yes*
MQTT		Publisher: 4 publishers, 3 blocks each Subscriber: 10 blocks		
Data Logging		N/A	N/A	Time, date, 16 addresses
CLICK Programming Software		Yes (Windows)		
Number of Instructions Available		21		
Control Relays		2000		
System Control Relays		1000		
Timers		500		
Counters		250		
Interrupt		Yes (external: 8 / timed: 4)		
Subroutines		Yes		
For/Next Loops		Yes		
Math (Integer and Hex)		Yes		
Drum Sequencer Instruction		Yes		
Internal Diagnostics		Yes		
Password Security		Yes		
System Error Log		Yes		
User Error Log		No		
Memory Backup		Super capacitor + battery		
Battery Backup		Yes (battery part #D0-MC-BAT)		
Calendar/Clock		Yes		

* EtherNet/IP available on the Ethernet RJ45 port only. Not available over Wi-Fi.

CLICK PLUS PLC Specifications

PLC Unit Specifications (continued)

CLICK PLUS PLC Unit Specifications							
		C2-01CPU	C2-01CPU-2	C2-02CPU	C2-02CPU-2	C2-03CPU	C2-03CPU-2
I/O Slot	Internal I/O	N/A (optional)					
	Option Slot Support	Yes, 1	Yes, 2	Yes, 1	Yes, 2	Yes, 1	Yes, 2
	Expansion I/O	Yes (max. 8 modules)					
Com. Ports	USB Port (programming)	Yes (device) (For programming and providing 5VDC power, microB USB)					
	Ethernet (RJ45)	Yes (10/100)		No		Yes (10/100)	
	Serial Port RS-232 (RJ12)	Yes		No		Yes	
	Serial Port RS-485 (terminal block)	No				Yes	
	WLAN	No		Yes (RP-SMA connection for optional external antenna, shared)			
	Bluetooth	No					
Status Indicators	WLAN Status LED	None		1			
	Bluetooth Status LED	None		1			
	CPU Status LED	3 (PWR/RUN/ERR)					
	Ethernet Status LED	2 (LINK/ACT 10/100)		None		2 (LINK/ACT 10/100)	
	Serial Status LED	2 (TX/RX)		None		2 (TX/RX)	
	SD Card Status LED	None				1	
Other	MicroSD Card Slot (SDHC-compatible)	No				Yes	
Power	Nominal Input Voltage	24VDC (4-pin terminal block)					
	Operating Voltage Range	24VDC, Class 2 or SELV (Safety Extra-Low Voltage) or Limited Energy Circuit power supply					
	Input Voltage Range	20.0–28.0 VDC					
	Maximum Inrush Current	30A @ 1ms					
	Power Consumption	20W	22W	20W	22W	20W	22W
	Acceptable External Power Drop	Max 10ms (AC power failure with C0-00AC or C0-01AC)					
	Current Required	110mA	120mA	105mA	115mA	130mA	140mA
	Fuse	None					
	External Fuse Recommended	No					
	Polarity Protection	Power input is reverse polarity protected					
	USB Supply	5VDC (via USB programming port)					
Communication Port & Terminal Block Replacement		N/A		N/A		AutomationDirect p/n C0-3TB	
24VDC Power Terminal Block Replacement		AutomationDirect p/n C0-4TB					
Antenna Requirements		N/A		2.4 GHz antenna, RP-SMA connector (AutomationDirect p/n SE-ANT250 or SE-ANT210)			
Drawing Link		PDF	PDF	PDF	PDF	PDF	PDF
Weight		3.5 oz [99g]	4.0 oz [114g]	3.3 oz [94g]	3.8 oz [109g]	4.0 oz [114g]	4.6 oz [129g]

CLICK PLUS PLC Specifications

General Specifications For All CLICK PLUS PLC Products

These general specifications apply to all CLICK PLUS PLCs. Please refer to the appropriate I/O temperature derating charts under the Option Slot module and Stackable I/O module specifications to determine best operating conditions based on the ambient temperature of your particular application.

General Specifications	
Operating Temperature	32°F to 131°F [0°C to 55°C]
Storage Temperature	–4°F to 158°F [–20°C to 70°C] IEC 60068-2-1 (Test Ab, Cold) IEC 60068-2-2 (Test Bb, Dry Heat) IEC 60068-2-14 (Test Na, Thermal Shock)
Ambient Humidity	30% to 95% relative humidity (non–condensing)
Environmental Air	No corrosive gases. Environmental pollution level is 2 (UL840)
Environment	For Indoor Use Only
Vibration	IEC60068-2-6 (Test Fc) 5–9Hz:3.5mm amplitude, 9–150Hz 1.0G 10 sweep cycles per axis on each of 3 mutually perpendicular axes.
Shock	IEC60068-2-27 (Test Ea) 15G peak, 11ms duration, 3 shocks in each direction per axis, on 3 mutually perpendicular axes.
Voltage Withstand (Dielectric)	1000VAC, 1 minute (between G and 24V IN)
Insulation Resistance	500VDC, 10M ohm (between G and 24V IN)
Noise Immunity	<EN61131-2> EN61000-4-2 (ESD): 4kV(Contact Discharge) 8kV(Air Discharge) EN61000-4-3 (RFI): 10V/m (80MHz–1GHz) ,3V/m (1.4 GHz–2.0 GHz) 1V/m (2.0 GHz–2.7 GHz) EN61000-4-4 (FTB) : 2kV ,positve/negative , 5kHz (DC Power Port) 1kV ,positve/negative, 5kHz (I/O and Communication Port) EN61000-4-5 (Surge): 0.5 kV/1kV line to line 0.5 kV/1kV line to earth EN61000-4-6 (Conducted): 10V ,0.15 MHz – 80MHz EN61000-4-8 (Power frequency magnetic field immunity) : 30A/m <Local Test> Impulse Immunity : 1000V @ 1µs pulse
Emissions	EN55011 Class A (Radiated RF emission)
Agency Approvals	UL61010 (File No. E157382, E316037); CE (EN61131-2); CUL Canadian C22.2
Radio Standards	FCC part15C (US), RED Article3.2 (CE), IC RSS-247 (Canada), MIC Item 19 of Article 2-1 (Japan), AS/NZS 4268 (Australia/New Zealand)
Other	RoHS 2011/65/EU Amendment (EU)2015/863

CLICK PLUS PLC Specifications

CLICK PLUS PLC Hardware/Software Compatibility

The table below shows the minimum software and hardware versions required for the CLICK PLUS PLCs and Option Slot Modules. The CLICK PLUS PLC can also utilize the CLICK Stackable I/O Modules, as any software and hardware version compatible with CLICK PLUS is also compatible with the CLICK Stackable I/O Modules.

CLICK PLUS PLC Features Software Compatibility

		Minimum CLICK Software Version				
Device Type	***Part Number***	***Hardware***	***High-Speed Inputs****	***High-Speed Outputs****	***EtherNet/IP***	***PID, DHCP, DNS, SNTP, MQTT***
CLICK PLUS CPU	C2-01CPU	v3.00	v3.00	v3.30	v3.00	v3.00
	C2-02CPU				N/A	
	C2-03CPU				v3.00	
	C2-01CPU-2	v3.20	v3.20		v3.20	v3.20
	C2-02CPU-2				N/A	
	C2-03CPU-2				v3.20	
Option Slot I/O Modules	C2-14D1	v3.00	v3.00	v3.30	N/A	N/A
	C2-14D2					
	C2-14DR			N/A		
	C2-14AR		N/A			
	C2-08D1-4VC	v3.00	v3.00	v3.30	N/A	N/A
	C2-08D2-4VC					
	C2-08DR-4VC			N/A		
	C2-08AR-4VC		N/A			
	C2-08D1-6C	v3.00	v3.00	v3.30	N/A	N/A
	C2-08D2-6C					
	C2-08DR-6C			N/A		
	C2-08AR-6C		N/A			
	C2-08D1-6V	v3.00	v3.00	v3.30	N/A	N/A
	C2-08D2-6V					
	C2-08DR-6V			N/A		
	C2-08AR-6V		N/A			
Option Slot Intelligent Modules	C2-DCM	v3.20	N/A	N/A	N/A	N/A

* High-speed Inputs and Outputs are only available when the Option Slot I/O Module is installed in Slot 0.

*DURA*PULSE GS4 AC Drives – Introduction

*DURA*PULSE GS4 AC Drives																					
Motor Rating	*HP*	*1*	*2*	*3*	*5*	*7.5*	*10*	*15*	*20*	*25*	*30*	*40*	*50*	*60*	*75*	*100*	*125*	*150*	*175*	*215*	*250*	*300*
	kW	*0.75*	*1.5*	*2.2*	*3.7*	*5.5*	*7.5*	*11*	*15*	*18.5*	*22*	*30*	*37*	*45*	*55*	*75*	*90*	*110*	*132*	*160*	*185*	*220*
230V Single-Phase Input / 230V Three-Phase Output		✓	✓	✓	✓	✓	✓	✓	✓	✓												
230V Three-Phase Input/Output		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
460V Three-Phase Input/Output		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Overview

The *DURA*PULSE GS4 series of AC drives includes many of the same standard features as our GS family of drives including dynamic braking, PID, removable keypad, and RS-485 Modbus communication.

The GS4 drive expands the *DURA*PULSE family by adding single-phase input capability (ALL 230VAC drives can be supplied single-phase), a built-in PLC, serial BACnet, and optional EtherNet/IP and ModTCP cards. GS4 QuickStart menus simplify configuration by consolidating the most-often-used parameters into concise groups.

*DURA*PULSE GS4 AC drives also offer sensorless vector control for improved speed regulation. The smart keypad is designed with defaults to quickly allow you to configure the drive, set the speed, start and stop the drive, and monitor critical parameters of your application. In addition, up to four drive configurations can be stored in the keypad, and transferred to additional *DURA*PULSE GS4 drives of the same model. Users can also store up to 32 parameters of their choice in a custom Quick-Start menu.

*DURA*PULSE GS4 offers three analog inputs, two analog outputs, one frequency output, ten digital inputs, two digital outputs, two SPDT relay outputs, and two STO inputs. All of the analog and digital I/O (except the Start/Stop and STO inputs) can be configured for a wide variety of input or output functions. Three option cards expand the I/O offering with a relay output card, an AC input card, and a combo DC I/O card.

Features

- Wide Offering from 1 to 300 hp
- Single-Phase/Three-Phase 230VAC Three-Phase 460VAC
- Single-Phase UL Ratings – 230VAC input for 1 to 100 hp models (see selection tables for derated output)
- Dual Rating Design – CT/VT Ratings (Light & Heavy Duty)
- Flexible Carrier Frequency to 15khz and Output Frequency to 600Hz
- STO – Safe Torque Off (TUV Certified)
- Built-in PLC to support up to 10k steps
- Free downloadable software for Drive Configuration and PLC Programming
- Field-upgradable Firmware via USB port (Drive, Keypad, & Communication Option Cards)
- Hot-Pluggable LCD Text-Based Keypad (IP20/ NEMA 1) can be remotely mounted
- Embedded Quick-Start Menus
- Local/Remote control mode selection from the Keypad or digital/comm input with Hand/ Off/Auto Control
- Display Units of Measure of your choice (GPM, FPM, etc.)
- Momentary Power Loss Restarts
- 100kA Short Circuit Current Rating
- Built-In DC Choke (some models)
- Flange-Mount Capability for frame sizes A to F (1 to 215 hp)
- Conduit Box(s) for NEMA 1 (Frame sizes D0 to G)
- Expanded I/O capability – 110V Inputs, Relay Outputs, combo DC I/O card
- Analog I/O – Configurable 3 Inputs and 2 Outputs
- Auto Speed Search capability
- Multi-Motor (Motor#1,#2) Control
- Dynamic Braking – Optional Dynamic Braking Units and Comprehensive offering of Resistors
- PID Controller – Including Sleep and Wake
- Password Protection
- RTD and/or PTC Input Motor Protection
- Parameter Organization similar to GS3 – GS3 Operational (External User PLC) control will work with minimal changes required.
- Calendar function allows a user to program the PLC with ON/OFF control in chronological order, daylight savings time, etc.
- Modularized design eases maintenance and expansion, including quick replacement of fans
- High speed communication interfaces with MODBUS RTU and BACnet protocols built in, with optional communication cards: MODBUS TCP, EtherNet/IP
- Circuit boards have conformal coating for improved environmental tolerance
- Excellent heat-sink design; able to operate at 50°C ambient temperature
- Fire Mode – Run fire mode during emergencies to have uninterrupted smoke removal and system pressure
- Multi-pump control: fixed quantity, fixed displacement, and fixed time-circulating control; able to control up to 8 pumps (Optional multi-control relay output card is required.)
- Two-year warranty
- CE, TUV, UL, cUL

Accessories

- AC line reactors
- EMI filters
- RF filter
- Braking resistors
- Braking units (for models 20hp and above)
- Fuses
- Conduit boxes
- Flange-Mount Kits
- Replacement cooling fans
- Replacement keypad (and remote-mount bezel kit)
- I/O Option Cards
- EtherNet/IP comm card
- Modbus TCP comm card
- Four and eight-port RS-485 multi-drop termination boards
- GSoft2 drive configuration software
- GSLogic PLC programming software
- USB-485M – USB to RS-485 PC adapter (see "Communications Products" chapter for detailed information)
- Detailed descriptions and specifications for GS accessories are available in the "GS/ DURApulse Accessories" section.

Typical Applications

- Conveyors
- Compressors
- Material handling
- Extruding
- Grinding
- Shop tools
- Fans
- Pumps
- HVAC
- Mixing

DURAPULSE GS4 AC Drives – Selection Specifications

460V Class GS4 Specifications – Constant & Variable Torque Frame Sizes A, B (1hp–20hp)										
Model Name				GS4-41P0	GS4-42P0	GS4-43P0	GS4-45P0	GS4-47P5	GS4-4010	GS4-4015	GS4-4020
Frame Size				A						B	
Output Rating	Constant Torque (CT)	Max Motor Output	hp	1	2	3	5	7.5	10	15	20
			kW	0.75	1.5	2.2	3.7	5.5	7.5	11	15
		Rated Output Capacity	kVA	2.3	3.0	4.5	6.5	8.8	14	18	24
		Rated Output Current	A	2.9	3.8	5.7	8.1	11	17	23	30
		Carrier Frequency	kHz	2 to 6							
	Variable Torque (VT)	Max Motor Output	hp	1	2	3	5	7.5	10	15	20
			kW	0.75	1.5	2.2	3.7	5.5	7.5	11	15
		Rated Output Capacity	kVA	2.4	3.2	4.8	7.2	9.6	14	19	25
		Rated Output Current	A	3	4	6	9	12	18	24	32
		Carrier Frequency	kHz	2 to 15							
Input Rating *	CT	Rated Input Current	A	4.1	5.6	8.3	13	16	19	25	33
	VT			4.3	5.9	8.7	14	17	20	26	35
	Rated Voltage/Frequency			3-phase 380–480 VAC (-15% to +10%), 50/60Hz							
	Operating Voltage Range			323–528 VAC							
	Frequency Tolerance			47–63 Hz							
	Short Circuit Withstand (SCCR) (A, rms symmetrical)			100kA							
IE2 Efficiency - Relative Power Loss				2.6%	2.3%	2.2%	2.0%	1.9%	2.1%	2.0%	1.8%
Weight (kg [lb])				2.6 [5.7]					5.4 [11.9]		
Watt Loss @ 100% I (W) **				59	74	104	141	180	292	380	518
Cooling Method				natural convection		fan					
Dynamic Braking				built in							
DC Choke				optional							
EMI Filter				optional							

* *For Use With Three-Phase Motors Only.*
If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS4 AC Drives User Manual, Chapter 2 (www.automationdirect.com).
Please refer to "GS4 DURApulse Accessories – Fusing" (pg.tGSX-162) for input fusing information.
***** Watt loss is reduced if the GS4 drive is flange mounted (frame sizes A through F).***

DURAPULSE GS4 AC Drives – General Specifications

GS4 General Specifications (Applicable to All Models)		
Control Characteristics	Control Method	1: V/F (V/Hz control); 2: SVC (sensorless vector control)
	Starting Torque	Up to 120% Variable Torque (VT) or 150% Constant Torque (CT) for one minute
	V/F Curve	4 point adjustable V/Hz curve and square curve
	Speed Response Ability	5Hz
	Torque Limit	VT: 170% output current CT: 180% output current
	Torque Accuracy	±5%
	Max Output Frequency (Hz)	230V series: 600.00 Hz (75hp & above: 400.00 Hz) 460V series: 600.00 Hz (125hp & above: 400.00 Hz)
	Output Frequency Accuracy	Digital command: ±0.01%, -10°C to +40°C Analog command: ±0.1%, 25±10°C
	Output Frequency Resolution	Digital command: 0.01Hz Analog command: (0.03) x (max output frequency) / 60Hz [±11 bit]
	Overload Tolerance	VT duty: rated output current is 120% for 60 seconds CT duty: rated output current is 150% for 60 seconds
	Frequency Setting Signal	+10V to -10V, 0 to 10V, 4–20mA, 0–20mA
	Accel/Decel Time	0.00–600.00 / 0.0–6000.0 seconds
	Main Control Function	Fault restart; Parameter copy; Dwell; BACnet communication; Momentary power loss ride-through; Speed search; Over-torque detection; Torque limit; 16-step speed (max); Accel/Decel time switch; S-curve accel/decel; 3-wire sequence; Auto-Tuning (rotational, stationary); Frequency upper/lower limit settings; Cooling fan on/off switch; Slip compensation; Torque compensation; JOG frequency; MODBUS communication (RS-485 RJ45, max 115.2 kbps); DC injection braking at start/stop; Smart stall; PID control (with sleep function); Energy saving control; Optional ModbusTCP or EtherNet/IP communication/control
	Fan Control	230V model GS4-2020 and above: PMW control 230V model GS4-2015 and below: ON/OFF switch control 460V model GS4-4025 and above: PMW control 460V model GS4-4020 and below: ON/OFF switch control
Protection Characteristics	Motor Protection	Electronic thermal relay protection
	Over-current Protection	For drive model 230V and 460V: Over-current protection for 240% rated current Current clamp: VT duty 170–175%; CT duty 180–185%
	Over-voltage Protection	230V: drive will stop when DC-BUS voltage exceeds 410V 460V: drive will stop when DC-BUS voltage exceeds 820V
	Over-temperature Protection	Built-in temperature sensor
	Stall Prevention	Independent stall prevention during acceleration, deceleration, and running
	Restart After Instantaneous Power Failure	Up to 20 seconds (parameter settable)
	Ground Leakage Current Protection	Leakage current is higher than 50% of rated current of the AC motor drive
	Hi-Pot Test	UL508C; EN 61800-5-1
	Conformal Coating	IEC-60721-3-3
Agency Approvals		CE, Reach, RoHS, TUV, cULus; (Accessories are CE; Agency approvals other than CE do not apply to accessory conduit box kits, fan kits, flange mount kits, and braking resistors.) *To obtain the most current agency approval information, see the Agency Approval Checklist section on the specific part number's web page.*

GS4-Specific Optional Accessories – Flange Mounting Kits

Flange Mounting Kits

Optional GS4 drive flange mounting kits allow the heat sinks on the back of select GS4 drives to be positioned through the back of the control enclosure. Since a majority of the heat generated by the GS4 drive will be outside the enclosure, heat load will be reduced and a smaller enclosure may possibly be used. These flange mounting kits are applicable to GS4 drive frame sizes A through C.

NOTE: GS4 Frames D0, D, E, and F have integral flange mounting hardware; additional Flange Mounting Kit not required (see cutout dimensions below). Frame size G cannot be flange-mounted.

GS4 Frame Sizes A–C – Flange Mounting Kit Selection Table

Drive		Flange Mounting Kit **			Description
Model	Frame*	Part #	Price	Photo	
GS4-22P0 GS4-23P0 GS4-43P0	A	GS4-FMKIT-1	$74.00		GS4 series Flange Mounting Kit, NEMA 1; for use with multiple GS4 Frame A drives; adapter plate and mounting hardware included
GS4-21P0 GS4-25P0 GS4-41P0 GS4-42P0 GS4-45P0 GS4-47P5	A	GS4-FMKIT-A	$62.00		GS4 series Flange Mounting Kit, NEMA 1; for use with multiple GS4 Frame A drives; mounting hardware included
GS4-27P5 GS4-2010 GS4-2015 GS4-4010 GS4-4015 GS4-4020	B	GS4-FMKIT-B	$70.00		GS4 series Flange Mounting Kit, NEMA 1; for use with GS4 Frame B drives; mounting hardware included
GS4-2020 GS4-2025 GS4-2030 GS4-4025 GS4-4030 GS4-4040	C	GS4-FMKIT-C	$79.00		GS4 series Flange Mounting Kit, NEMA 1; for use with GS4 Frame C drives; mounting hardware included

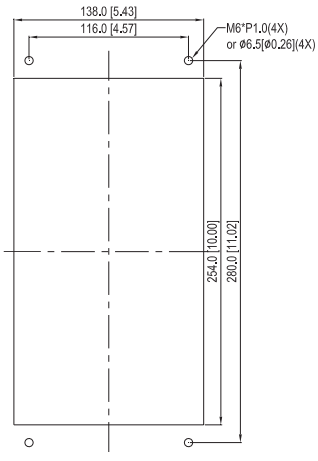
* *See panel cutout dimensions below for GS4 Frames A, B, C.*

* ***GS4 Frames D0, D, E, and F have integral flange mounting hardware; additional Flange Mounting Kit not required. See Appendix A of the GS4 User Manual for panel cut-out dimensions for frames D0, E, F.***

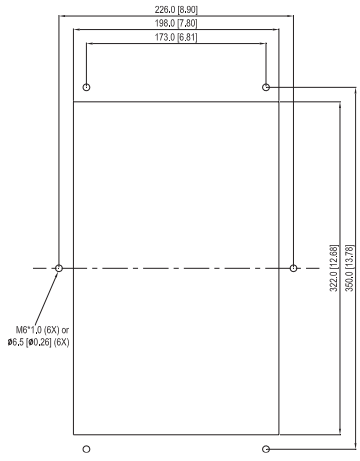
* ***Frame size G cannot be flange-mounted.***

GS4 Flange Mounting Kit Cutout Dimensions (mm [in])

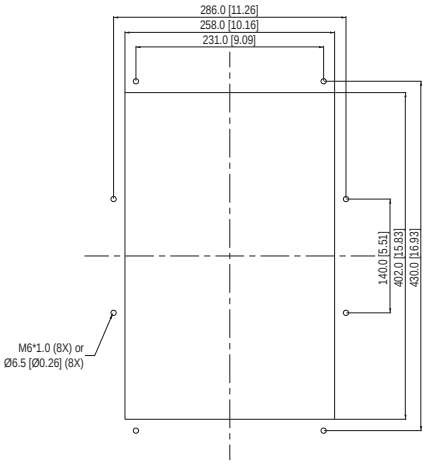
Frame A



Frame B



Frame C

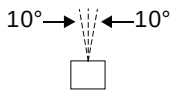


*DURA*PULSE GS4 AC Drives Specifications – Installation

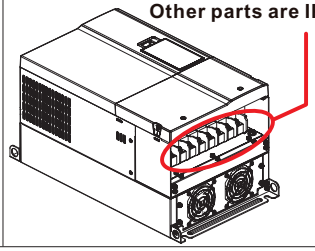
Understanding the installation requirements for your *DURA*PULSE AC drive will help to ensure that it operates within its environmental and electrical limits.

Note: Never use only this catalog for installation instructions or operation of equipment; refer to the User Manual, GS4_UMW.

Environmental Conditions for GS4 AC Drives

Condition	Operation	Storage	Transportation
Installation Location	IEC60364-1/IEC60664-1 Pollution degree 2, Indoor use only	n/a	n/a
Ambient Temperature	see separate Operating Temperature table below	-25°C to +70°C	
Relative Humidity	Max 90%, non-condensing, non-frozen	Max 95%, non-condensing, non-frozen	
Air Pressure	86 to 106 kPa		70 to 106 kPa
Pollution Level	IEC721-3-3, no concentrate		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Altitude	0–1000m (see separate derating section for altitudes of 1000–3000m)	n/a	n/a
Package Drop	n/a	ISTA procedure 1A(according to weight) IEC60068-2-31	
Vibration	1.0mm, peak to peak value range from 2Hz to 13.2Hz; 0.7G–1.0G range from 13.2Hz to 55Hz; 1.0G range from 55Hz to 512Hz. Comply with IEC 60068-2-6		
Impact	IEC/EN 60068-2-27		
Installation Orientation	 Max allowed offset angle ±10° (from vertical installation position)		

Operating Temperature and Protection Level

Frame Size		Top cover	Conduit Box	Protection Level	Operating Temperature
A–C	230V: 1.0–30 hp 460V: 1.0–40 hp	With top cover removed	Standard conduit plate	IP20 / UL Open Type	-10–50°C [14–122°F]
		With top cover in place		IP20 / UL Type1 / NEMA 1	-10–40°C [14–104°F]
D0–G	230V: >30hp 460V: >40hp	N/A	With conduit box	IP20 / UL Type1 / NEMA 1	-10–40°C [14–104°F]
	230V: >30hp 460V: >40hp	N/A	Without conduit box	IP00 / IP20 / UL Open Type * **Only the circled area is IP00.** **Other parts are IP20.** 	-10–50°C [14–122°F]

** Only the exposed terminal blocks are IP00; the other components are IP20*

WARNING: AC DRIVES GENERATE A LARGE AMOUNT OF HEAT WHICH MAY DAMAGE THE AC DRIVE. AUXILIARY COOLING METHODS MAY BE REQUIRED TO AVOID EXCEEDING MAXIMUM OPERATING TEMPERATURE. WHEN POSSIBLE, CONSIDER FLANGE MOUNTING TO LOWER ENCLOSURE TEMPERATURES.

WARNING: MAXIMUM AMBIENT TEMPERATURES MUST NOT EXCEED 50°C (122°F), OR 40°C (104°F), FOR ALL GS4 MODELS.

DURAPULSE GS4 AC Drives Specifications – Air Flow and Power (Heat) Dissipation

GS4 AC Drives Air Flow and Power (Heat) Dissipation

Model Number	Airflow Rate[1] for Cooling						Power (Heat) Dissipation[2]		
	Flow Rate[1] (cfm)			Flow Rate[1] (m^3/hr)			Power Dissipation[2] (Watt)		
	External	Internal	Total	External	Internal	Total	External (Heat sink)	Internal	Total
GS4-21P0	–	–	–	–	–	–	33	27	60
GS4-22P0	14	–	14	24	–	24	56	31	87
GS4-23P0	14	–	14	24	–	24	79	36	115
GS4-25P0	10	–	10	17	–	17	113	46	159
GS4-27P5	40	14	54	68	24	92	197	67	264
GS4-2010	66	14	80	112	24	136	249	86	335
GS4-2015	58	14	73	99	24	123	409	121	530
GS4-2020	166	12	178	282	20	302	455	161	616
GS4-2025	166	12	178	282	20	302	549	184	733
GS4-2030	166	12	178	282	20	302	649	216	865
GS4-2040	179	30	209	304	51	355	913	186	1099
GS4-2050	179	30	209	304	51	355	1091	220	1311
GS4-2060	228	73	301	387	124	511	1251	267	1518
GS4-2075	228	73	301	387	124	511	1401	308	1709
GS4-2100	246	73	319	418	124	542	1770	369	2139
GS4-41P0	–	–	–	–	–	–	33	25	58
GS4-42P0	–	–	–	–	–	–	45	29	74
GS4-43P0	14	–	14	24	–	24	71	33	104
GS4-45P0	10	–	10	17	–	17	103	38	141
GS4-47P5	10	–	10	17	–	17	134	46	180
GS4-4010	40	14	54	68	24	92	216	76	292
GS4-4015	66	14	80	112	24	136	287	93	380
GS4-4020	58	14	73	99	24	123	396	122	518
GS4-4025	99	21	120	168	36	204	369	138	507
GS4-4030	99	21	120	168	36	204	476	158	634
GS4-4040	126	21	147	214	36	250	655	211	866
GS4-4050	179	30	209	304	51	355	809	184	993
GS4-4060	179	30	209	304	51	355	929	218	1147
GS4-4075	179	30	209	304	51	355	1156	257	1413
GS4-4100	186	30	216	316	51	367	1408	334	1742
GS4-4125	257	73	330	437	124	561	1693	399	2092
GS4-4150	223	73	296	379	124	503	2107	491	2598
GS4-4175	224	112	336	381	190	571	2502	579	3081
GS4-4200	289	112	401	491	190	681	3096	687	3783
GS4-4250	–		454	–		771	–		4589
GS4-4300			454			771			5772

The required airflow shown in chart is for installing a single GS4 drive in a confined space.
When installing multiple GS4 drives, the required air volume would be the **cumulative air volume for all drives in the enclosure.**

Heat dissipation shown in the chart is for installing a single GS4 drive in a confined space.
When installing multiple drives, the volume of heat dissipation should be the cumulative heat dissipation of all drives in the enclosure.
Heat dissipation for each model is calculated by rated voltage, current and default carrier frequency.

1) External flow rate is across the heat sink. Internal flow rate is through the chassis.
Published flow rates are the result of active cooling using fans; factory-installed in the drive.
Unpublished flow rates (-) are the result of passive cooling in drives without factory-installed fans.
2) **When calculating power dissipation (Watt Loss) use the total value if the drive is foot mounted, or the internal value if the drive is flange mounted. Where only a total value is published, these models cannot be flange mounted.**

Dimensions for Minimum Clearance * (mm / in)

Frame Size	Above & Below	Side to Non-Heat Source	Side to Heat Source	Front
A–C	60 / 2.4	30 / 1.2	10 / 0.4	0 / 0
D(0)–F	100 / 4.0	50 / 2.0	n/a	0 / 0
G	200 / 7.9	100 / 4.0	2 x B	0 / 0

*** The minimum mounting clearances stated in this table applies to GS4 drives frames A to G. Failure to follow the minimum mounting clearances may cause the fan to malfunction and cause a heat dissipation problem.**

DURAPULSE GS4 AC Drives Specifications – Terminals

Main Circuit Terminals	
Terminal	***Description***
R/L1	Input Power – phase 1
S/L2	Input Power – phase 2
T/L3	Input Power – phase 3
U/T1, V/T2, W/T3	AC Drive Output
+1, +2	DC Choke Connection (frames A–C)
B1, B2	Braking Resistor Connection (frames A–C)
+1/DC+, -/DC-	External Dynamic Brake Unit (frames D–G)
⏚	Ground

Control Circuit Terminals

Terminal	***Description***	***Remarks***
+10V	Potentiometer Power Supply	Analog frequency setting: +10VDC 20mA max output
-10V		Analog frequency setting: -10VDC 20mA max output
+24V	Digital Control Signal Source	+24V±5%, 200mA max output; use with DCM
AI1	Analog Input 1	Range: 0–10V or 0/4–20mA = 0–Max Output Frequency AI1 switch = SW3; factory setting is 0–10V Impedance: 20kΩ (SW3 = 0–10V); 250Ω (SW3 = 0/4–20mA)
AI2	Analog Input 2	Range: 0/4–20mA or 0–10V = 0–Max Output Frequency AI2 Switch = SW4; factory setting is 0–20mA Impedance: 250Ω (SW4 = 0/4–20mA); 20kΩ (SW4 = 0–10V);
AI3	Analog Input 3	Impedance: 20kΩ Range: -10VDC to +10 VDC = 0–Max Output Frequency *Note: For -10V to +10V operation, connect the pot to +10V and -10V. Keep the pot wiper connected to AI3.*
ACM	Analog Common	Common for analog terminals
AO1	Analog Output 1	-10 to +10V max output current 2mA; max load 5kΩ Resolution: 0–10V corresponds to max operation frequency Range: 0–10V or -10 to +10V AO1 Switch = SW1, factory setting is 0–10V
AO2	Analog Output 2 (internal circuit same as AO1)	0–10V max output current 2mA; max load 5kΩ 0–20mA max output current 20mA; max load 500Ω Resolution: 0–10V corresponds to max operation frequency Range: 0–10V or 0/4–20mA AO2 Switch = SW2; factory setting is 0–10V
DIC	Digital Input Common Rail	Common terminal for multi-function inputs; Can be tied to DCM (for sinking) or to +24V (for sourcing)
DI1–DI8	Digital Inputs 1 thru 8	ON: the activation current is 3.3mA ≥ 11VDC OFF: leakage current tolerance is 1.4mA ≤ 5VDC
DCM	Digital Signal Common	Refer to terminals FO, FWD, REV
DO1	Digital Output 1	The AC motor drive releases various monitor signals such as drive in operation, frequency attained, and overload indication via transistor (open collector). Range: 5–48 VDC. Use with DOC.
DO2	Digital Output 2 (internal circuit same as DO1)	Multi-function Output 2 (photocoupler). Range: 5–48 VDC. Use with DOC.
DOC	Digital Output Common	Max 5–48 VDC, 50mA (user supplied)
+24V	STO Control Signal Source	Safe Torque Off function. Refer to Appendix E: Safe Torque Off for more details.
ECM	EStop Common	
SCM1	STO Input 1 Common	
SCM2	STO Input 2 Common	
STO1	STO Input 1	
STO2	STO Input 2	
FO	Digital Frequency Output	High-speed pulse output. Use with DCM. Digital Frequency Out = Drive Output Frequency [Hz] x P3.38 [Frequency Output Multiplier]. Duty-cycle: 50% ±1% Min load impedance: 1kΩ/100pf Max current: 30mA Max voltage: 30VDC
FWD	Forward Command	Use with DCM. ON = forward running OFF = deceleration to stop
R1	R1 Relay Common	Resistive Load: 3A(N.O.) / 3A(N.C.); 250VAC 5A(N.O.) / 3A(N.C.); 30VDC Inductive Load (COS 0.4): 1.2A(N.O.) / 1.2A(N.C.); 250VAC These terminals are to output monitoring signals, such as drive in operation, frequency attained, or overload indication. Note: R1 and R2 have N.O. and N.C. contacts.
R1C	R1 Relay N.C.	
R1O	R1 Relay N.O.	
R2	R2 Relay Common	
R2C	R2 Relay N.C.	
R2O	R2 Relay N.O.	
REV	Reverse Command	Use with DCM. ON = reverse running OFF = deceleration to stop
RJ45-1	RJ45 Port 1 (RS-485)	Pins 1,2,7,8: Reserved Pins 3,6: SGND Pin 4: SG- Pin 5: SG+ (RJ45-1 and RJ45-2 are connected internally to ports SG+ and SG- below)
RJ45-2	RJ45 Port 2 (RS-485)	
SG+, SG-, SGND	Modbus RS-485 (SG+ and SG- are connected internally to the two RJ45 ports above)	
⏚	Digital Control Ground	

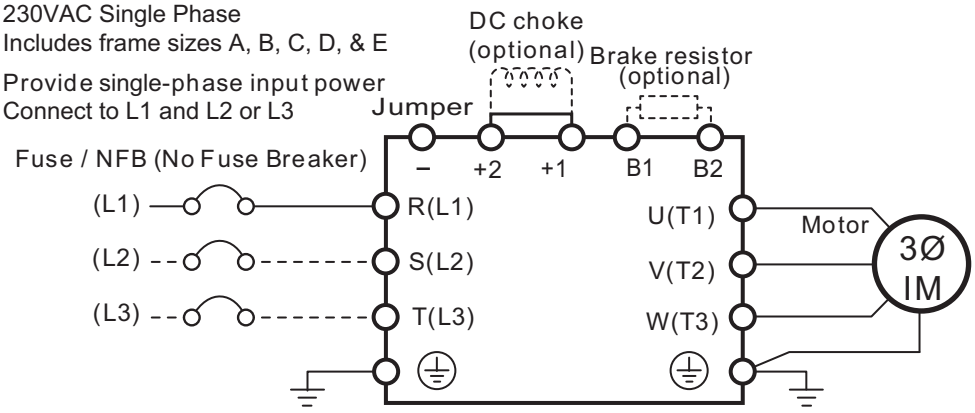
DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Power Wiring Diagram: GS4 230V Models – Single-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)
Note: We specify DC chokes, but we do not stock them.

GS4-2xxx models,
230VAC Single Phase
Includes frame sizes A, B, C, D, & E

Provide single-phase input power
Connect to L1 and L2 or L3



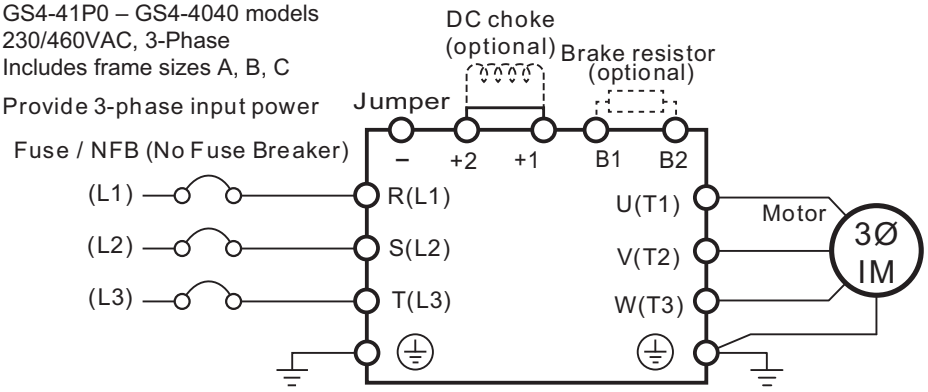
Connect 230VAC, Single-Phase power to any two of the R, S, or T terminals

Power Wiring Diagram: GS4 Frame Size A, B, C Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)
Note: We specify DC chokes, but we do not stock them.

GS4-21P0 – GS4-2030
GS4-41P0 – GS4-4040 models
230/460VAC, 3-Phase
Includes frame sizes A, B, C

Provide 3-phase input power



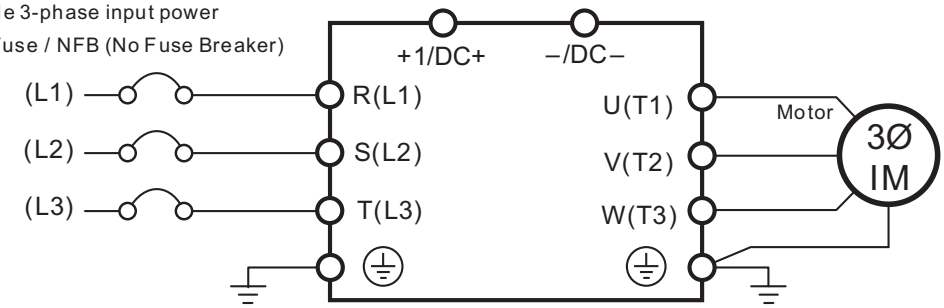
Power Wiring Diagram: GS4 Frame Size D0, D, E, F Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)

GS4-2040 – GS4-2100
GS4-4050 – GS4-200 models
230/460VAC, 3-Phase
Includes frame sizes D0, D, E, F

Provide 3-phase input power

+1/DC+ & -/DC- terminals are for the connection of an optional GS-xDBU dynamic braking unit.
Do NOT connect a braking resistor directly to terminals +1/DC+ and -/DC-. Connecting a resistor directly to these terminals will damage the GS4 drive!



DURAPULSE GS4 AC Drives – Basic Wiring Diagram

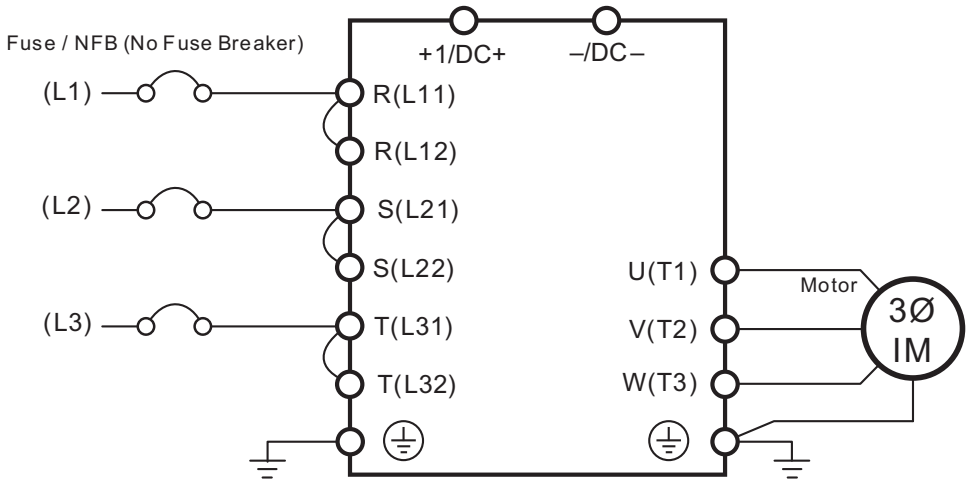
Power Wiring Diagram: GS4 Frame Size G Models – Three-Phase

Note: Users MUST connect wiring according to the circuit diagram shown below. (Refer to user manual GS4-UMW for additional specific wiring information.)

GS4-4250 &
GS4-4300 models
460VAC, 3-Phase

Provide 3-phase input power

+1/DC+ & -/DC- terminals are for the connection of an optional GS-xDBU dynamic braking unit.
Do NOT connect a braking resistor directly to terminals +1/DC+ and -/DC-. Connecting a resistor directly to these terminals will damage the GS4 drive!

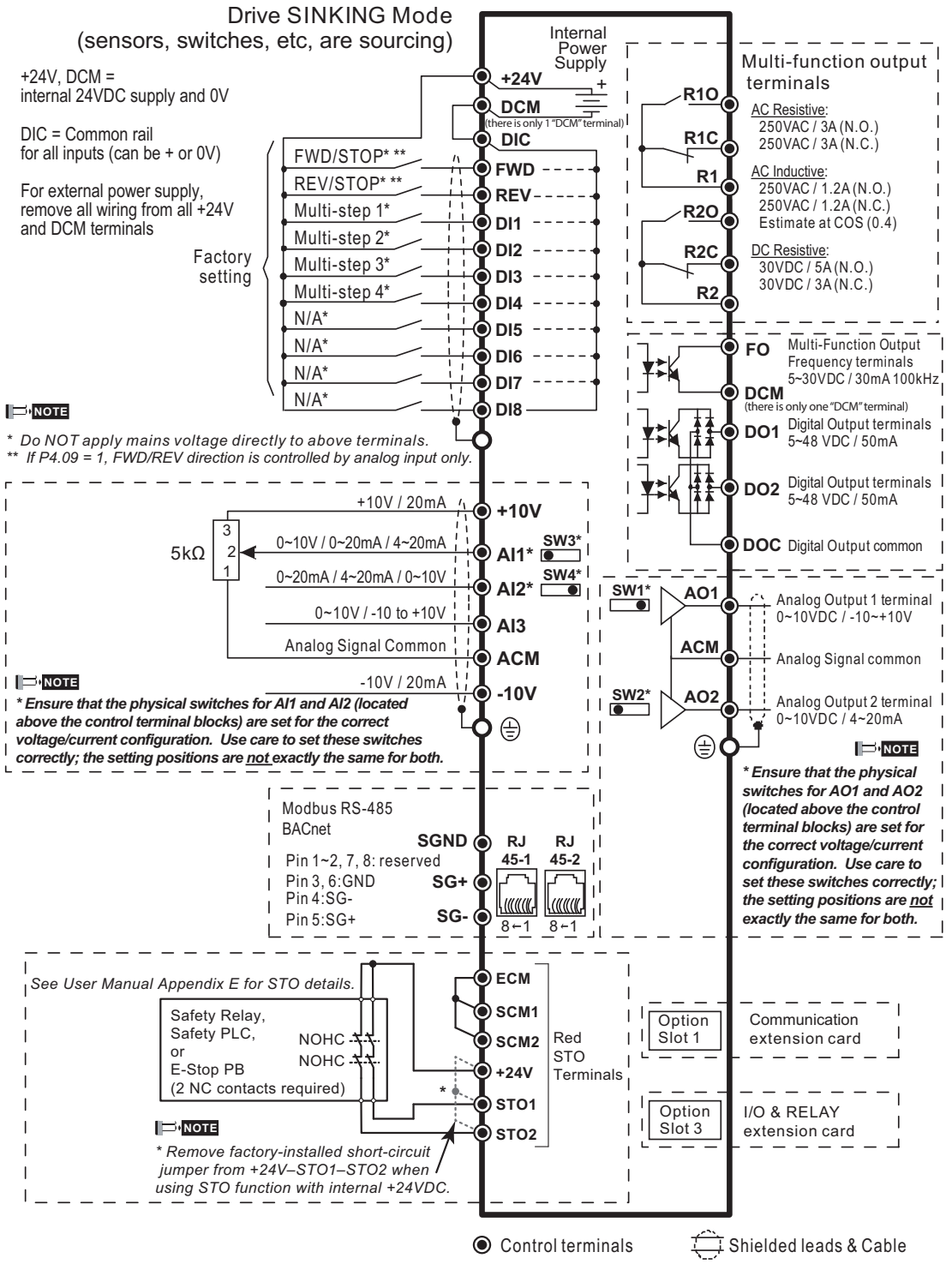


DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Control Wiring Diagram: Full I/O with Sinking Inputs (field devices are sourcing)

Note: Users must connect wiring according to the circuit diagram shown below.

WARNING: DO NOT PLUG A MODEM OR TELEPHONE INTO THE DURAPULSE RJ45 SERIAL COMM PORT, OR PERMANENT DAMAGE MAY RESULT.

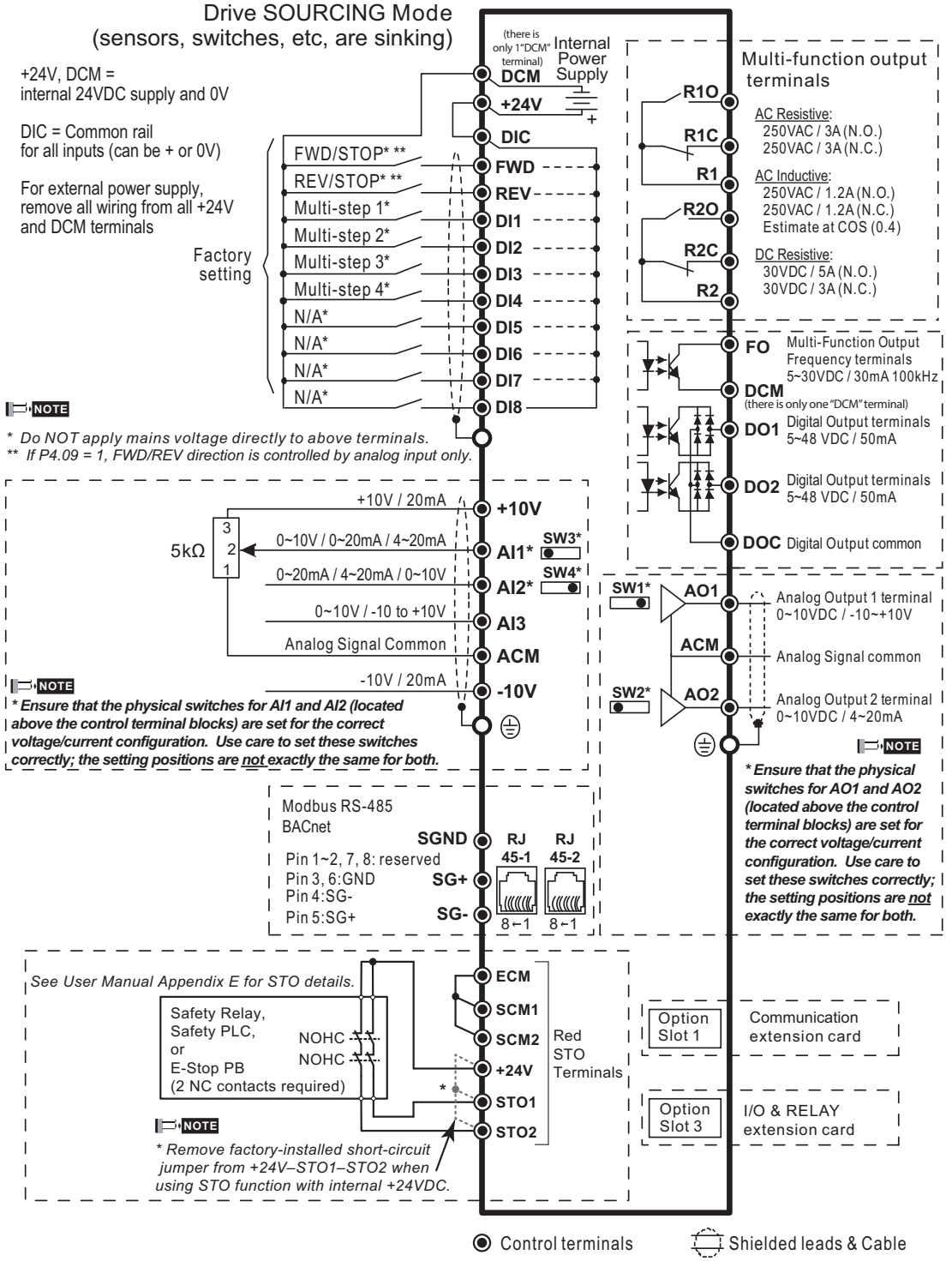


DURAPULSE GS4 AC Drives – Basic Wiring Diagram

Control Wiring Diagram: Full I/O with Sourcing Inputs (field devices are sinking)

Note: Users must connect wiring according to the circuit diagram shown below.

WARNING: DO NOT PLUG A MODEM OR TELEPHONE INTO THE DURAPULSE RJ45 SERIAL COMM PORT, OR PERMANENT DAMAGE MAY RESULT.

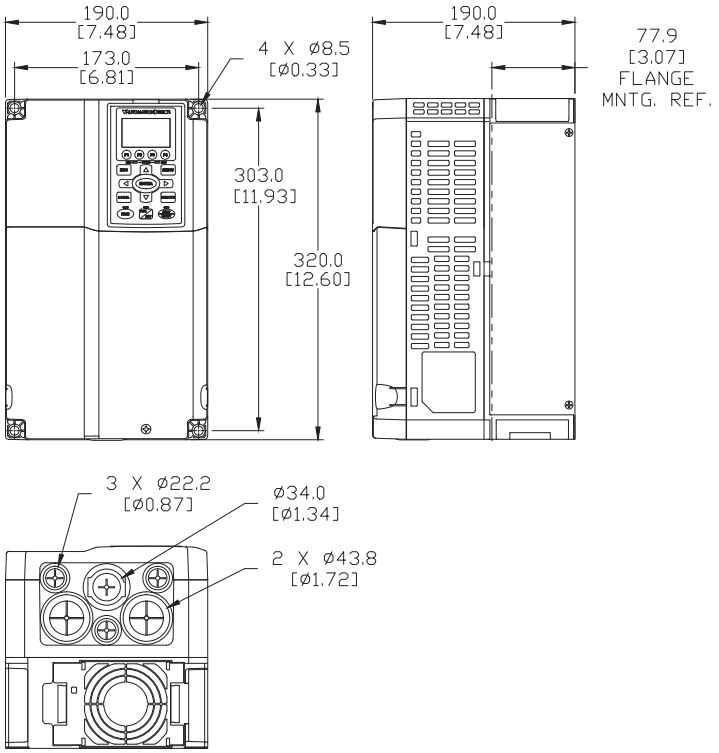


DURAPULSE GS4 AC Drives – Dimensions

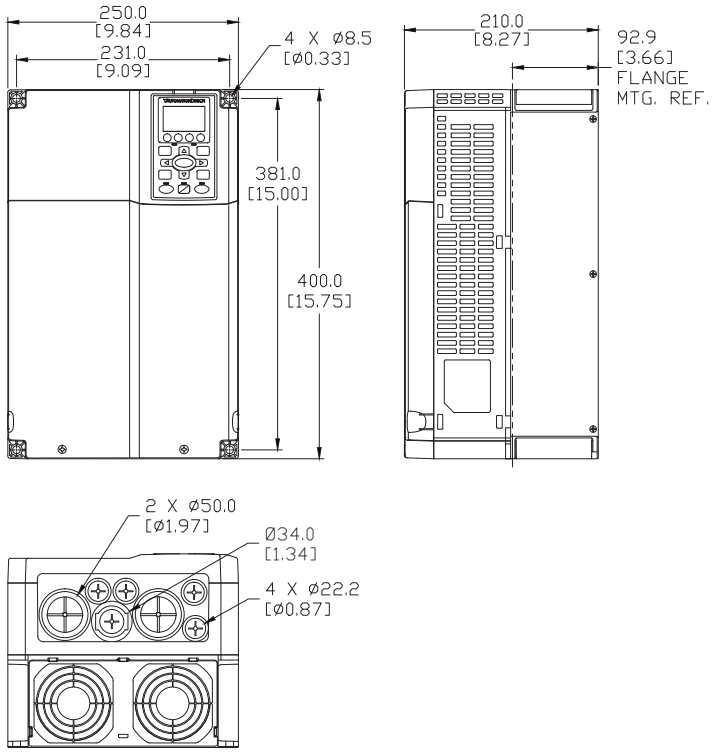
Dimensions – GS4 AC Drives (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings.

Dimensions – Frame Size B



Dimensions – Frame Size C



Submittal #19 Steel Access Door

Date: 02/13/23
Page: 1

COSMO WIND AND DR LLC- HIC
C/O NASSAU DOOR & WINDOW
487 W JOHN ST

HICKSVILLE NY 11801
(631)944-3400

Reference:

Quantity	UOM	Item/Description
1.0000	EA	EXT SU EXTERIOR DOOR UNIT STEEL DOOR, STEEL FRAME, CONTOUR 90MIN, SGL, LH, OS, 3-0, 6-8 HGT, FD90CT100, NO REINFORCE, SGL BORE & 218 DBLT BORE, ZINCROME STRIKE, NO DBLT STRIKE, STAIN STEEL RADIUS NRP, 3 NRP, C53 (4-1/2 - 5-1/2), BRONZE W/S, 90MIN DR LABEL, PUBLIC ACCESS MILL, NO CASING

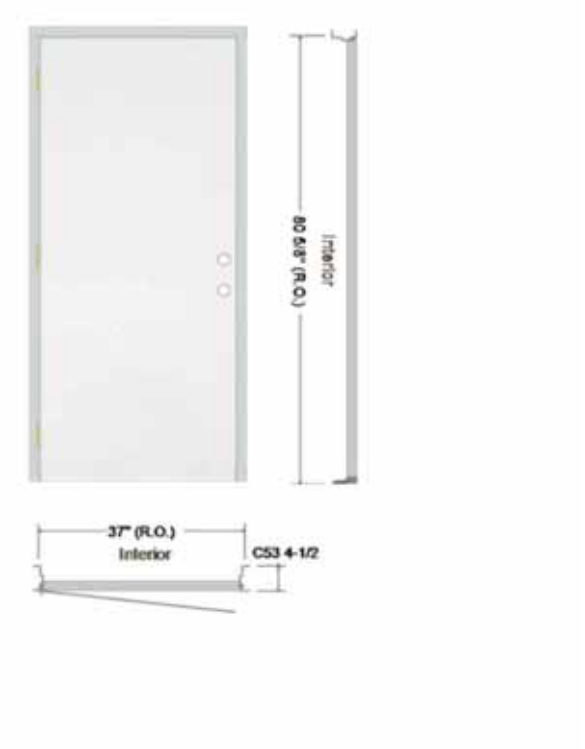
:
Date: 02/13/23
Page: 2

COSMO WIND AND DR LLC- HIC
C/O NASSAU DOOR & WINDOW
487 W JOHN ST

HICKSVILLE NY 11801
(631)944-3400

Reference:

Quantity	UOM	Item/Description
1.0000	EA	EXT SU EXTERIOR DOOR UNIT STEEL DOOR, STEEL FRAME, CONTOUR 90MIN, SGL, RH, OS, 3-0, 6-8 HGT, FD90CT100, NO REINFORCE, SGL BORE & 218 DBLT BORE, ZINCROME STRIKE, NO DBLT STRIKE, STAIN STEEL RADIUS NRP, 3 NRP, C53 (4-1/2 - 5-1/2), BRONZE W/S, 90MIN DR LABEL, PUBLIC ACCESS MILL, NO CASING



66895
Rev 03

Kwikset

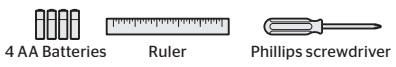
ENGLISH

Powerbolt 2

TOUCHPAD KEYLESS ENTRY

Installation and User Guide

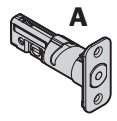
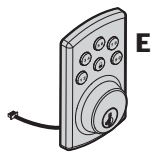
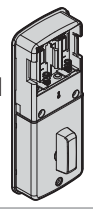
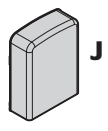
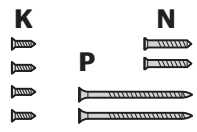
Required tools



Additional Tools (depending on application)

Kwikset Technical Support
1-800-327-5625
www.kwikset.com

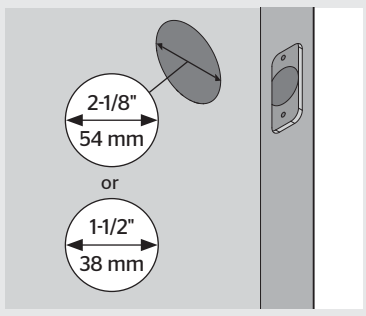
Parts List

Latch 	Drive-In Collar	Strike	SmartKey Tool
Exterior Assembly 	Keys	Mounting Plate	Interior Assembly 
Interior Cover 	Latch and Strike Screws 	Interior Assembly Screws	Mounting Plate Screws

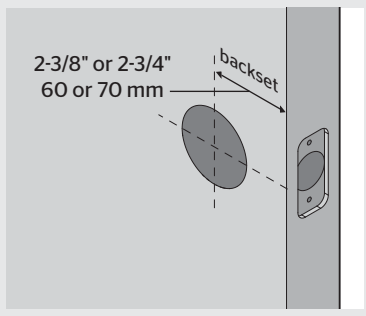
1 Prepare the door and check dimensions

If drilling a new door, use the supplied template and the complete door drilling instructions available at www.kwikset.com/doorprep

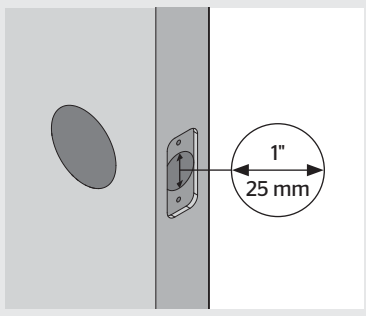
A Measure to confirm that the hole in the door is either 2-1/8" (54 mm) or 1-1/2" (38 mm).



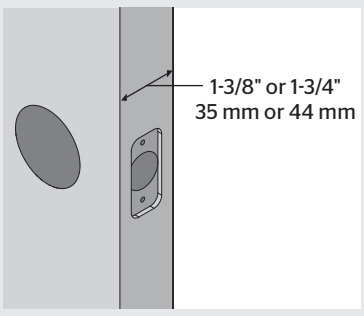
B Measure to confirm that the backset is either 2-3/8" or 2-3/4" (60 or 70 mm).



C Measure to confirm that the hole in the door edge is 1" (25 mm).



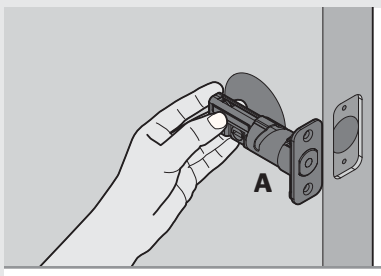
D Measure to confirm that the door is either 1-3/8" or 1-3/4" (35 mm or 44 mm) thick.



Note: Additional door preparation may be required for doors with 1-1/2" (38 mm) holes. Consult the deadbolt drilling instructions at www.kwikset.com/doorprep

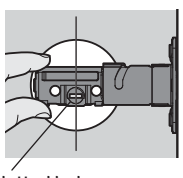
2 Install the latch and strike

A Hold the latch in front of the door hole, with the latch face flush against the door edge.



Is the slotted hole centered in the door hole?

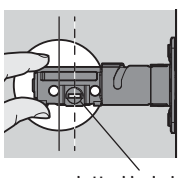
YES



slotted hole is centered

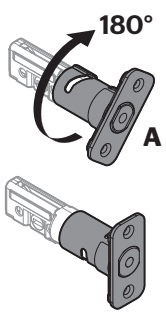
No adjustment is required. Proceed to next step.

NO



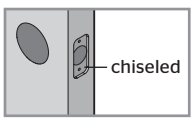
slotted hole is NOT centered

Rotate latch face as shown to extend latch.

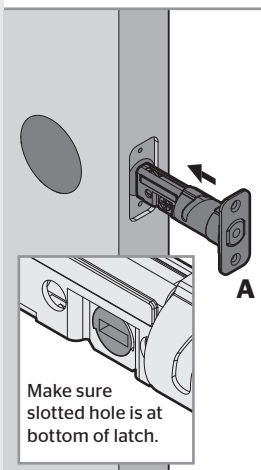


B Is the door edge chiseled?

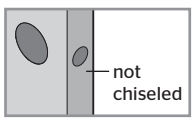
YES



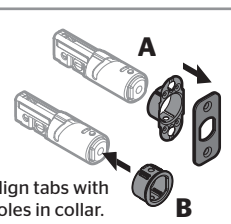
Install latch in door with supplied screws.



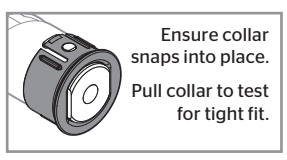
NO



Use a flathead screwdriver to lift tabs on collar of rectangular face to remove it from latch. Install drive-in collar.



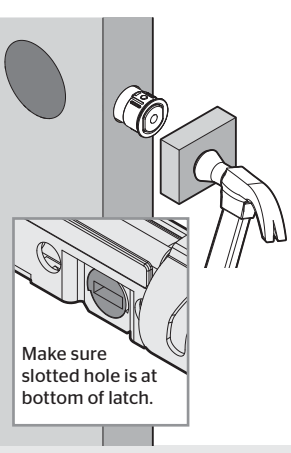
Align tabs with holes in collar.



Ensure collar snaps into place.

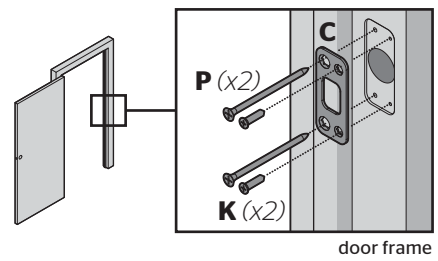
Pull collar to test for tight fit.

Install latch in door with wood block and hammer.

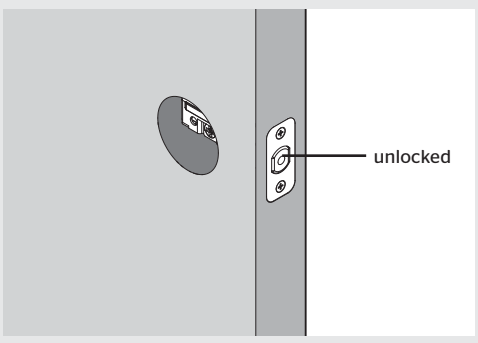


C Install strike on the door frame.

⚠ Make sure hole in door frame is drilled a minimum of 1" (25 mm) deep.



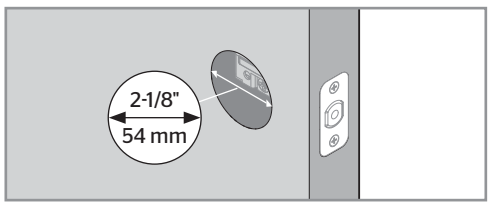
D ⚠ **IMPORTANT:** Make sure the latch bolt is fully retracted (in the unlocked position).



3 Prepare keypad and mounting plate (only for doors with smaller holes)

What is the diameter of the hole in the door?

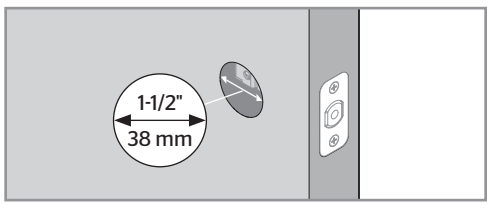
Diameter is 2-1/8" (54 mm)



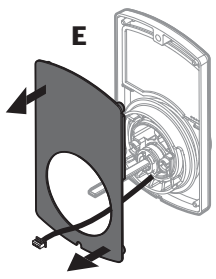
No adjustment is required.
Proceed to step 4.

or

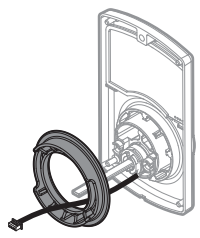
Diameter is 1-1/2" (38 mm)



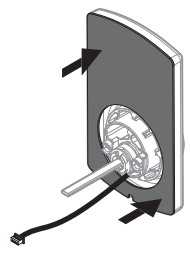
A Remove adapter ring from exterior assembly:



1. Remove gasket.

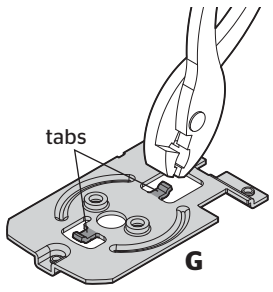


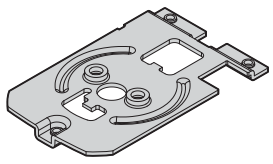
2. Remove adapter ring from exterior assembly.



3. Reinstall gasket, ensuring tight seal.

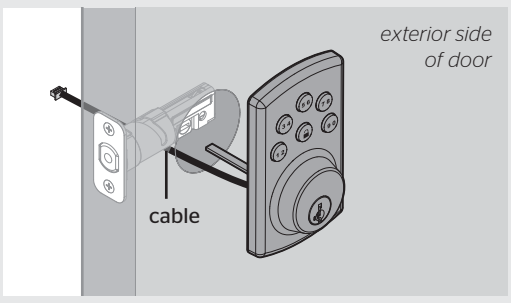
B Use pliers to remove two tabs from mounting plate:



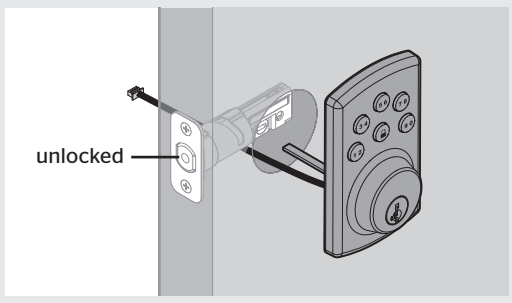


4 Install exterior assembly

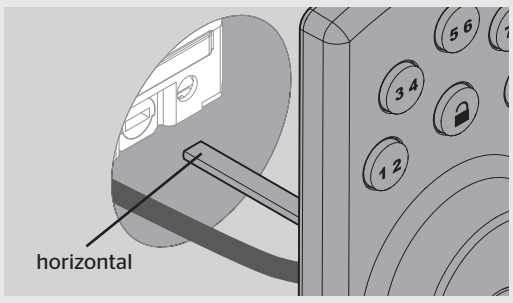
A Route the cable below the latch.



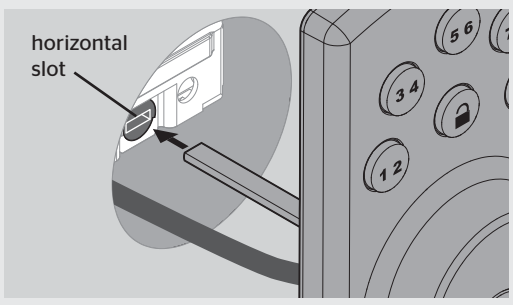
B **IMPORTANT:** Make sure the latch is fully retracted (in the unlocked position).



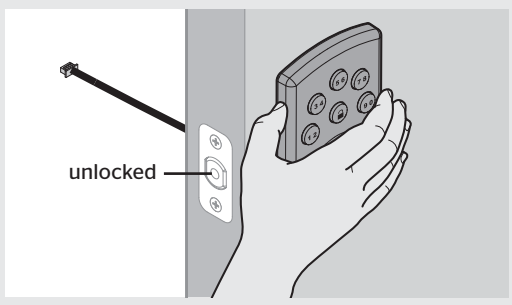
C **IMPORTANT:** Make sure the torque blade is in the horizontal position.



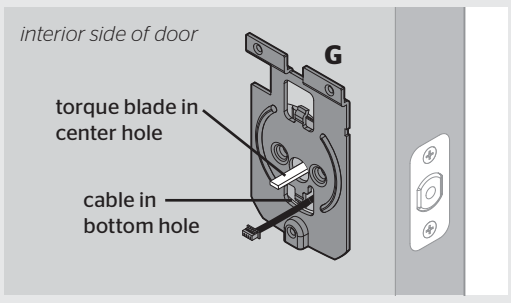
D Insert the torque blade through the horizontal slot in the latch.



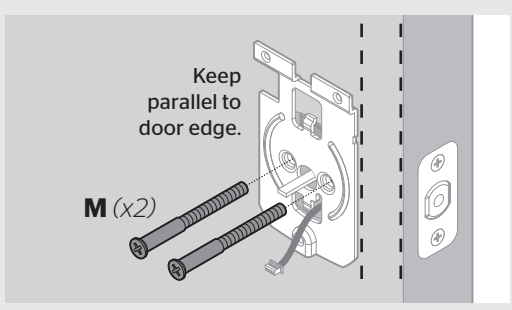
E **IMPORTANT:** Hold the exterior assembly on the outside firmly (or have a second pair of hands) for the next steps.



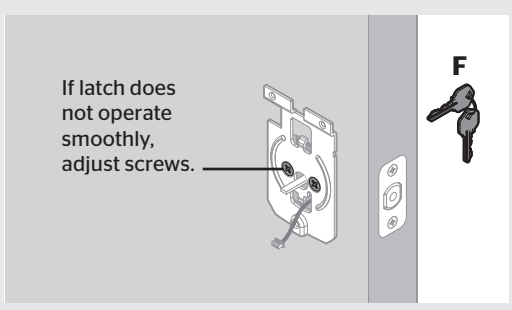
F Push the torque blade through the center hole in the mounting plate and send the cable through the bottom hole.



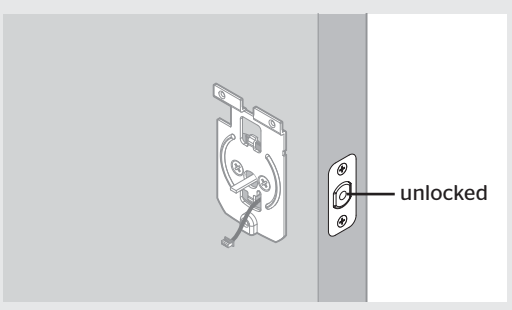
G Secure the mounting plate with the supplied screws.



H Insert the key and test the latch for smooth operation.

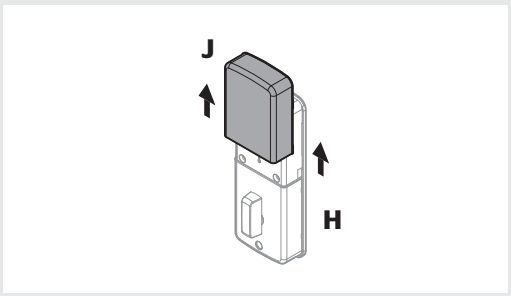


I Remove the key and make sure the latch bolt is still in the unlocked position.

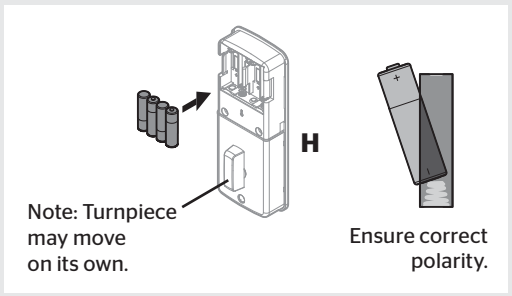


5 Install interior assembly

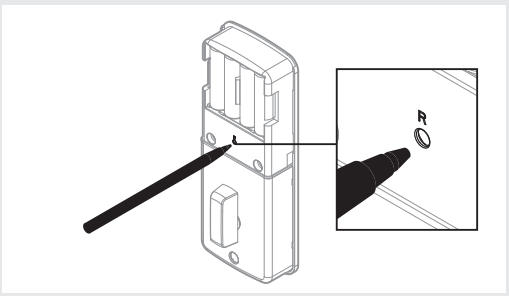
A Remove the battery cover.



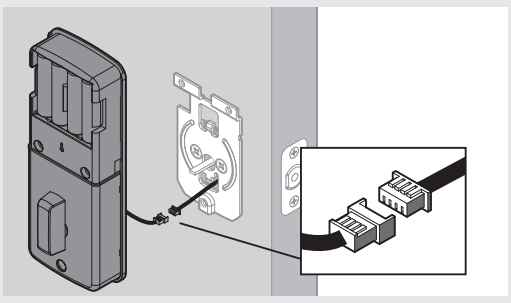
B Load 4 AA batteries into the interior assembly. For best results, use new, non-rechargeable Alkaline batteries only.



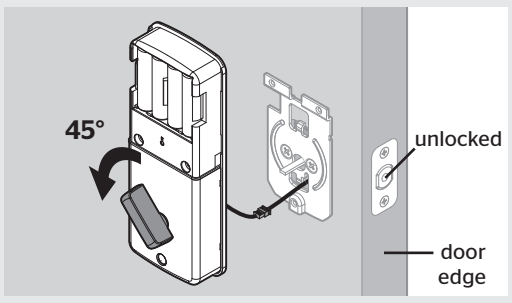
C Press and hold the Reset button on the interior assembly for 5 seconds, until you hear 3 long beeps.



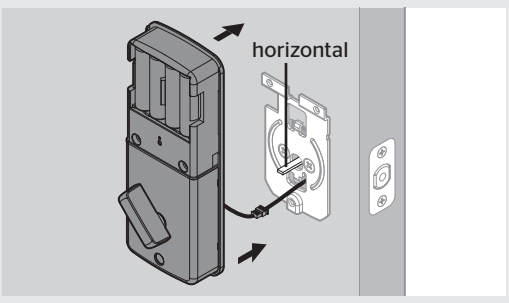
D Align the colored edges of the connectors and ensure a tight cable connection.



E **IMPORTANT:** Rotate the turnpiece AWAY from the door edge and make sure the latch is fully retracted (in the unlocked position).

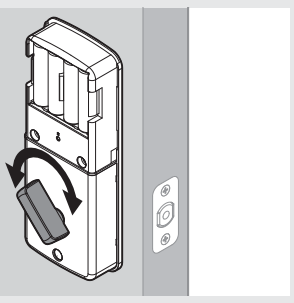


F Make sure the torque blade is still in the horizontal position and install the interior assembly.

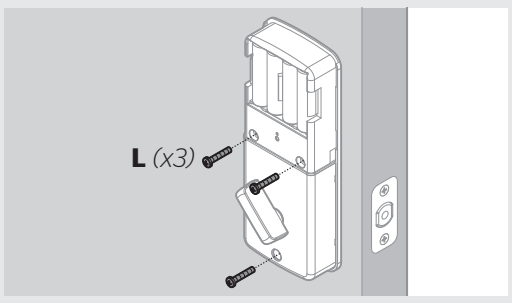


G Test the turnpiece for smooth rotation.

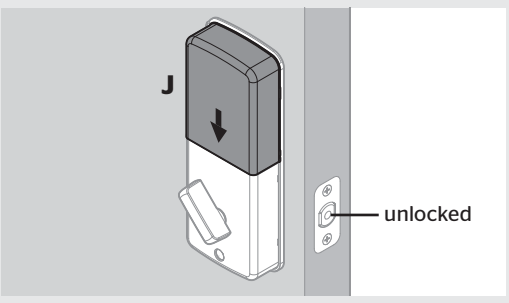
If turnpiece doesn't rotate, repeat steps 5E and 5F, making sure to rotate the turnpiece AWAY from the door edge.



H Secure the interior assembly with the supplied screws.



I Reinstall battery cover and make sure the latch is still in the unlocked position.



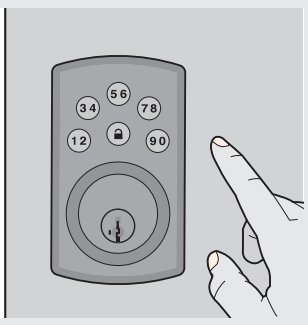
6 Set locking and unlocking direction

A While the door is OPEN and UNLOCKED, enter the following code to teach the lock the orientation of the door:

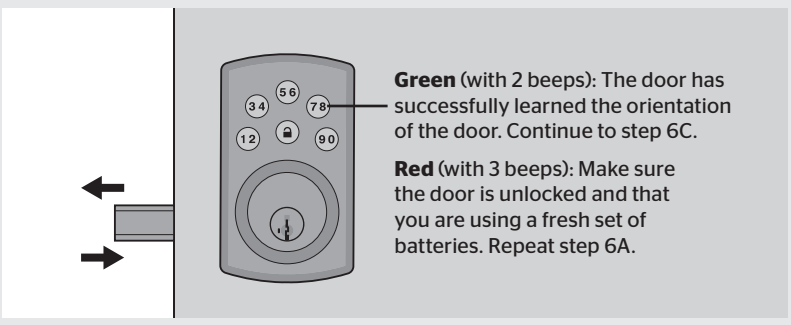
This is your default Mastercode.

1. Press 0-0-0-0.
2. Press 🔒. You will hear one beep.
3. Press 0.
4. Press 🔒.

Note: Each button on the keypad represents two numbers. You only need to push the button once to get either number.



B The latch bolt will extend and retract. The lock will beep and the keypad will turn green or red.



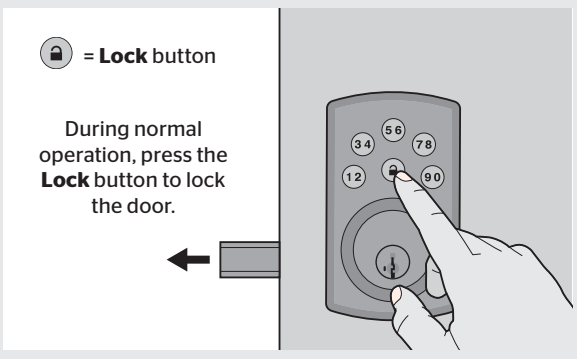
Green (with 2 beeps): The door has successfully learned the orientation of the door. Continue to step 6C.

Red (with 3 beeps): Make sure the door is unlocked and that you are using a fresh set of batteries. Repeat step 6A.

C Press the **Lock** button. The latch bolt will extend to lock.

🔒 = **Lock** button

During normal operation, press the **Lock** button to lock the door.

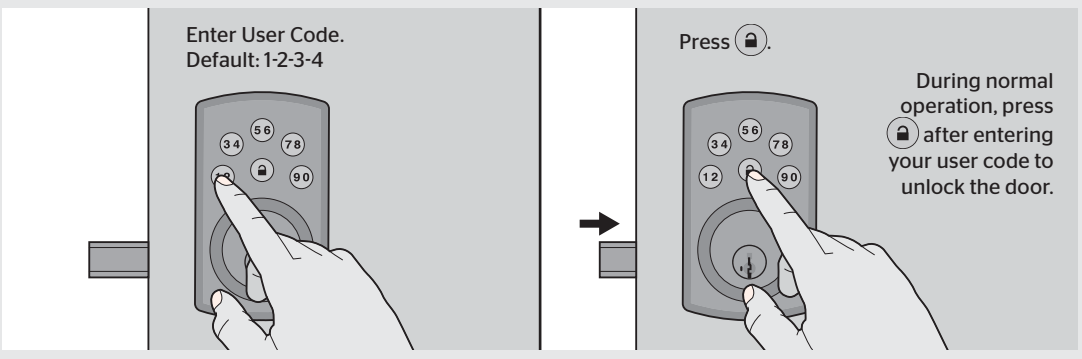


D Enter the default User Code (1-2-3-4), then press the **Lock** button. The door will unlock.

Enter User Code. Default: 1-2-3-4

Press 🔒.

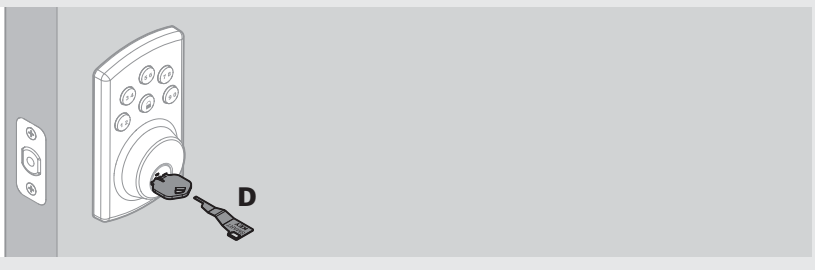
During normal operation, press 🔒 after entering your user code to unlock the door.



IMPORTANT: It is recommended that you replace the default Mastercode and default User Code with codes of your own. See page 4.

7 Optional: Re-key the lock

If needed, re-key the lock to work with your existing key. See the supplied SmartKey Re-Key instructions for more information.



8 Quick Setup and Use

Move swiftly during programming. If no digit is pressed for 10 seconds, the system will time out and you will need to restart the procedure.

A How to delete all User Codes

CAUTION: A User Code is used to unlock the door while a Mastercode is a password for making changes to the lock features.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode - for new install, default is 0-0-0-0.
3. Press (🔒). You will hear one beep.
4. Press **5**.
5. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

For a new installation, this will delete the default User Code 1-2-3-4. For subsequent instances, this will delete all User Codes in the lock.

Now the lock can only be operated by the key and turnpiece until a new User Code is added in step B.

B How to add User Codes

A total of 6 User Codes (and a temporary one-time User Code) may be programmed. Do not program a User Code that is the same as your Mastercode.

CAUTION: A User Code is used to unlock the door while a Mastercode is a password for making changes to the lock features.

1. Make sure the lock is unlocked and the door is open.
2. Enter your Mastercode - for new install, default is 0-0-0-0.
3. Press (🔒). You will hear one beep.
4. Press **1**.
5. Press (🔒). You will hear one beep.
6. Enter a new User Code. It must be 4-10 digits.
7. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.
8. Test the code: While your door is open, lock it. Enter your new User Code, then press (🔒). The door should unlock.

C How to change your Mastercode

The Mastercode will not unlock your door. It is an added security feature that is used to set up all functions.

The default Mastercode is 0-0-0-0. It is recommended that you change it to a code of your own.

1. Make sure the lock is unlocked and the door is open.
2. Enter your Mastercode - for new install, default is 0-0-0-0.
3. Press (🔒). You will hear one beep.
4. Press **7**.
5. Press (🔒). You will hear one beep.
6. Enter a new Mastercode. It must be between 4 and 10 digits.
7. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

9 Additional Programming Features

How to enable/disable Auto-Lock

The Auto-Lock feature automatically re-locks your door 30 seconds after unlocking. This feature is off by default.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **1 - 1**.
5. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

How to enable/disable User Codes

If User Codes are disabled (example: when you go on vacation), the lock can only be operated by the key and turnpiece until they are enabled again.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **1 - 7**.
5. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

How to add a one-time User Code

A one-time user code may be used only once, and then it will be deleted immediately after use.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **1 - 9**.
5. Press (🔒). You will hear one beep.
6. Enter a new User Code. It must be 4-10 digits.
7. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

How to change Auto-Lock time delay

You can set the Auto-Lock time delay to 10, 20, 30, 40, or 50 seconds.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **1 - 3**.
5. Press (🔒). You will hear one beep.
6. For 10 seconds, press **1**.
   For 20 seconds, press **3**.
   For 30 seconds, press **5**.
   For 40 seconds, press **7**.
   For 50 seconds, press **9**.
7. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

How to delete individual User Codes

The lock is pre-programmed with a default User Code of 1-2-3-4. It is recommended that you delete this code.

1. Make sure the lock is unlocked and the door is open.
2. Enter your existing Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **3**.
5. Press (🔒). You will hear one beep.
6. Enter the User Code you wish to delete.
7. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.
8. Test the code: While your door is open, lock it. Enter the User Code, then press (🔒). The door should not unlock.

How to mute/unmute lock

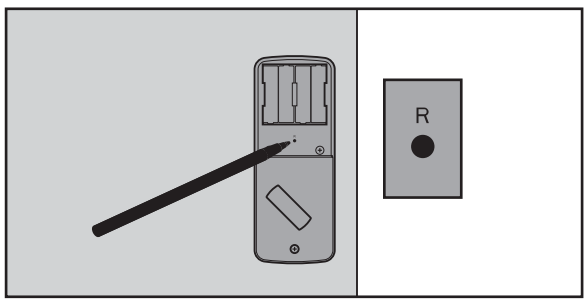
If the lock is muted, you will not hear beeping during programming, normal operation, low battery indicators, or system alerts.

1. Make sure the lock is unlocked and the door is open.
2. Enter your Mastercode.
3. Press (🔒). You will hear one beep.
4. Press **1 - 5**.
5. Press (🔒). You will hear two beeps if successful. If you hear three beeps, it was unsuccessful. Repeat from step 1 slowly.

How to restore default settings

This procedure will delete all User Codes associated with the lock, and the default Mastercode (0-0-0-0) and User Code (1-2-3-4) will be restored.

1. Make sure the door is open and unlocked.Press and hold the Reset button for 5 seconds, until you hear 3 long beeps.



2. Enter the default Mastercode (0-0-0-0).
3. Press (🔒). You will hear one beep.
4. Press **0**.
5. Press (🔒). The latch bolt will extend and retract to learn the orientation of the door. If successful, the keypad will flash green and you will hear 2 beeps. If unsuccessful, the keypad will flash red and you will hear 3 beeps (make sure the door is open and unlocked and that you are using a fresh set of batteries).
6. Test the lock: With the door open and unlocked, press (🔒). Make sure it locks the door.
7. Test the default User Code: Enter the default User Code (1-2-3-4), then press (🔒). Make sure it unlocks the door.

The default Mastercode is 0-0-0-0. It is recommended that you change it to a code of your own.

The lock is pre-programmed with a default User Code of 1-2-3-4. It is recommended that you delete this code.

System Alerts

Alert	Reason	Solution
Keypad flashes red 3 times with 3 beeps.	Door jammed while attempting to lock.	Manually re-lock door. If needed, reposition strike.
	Door handing code has not been entered.	Enter door handing code.
	No User Code programmed, or User Codes are disabled.	Program at least one User Code, or re-enable User Codes.
	Unsuccessful programming.	Attempt programming procedure again.
	Incorrect User Code entered.	Re-enter User Code.
Keypad flashes red 5 times with 5 beeps.	5 incorrect User Codes entered within one minute.	Re-enter User Code after 45-second keypad lockout.
Keypad flashes red 10 times with 10 beeps.	Low battery.	Replace batteries.

Regulatory Compliance

This product complies with standards established by the following regulatory bodies:

- Federal Communications Commission (FCC)
- Industry Canada

FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

IMPORTANT! Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

Industry Canada

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Troubleshooting

The lock cannot be locked or unlocked by the keypad.

Make sure the lock is programmed with at least one User Code and that the User Codes are not disabled. If needed, restore the lock's default settings.

The keypad doesn't respond when touched (no lights are visible and no beeping is heard).

Make sure the cables are properly connected, and make sure the batteries are new and installed correctly.

The door can be locked with the Lock button, but the User Code will not unlock the door.

Make sure the User Code is correct and that the Lock button is pushed after entering the User Code. If the door still won't unlock, use a key to unlock the door. Call technical support for further troubleshooting.

When the door is closed and the Lock button is pressed to lock the door, the lock beeps 3 times. When the door is open and the Lock button is pressed to lock the door, the lock doesn't beep.

Make sure that the hole in the door frame behind the strike is drilled at least 1 inch (25 mm) deep. Also make sure the strike plate is aligned with the latch bolt. If needed, reposition the strike.

Important Safeguards

1. Read all instructions in their entirety.
2. Familiarize yourself with all warning and caution statements.
3. Remind all family members of safety precautions.
4. Restrict access to your lock's interior assembly and routinely check your settings to ensure they have not been altered without your knowledge.
5. Protect your User Codes and Mastercode.
6. Dispose of used batteries according to local laws and regulations.

⚠ CAUTION: Prevent unauthorized entry. This lock has a pre-set User Code and Mastercode. Upon installation and set-up, replace both of these codes with your own. Since anyone with access to the interior assembly can reset the lock and change the User Codes, you must restrict access to the interior assembly and routinely check the User Codes to ensure they have not been altered without your knowledge.

⚠ WARNING: This Manufacturer advises that no lock can provide complete security by itself. This lock may be defeated by forcible or technical means, or evaded by entry elsewhere on the property. No lock can substitute for caution, awareness of your environment, and common sense. Builder's hardware is available in multiple performance grades to suit the application. In order to enhance security and reduce risk, you should consult a qualified locksmith or other security professional.

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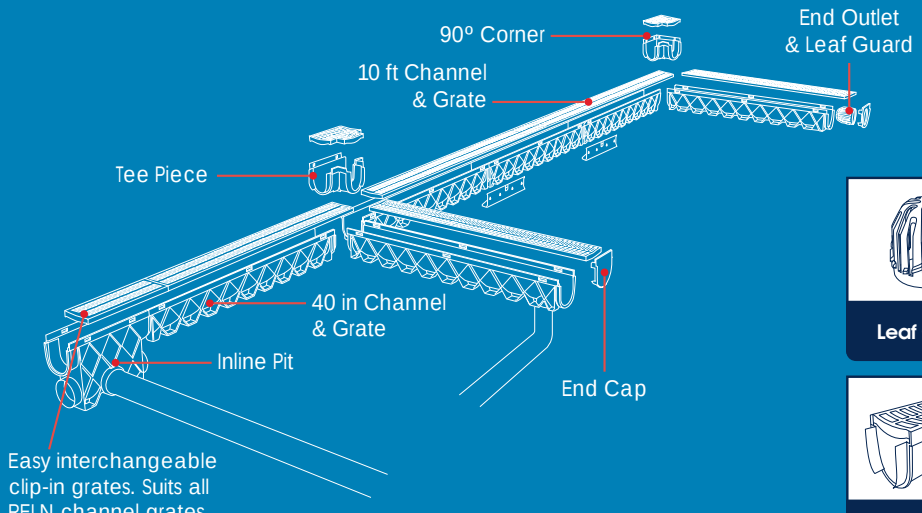
RELN Storm DRAIN™

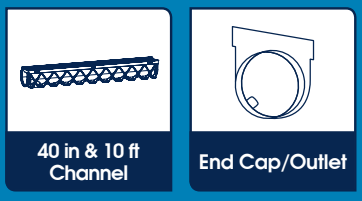
Complete Drainage System

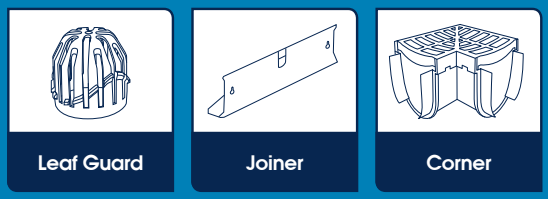
- Ideal for paths, driveways and domestic areas with corners & T sections
- Made in Australia from tough, durable and light-weight, UV-stabilised recycled plastic
- Hold down feet to stop flotation during pouring of concrete
- Available in 40 in & 10 ft lengths, plus a whole range of accessories
- All grates comply to Australian Standards



F Foundation L Landscape Y Yard

Components:

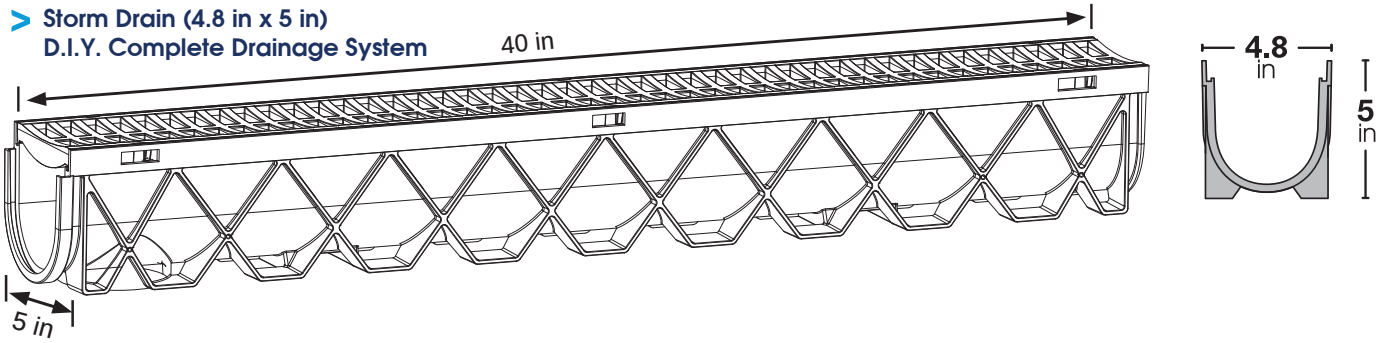




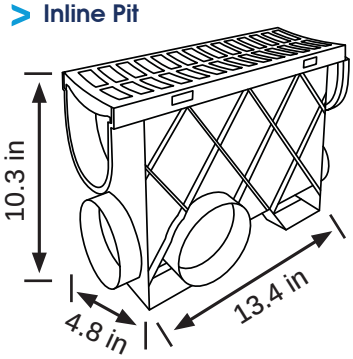
Storm Drain - D.I.Y. Complete Drainage System

RELN Storm Drain is the complete DIY drainage system designed for paths, driveways and any domestic areas with corners and T sections. With a complete range of accessories available and easily interchangeable clip in grates, Storm Drain is designed to make life easy!

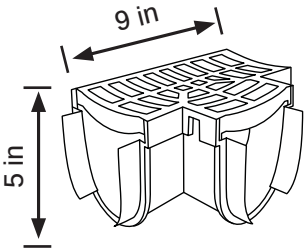
> Storm Drain (4.8 in x 5 in) D.I.Y. Complete Drainage System



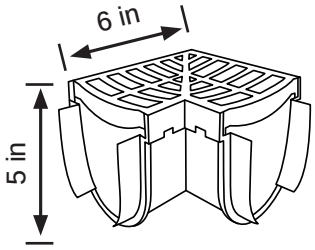
> Inline Pit



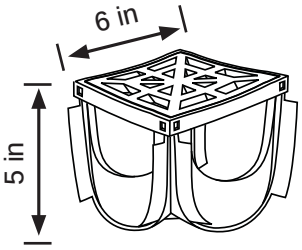
> Tee Piece



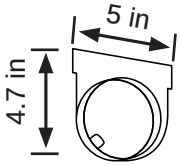
> Corner



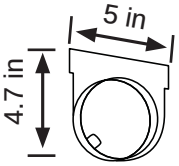
> 4-way connector



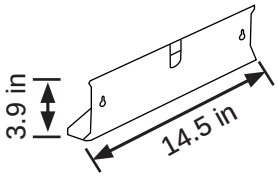
> End Outlet



> End Cap



> Joiner



- Ideal for paths, driveways and domestic areas with corners and T sections
- Designed to withstand 5.5 ton vehicle weight when correctly installed
- Tough, durable and lightweight UV stabilised recycled plastic
- Available in 40 in and 10 ft lengths
- 100% recycled material
- Australian Made
- Available in all RELN grates
- Easily interchangeable clip in grates
- Hold down feet to stop flotation during pouring of concrete
- Bottom outlet, End Outlet and Inline pit can be glued to 4 in PVC stormwater pipe
- Leaf Guard prevents blocking outlets and pipes for use on channel and Inline Pit
- 90° corner and T-piece for left or right extensions

Easy clip-together joining for all Storm Drain range accessories

Grate Options: (4.4 in x 1 in x 40 in): Plastic in Black and Portland Grey. Black Heel Guard Plastic, Architectural, Stainless Steel, Galvanised Steel

Range: 40 in and 10 ft Channels, Inline Pit, Joiner, Leaf Guard, End Outlet, 90° Corner, End Cap, Tee Piece, Bottom Outlet, 4-Way Connector

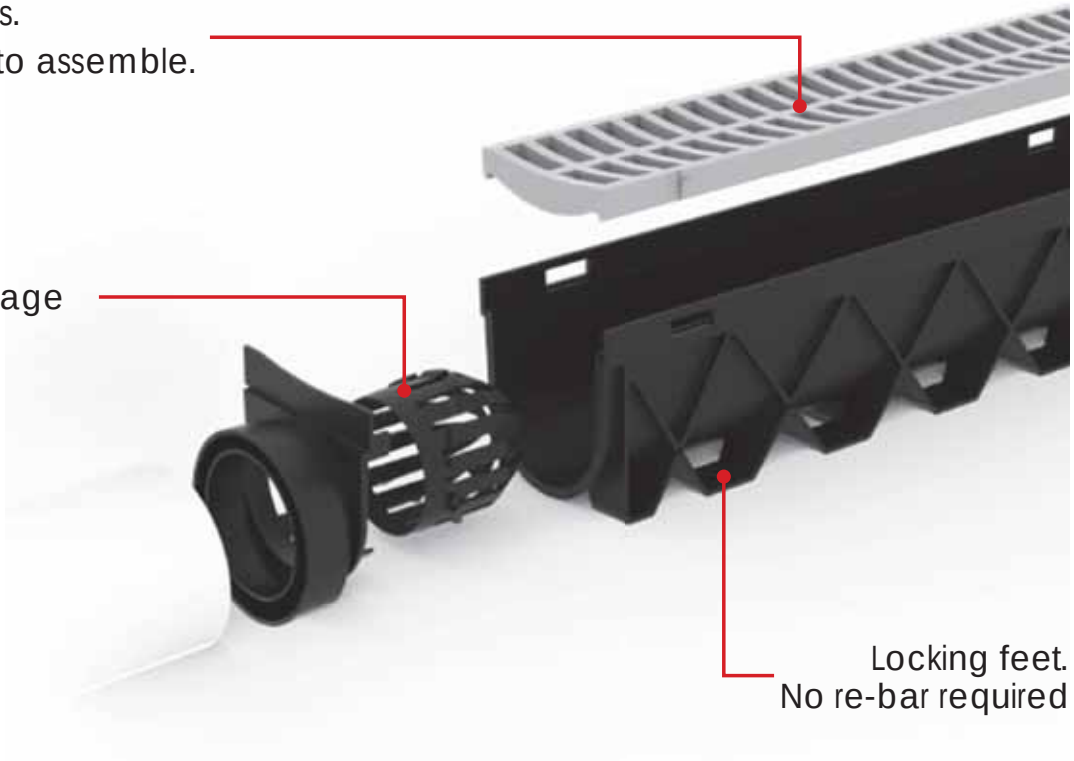
Displays: Hang Pad and Flyer available

FEATURES

Ideal for paths, driveways and domestic areas with corners and T sections

Easy clip-on grates.
No tools required to assemble.

Prevents pipe blockage



Locking feet.
No re-bar required

5 Tonne Vehicle Safe

COMPONENTS

Channel

Designed with unique feet, no re-bar required

P/N 003102 (Grey)
P/N 003017 (Steel)
P/N 003107 (Grey 10')
P/N 003018 (Steel 10')

Inline pit

Easy interlocking design for lower pipe in ground.

P/N 003431 (Grey)
P/N 003441 (Steel)

Joiner

Connects two channels

P/N 003005 (Grey)

End Cap

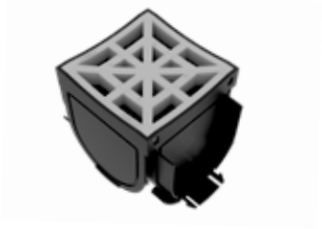
Easy fit design

P/N 003407 (Grey)

End outlet

Compatible with 4" sewer pipe

P/N 003408



4 Way Channel

Changes direction of channels

P/N 003125 (Grey)
P/N 0031241 (Steel)

Leaf Guard

Prevents pipe blockage

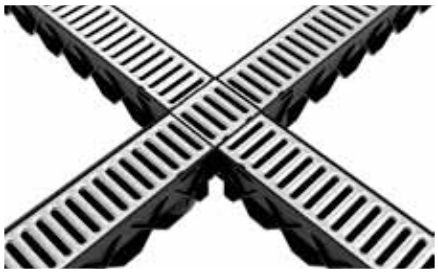
P/N 0034048

Concrete Tape 9m

Protect your grates fo a clean finish

P/N 000070

UNIQUE AND INNOVATIVE OPTIONS THAT PROVIDE SOLUTIONS TO SUIT VARIOUS APPLICATOIONS AROUND THE HOME



4 Way Channel

Can change direction of channels 4 ways

Stake Kit

Secure Storm Drain™ channel in your yard and lawn

P/N 003103

Inline Pit

Addresses issues in an interlocking stone applicationvw

EASE OF INSTALL TIME-SAVING FEATURES

Anti-Rotation fee

Innovative Anti-Rotation feet,
no re-bar required

Snap-in Grates

Easy install and removal.
no tools required

Interlocking Channel

Easily create desired lengths by
snapping channel lengths together

Concrete Tape

Protect your grate during Install for
best results

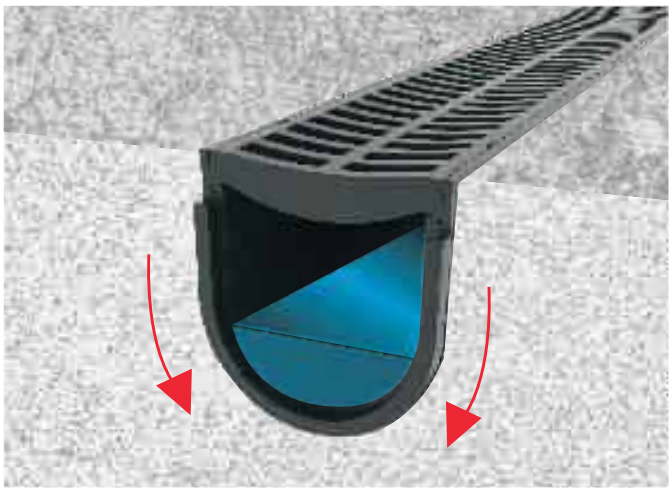
Stake Kit

Secure directly in ground,
No re-bars required

EASE OF MAINTENANCE

Leaf Guard

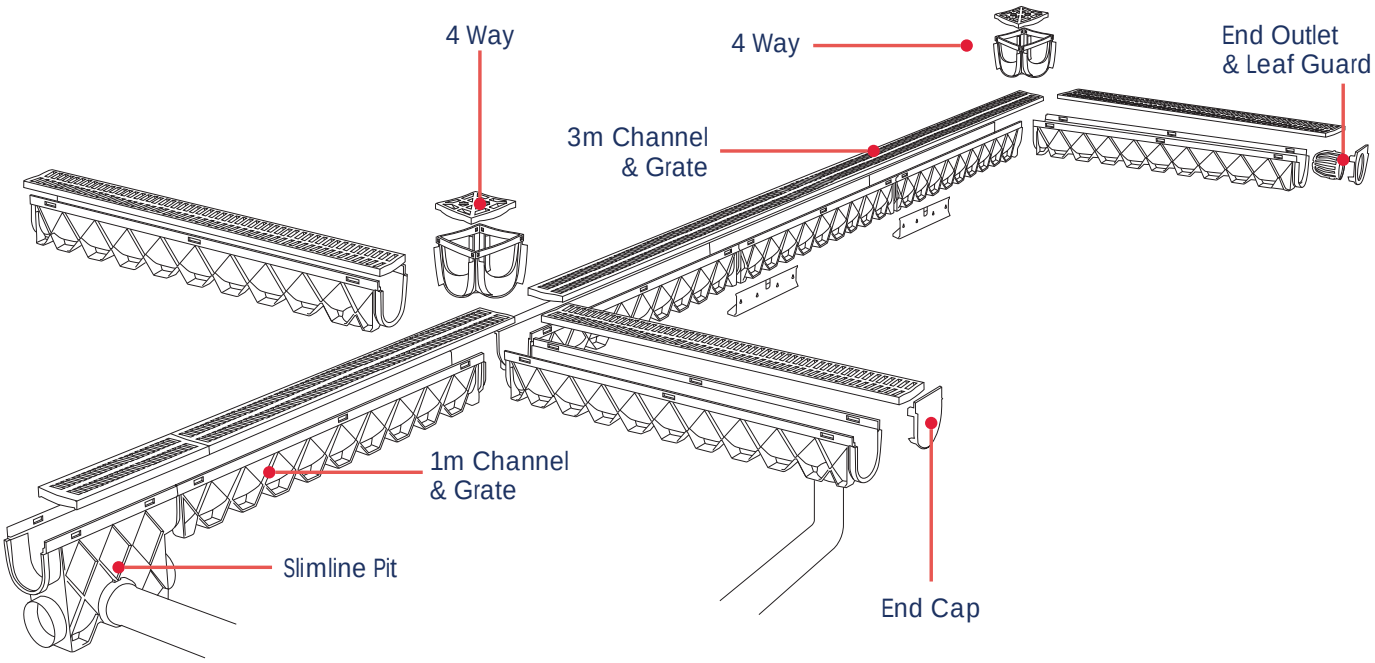
Smart system clogging prevention leaf guard.z`



Stake Kit

Intelligent self-cleaning u-shaped Design

Storm Drain system setup using 4 way



FREQUENTLY ASKED QUESTIONS

>Features

Can the RELN Channel Drains with Grates be cut to size?
Yes, the RELN Channel Drains with either Plastic or Metal grates can be cut with an appropriate saw at the desired length.

Can the RELN Channel Drains support a passenger vehicle?
Yes, with the appropriate concrete installation the RELN Storm Drain and Storm Mate Channels can support medium duty pneumatic tire traffic, autos and light trucks at speeds less than 12mph (20kmh).

Are the channel grates removable once the drains are installed in a concrete application?
The RELN channels and grates are designed with pry slots which allows the grates to clip in and out, with just a flat head screwdriver.

Can grates be interchangeable with other RELN Channel Drains?
Yes, the Storm Mate and Storm Drain Channels are the same width and length which allows the grates to be interchangeable.

What material is the RELN channel and grate made of?
The channel is manufactured from 100% recycled plastic polypropylene. The Grey grate and Black Heel Guard grate are made from a tough, durable, structurally foamed impact polymer.

What lengths are the RELN Channel Drains available in?
The Channels are sold in lengths of 40 inches (1 meter) or 10 feet (3 meter) lengths.

Can the RELN Channel Drains support forklift traffic?
To support a forklift, we recommend using the Ductile Iron grates (please reach out to sales@ftrproducts.ca). These grates can clip into the Storm Mate or Storm Drain channels. Suitable design of the concrete slab is required by an engineer to cater for the type of forklift load the concrete will be subjected to.

What is the recommended slope the channels should be installed at to ensure adequate drainage?
Water will always find its own level, so the drain must always be graded towards the outlet, whether the grade be less or more than the ideal. The ideal minimum grade is a slope of 2/10" per 40inch length (5mm per 1m).

Where should the runoff water that is captured from the Channel Drains be drained to?
Preplanning should be completed prior to installation. Any discharge water should be away from the property foundation and in an area where erosion will not be an issue. It is also beneficial in reusing the runoff water to hydrate garden beds and/or flowers. Checking with your council/local authority will also ensure that any drainage works complies with local regulations.

FREQUENTLY ASKED QUESTIONS

>Installation

What is the recommended slope the channels should be installed at to ensure adequate drainage?
Water will always find its own level, so the drain must always be graded towards the outlet, whether the grade be less or more than the ideal. The ideal minimum grade is a slope of 2/10" per 40inch length (5mm per 1m).

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Preplanning should be completed prior to installation. Any discharge water should be away from the property foundation and in an area where erosion will not be an issue. It is also beneficial in reusing the runoff water to hydrate garden beds and/or flowers. Checking with your council/local authority will also ensure that any drainage works complies with local regulations.

How do you secure the End Cap to a cut end of the channel drain?
The End Caps for both the Storm Drain and Storm Mate series have pressure tabs to allow them to hold in place. Silicone can be added to seal the connection point. For additional support, a screw can be inserted from the tabs into the channel section.

In a non-concrete (lawn) application, what is the recommend installation method to secure the Storm Drain channels?
RELN part 003103 Channel Drain Stake Kit securely holds the channel drain in place in softscape applications.

I have an interlock stone driveway, and I would like to have the stone installed at the edge of the channel, is this approved?
Encase RELN Channel Drain in concrete, minimum of 4 inches. Ensure concrete is consolidated around the channel to eliminate any air pockets. Secure pavers adjacent to the RELN channel in high strength mortar.

I have a pre-existing concrete slab; can I just cut the width of the channel and sit it in place?
If the application is not to support vehicle traffic, we recommend cutting a slightly larger cavity and encase with fill material to secure the channel drains. For an application to support a passenger vehicle, we recommend you encase the channel drains in concrete, minimum of 4 inches around each side of the channel drains.

How do you install rebar with the RELN Channel Drains?
The RELN Storm Mate and Storm Drain channels are designed with Anti-Floatation Channel "Feet" prevent floating when encased in fill material. With this feature, rebar is not required. If the applications require the use of rebar support, RELN part 003103 Channel Drain Stake Kit allows for the installation of rebar.

Can you connect 4 in. corrugated drain pipe to the RELN Storm Drain channels?
By using RELN part 000225 Corrugated Adapter, you can connect corrugated pipe to the Storm Drain End Outlet part 003408 or to the Storm Drain Inline basin part 003431 & 003441.

Can you connect MOLE-Pipe to a Storm Drain channel section?
Yes, MOLE-Pipe can be connected to the Storm Drain channel section by using the MOLE-Pipe Female connector (part 1003FA-FTR) and the RELN 4 in. Corrugated Pipe adapter (part 000225). The two fittings snap into each other to create a secure connection and the opposite end of the Corrugated adapter can glue into the Storm Drain End Outlet (part 003408) which is connected to the channel section.

Can you connect a drain pipe to the end of the RELN Channel Drains?
With the Storm Drain channel system you can discharge water off the end by using part 003408 Storm Drain End Outlet. The End Outlet is compatible with 4 in. PVC pipe, or with the RELN part 000225 or 000226, you can connect 4 in. corrugated or sch 40 pipe. The Storm Mate channel system is only designed to discharge water from the bottom and not the ends. Storm Drain and Storm Mate channels have built-in bottom outlet which accommodates 4 in. sch 20 PVC pipe.

How do you protect the grates and channels during installation?
RELN part 000070 Channel Drain Tape is used to protect the grates and channel drains during install. The RELN tape is the same width of the channels and leaves no residue.

How do you connect two lengths of the RELN channel drains together?
Both Storm Mate and Storm Drain channels have interlocking clip-in connections. If additional support is required, joiners' (part 003005) are available for the Storm Drain channel series. This would be an ideal solution for a long run of channel.

What do you recommend for sealing connections points?
Outdoor weather rated silicone can be used to seal any connection points.

When connecting PVC pipe to the Storm Drain End Outlet, what adhesive should be used?
The Storm Drain End Outlet part 003408 is made of ABS plastic. ABS to PVC transition glue is required when using PVC pipe.

Can the RELN Channel Drains be installed as a sewer drainage system inside a home?
The RELN Channel Drains are only approved and designed to manage storm water around the outside of a home and should at no time be used for sewage applications.

Can the RELN Channel Drains be installed around a perimeter?
Yes, the Storm Drain part 003124 & 003125 4 Way Adapter allows for 90-degree corners as well, Tee and intersections.

Can heating cables (ice melting) be used within the RELN Channel Drains?
Heating cables should only be used if they are approved for use with polypropylene plastic. It is recommended to discuss with the heating cable manufacture.

What should be considered when designing a new driveway?
Drainage should be considered in the design of a new driveway so that water will run off into a suitable drainage system and not be directed into the garage or home.

FREQUENTLY ASKED QUESTIONS

>Maintenance

If water remains in the RELN Channel Drains during the cold winter temperature will this have any impact on the drains?
Small pockets of water in the channel will indicate that it has not been suitably graded to ensure complete run-off. Small pockets of water will freeze but not cause and damage to Storm Drain or Storm Mate.

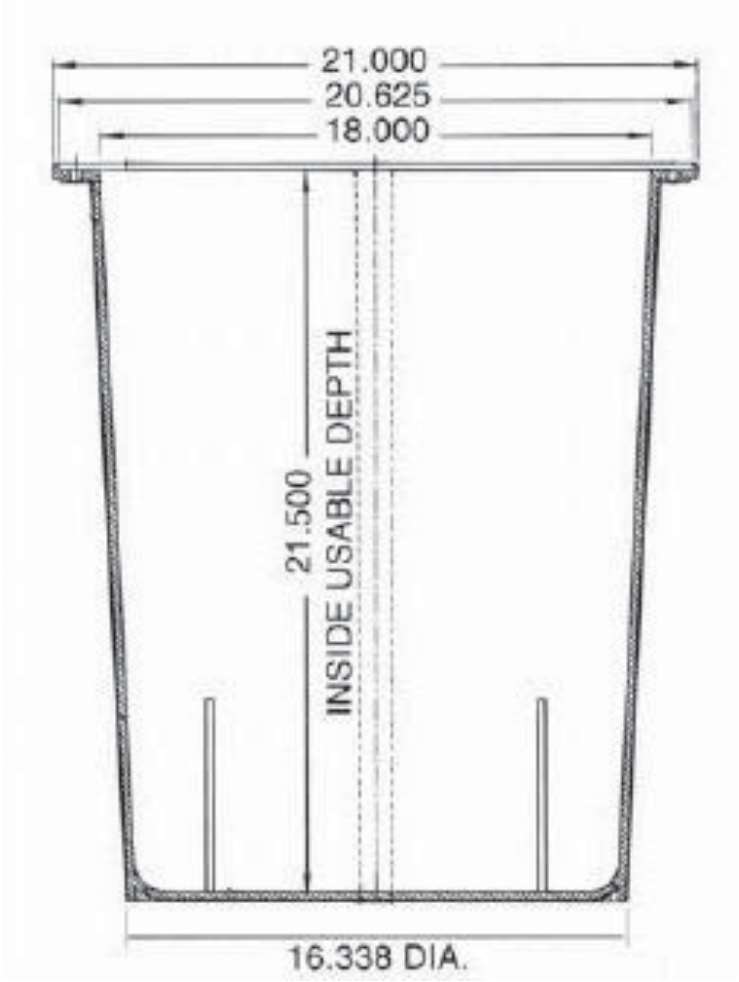
Do the drains require any maintenance?
We suggest you periodically inspect your drains for any debris or leaves that may have entered the channels, and have any build-up cleaned out to eliminate pipe clogging. We recommend installing the Storm Drain Leaf Guard (RELN Part 003410) with your system.

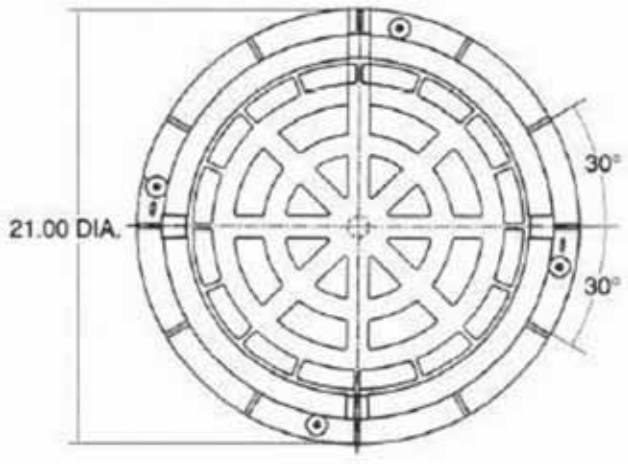
How can I prevent my drain pipe lines from getting clogged with leaves and debris?
RELN part 003410, Storm Drain Leaf guard is designed to clip into any outlet point for the Storm Drain channel series to prevent pipe blockage.

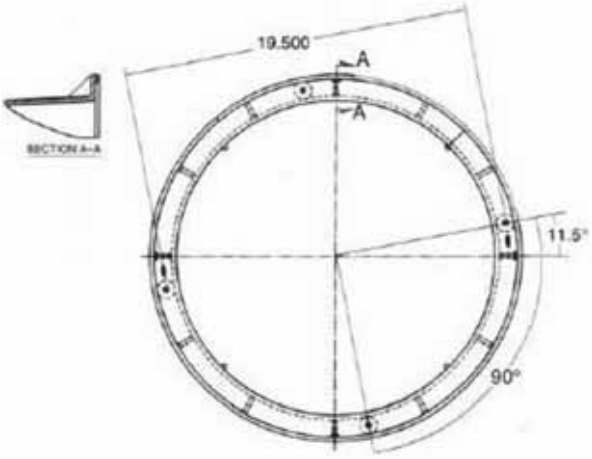
Are the Channel Drains water tight?
The sump area in the bottom of the channels is water tight. The connections between channel sections, end outlets, end caps and inline basins are soil tight, not water tight. Adding a bead of water proof silicone on each connection point will create a water tight connection.

18 in. x 22 in. Sump Pump Basin

Store SKU #1000027544 | Model SF20







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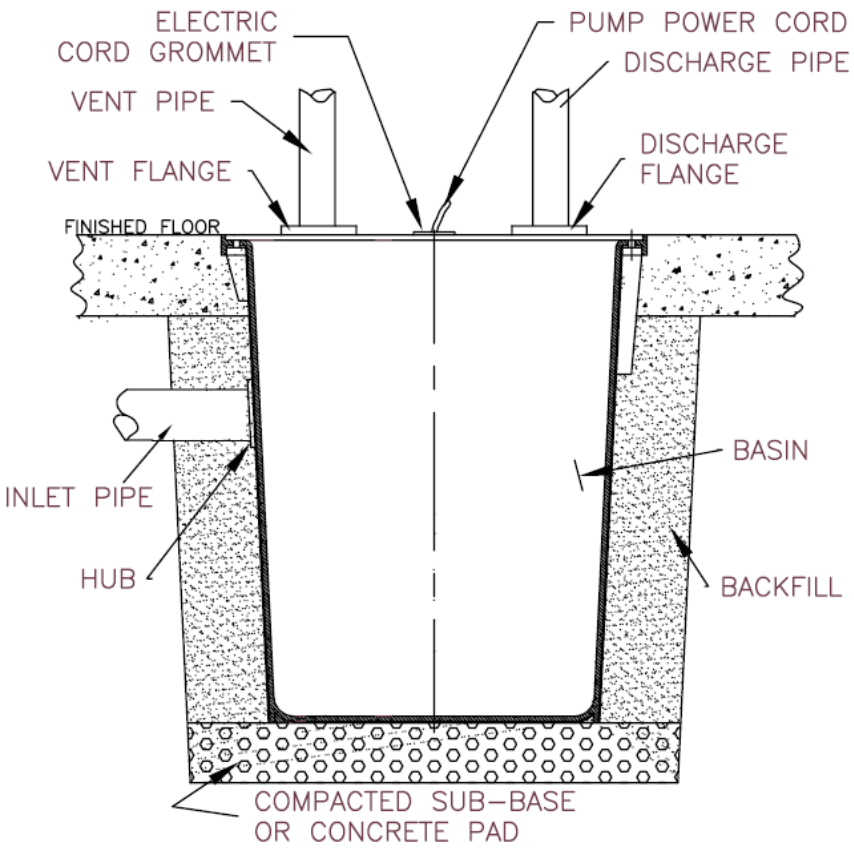
Installation Guide for Molded Sump and Sewage Basins

The below serves only as an installation guide for Everbilt™ molded sump and sewage basins. Please refer to your state and/or local plumbing or onsite wastewater treatment and disposal regulations for details pertaining to your systems design, installation and maintenance requirements.

1. Inspect all parts and materials supplied by The Home Depot to assure that no shipping damage occurred.
2. Excavate hole large enough to accommodate basin, backfill material and inlet piping.
3. Add 4” - 6” of clean backfill material or concrete to the bottom of the hole. Assure that it is level, compacted and smooth.
4. Place the basin in the hole making sure that it is level.
5. Carefully backfill with naturally rounded gravel or stone, larger than 3/8” and smaller than 3/4” diameter, around the periphery of the basin.
6. Connect all piping as required.
7. Finish floor around the basin as required.



Questions, problems, missing parts? Before returning to the store,
call Everbilt Customer Service
8 a.m. - 7 p.m. EST, Monday - Friday and Saturday 9 a.m. - 6 p.m. EST

1-877-297-6069

HOMEDEPOT.COM

SPECIFICATION SUBMITTAL SHEET

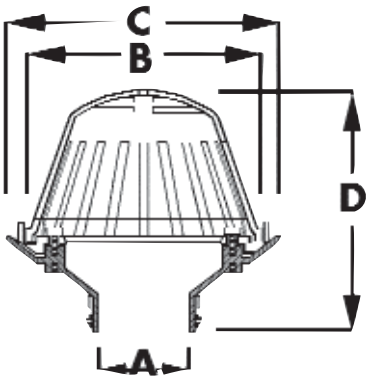
jones stephens corporation

ROOF DRAIN

features and benefits:

FITS OVER SCHEDULE 40 DWV PIPE

- Brass inserts in underside for underdeck clamps
- Dome has 50 square inches of free area



CAST IRON DOME

PVC	ABS	SIZE	A	B	C	D
❑ R18-001	❑ R18-009	2″	Over 2″ pipe	8 1/4″	11″	9″
❑ R18-005	❑ R18-007	3″	Over 3″ pipe	8 1/4″	11″	9″
❑ R18-006	❑ R18-008	4″	Over 4″ pipe	8 1/4″	11″	9″
❑ R18-026	❑ ----------	6″	Over 6″ pipe	8 1/4″	11″	8″

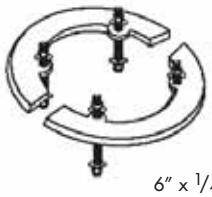
PLASTIC DOME

PVC	ABS	SIZE	A	B	C	D
❑ R18-013	❑ R18-016	2″	Over 2″ pipe	8 1/4″	11″	8″
❑ R18-014	❑ R18-017	3″	Over 3″ pipe	8 1/4″	11″	8″
❑ R18-015	❑ R18-018	4″	Over 4″ pipe	8 1/4″	11″	8″
❑ R18-027	❑ ----------	6″	Over 6″ pipe	8 1/4″	11″	8″

ACCESSORIES

PART NO.	DESCRIPTION
R18-011	2″, 3″ & 4″ Underdeck clamp
R18-028	6″ underdeck clamp
R18-012	16″ receiving pan
R18-019	Plastic roof dome
R18-020	Cast iron roof dome

UNDERDECK CLAMP



jones stephens corporation
3249 moody parkway • moody, alabama 35004
toll free phone: 1-800-355-6637 • toll free fax: 1-800-462-6991
www.plumbest.com

SUBMITTAL #24

CONTAINMENT BERM

PIG® Build-A-Berm® Barrier Straight Section

PLR278 Ideal For Long-Term Custom Containment,4.5" x 15' x 1.5",1 each

Build a semi-permanent barrier around your machinery or storage areas with our crush-resistant spill berms.

- Barriers can be constructed into a semi-permanent, high-visibility barrier that's exactly the size and shape you need - indoors or out
- Pliable open-cell foam barrier springs back into shape after you walk or roll over it with light, wheeled equipment
- Durable, 18-oz. all-vinyl covering resists oils, coolants and most chemicals
- Cut to length with utility knife; for best installation results, secure to a smooth, sealed surface with sealant (sold separately) and join seams with vinyl cement (sold separately)
- Combine with Build-A-Berm Barrier Corners (sold separately) to create liquid-proof containment; ends overlap and seams can be sealed together with Industrial-Strength Vinyl Cement (sold separately)
- Contain leaks and spills around your machinery without building expensive concrete curbs or cutting and installing angle iron
- High-visibility yellow color draws attention to barrier for increased safety
- Easy removal requires only a flat-bladed shovel
- Great for use around battery charging stations, machinery or any other leak-prone areas
- Sealant, industrial-strength vinyl cement and barrier corner pieces sold separately

Specifications

Style	Straight Section
Dimensions	4.5" W x 15' L x 1.5" H
Barrier Height	1.5" H
Brand	PIG
Ideal For	Long-Term Custom Containment
Install/Deploy Type	Glued In Place Barrier

Color	Yellow
Temperature Limit	Works from -22°F to 160°F
Traffic	Cart Traffic
Sold as	1 each
Weight	4.3 lbs.
New Pig Patent	5,820,297
# per Pallet	36
Composition	Cover: 18 oz. Vinyl-Coated Fabric Core: Open-Cell Polyurethane Foam
UNSPSC	24101907
Pigalog® Page Number	Page 151

Metric Equivalent

Weight	2 kg
Dimensions	11cm W x 4.6m L x 3.8cm H

Technical Information

Technical Documents

PIG Build-A-Berm® Barrier

Instructions for Using PIG® Build-A-Berm® Barrier

40 CFR 112.7

40 CFR 122.26

40 CFR 264.175

New Pig
World's best stuff for leaks, drips and spills.

One Pork Avenue • Tipton, PA 16684-0304
1-855-493-4647 • Fax: 1-800-621-7447• newpig.com • hothogs@newpig.com

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 05/30/23**
TO:	**TRC** 10 Maxwell Drive Suite 200 Clifton Park, NY 12065 Attn: Peter Wanfried	***DATE RECEIVED:_____***

PROJECT:

Remedial System Optimization (RSO) RFP
Former Chromalloy Facility, West Nyack, New York

We are transmitting (Herewith ☒, Under separate cover ☐, Electronic ☒, Hard copy ☐), the following:

Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	Figure 1 – Pump and Treat System P&ID	01	☒ Yes ☐ No
2	EQ Tank Float Switches Specifications	05	☒ Yes ☐ No
3	Bag Filter Inlet/Outlet Pressure Transmitter Specifications	09	☒ Yes ☐ No
4	Mechanical Flow Totalizer Specifications and Manual	10	☒ Yes ☐ No
5	pH Monitor/Probe Specifications and Operation Manual	12	☒ Yes ☐ No
6	Variable Frequency Drive Specifications	18	☒ Yes ☐ No
7	Figure 2 – EQ Tank Connection Details	25	☐ Yes ☒ No
8	LGAC Media Specifications	26	☐ Yes ☒ No

Copy to: File

Signed:

TRC Comments w/ ET Responses

- Check valve not needed in well pump and sump pump lines if connections go through top of EQ tank. Please confirm the discharge will be to the top of the tank.

  Three (3) influent ports and one (1) vent port to the EQ tank will be top mounted.

- Include sump pump's integral float switch in the P&ID

  Included on updated Figure 1 P&ID.

- Include a drawing of the well and sump pump connections to the EQ tank (please specify how the lines will be secured)

  Included as Figure 2.

- Describe backwash discharge location and include on EQ tank drawing

  4" male camlock and cap to be installed for backwash discharge connection to EQ tank.

- Call out how many floats are needed in the EQ tank

  Three (3) separate floats to be used for EQ tank LSL, LSH, and LSHH level switches.

- Add a sample port to the lower portion of the EQ tank

  Included on updated Figure 1 P&ID.

- Include a pressure gauge after the bag filters

  Included on updated Figure 1 P&ID.

- Include interlocks 5 and 6 in VFD and well pump connection

  Included on updated Figure 1 P&ID.

- For interlock 2, change T-2 to T-1

  Corrected on updated Figure 1 P&ID.

- Provide information on pH transmitter calibration frequency, and the cleaning and maintenance frequency for the transmitter and probe.

  New pH probe/monitor specifications and manual & submittal attached.

EnviroTrac

- pH running average, lag time, and warning or system shut down triggers TBD based upon permit

  Warning notification added to updated Figure 1 P&ID.

- Provide estimate of friction loss through flow totalizer in English units

  Manual with pressure drop curve attached.

- Pertaining to flow totalizer and flow transmitters, show pipe diameters on the P&ID (2" for manual and 3" for magnetic)
  - Need 10 pipe diameters of un-interrupted straight flow before and 5 after so they can't be within 20 inches of each other

  Included on updated Figure 1 P&ID.

ET Comments

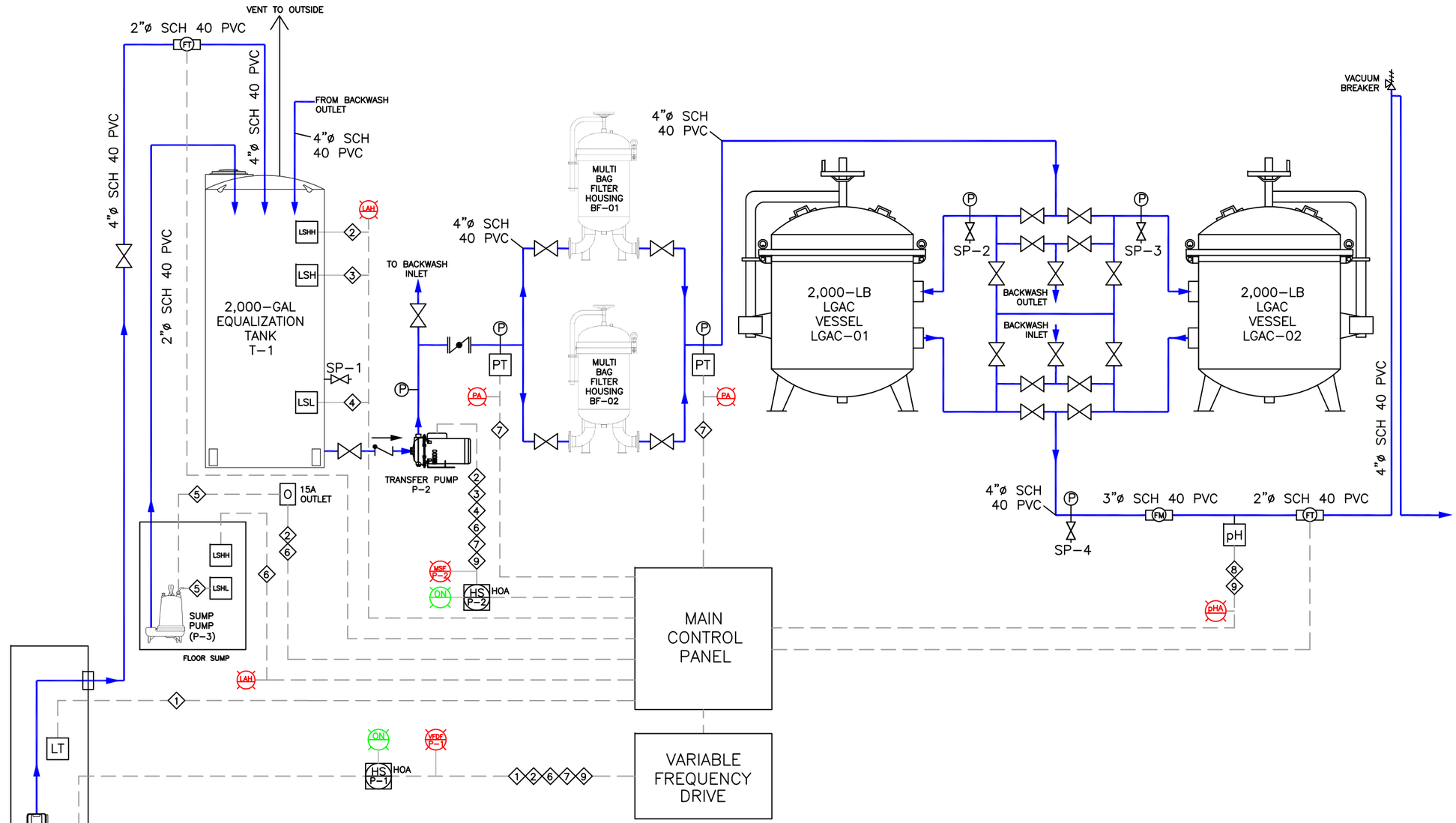
1, Revised VFD submittal included due to better availability and easier ability to program and test.

EnviroTrac

NOTES:
1. 10–PIPE DIAMETERS OF STRAIGHT PIPE RUN TO BE INSTALLED BEFORE EACH FLOW METER OR FLOW TRANSMITTER.
2. 5–PIPE DIAMETERS OF STRAIGHT PIPE RUN TO BE INSTALLED AFTER EACH FLOW METER/TRANSMIITTER.

SYSTEM LEGEND:

- PRESSURE GAUGE
- LS — LEVEL SWITCH
- LT — LEVEL TRANSMITTER
- PT — PRESSURE TRANSMITTER
- pH — pH TRANSMITTER
- FM — FLOW METER/TOTALIZER
- FT — FLOW TRANSMITTER
- BALL VALVE
- BUTTERFLY VALVE
- SP — SAMPLE PORT
- CHECK VALVE
- HS — HMI SWITCH
- CONTROL PANEL INTERLOCK
- ELECTRIC LINE
- AIR FLOW DIRECTION
- WATER FLOW DIRECTION
- ENCLOSURE LIMITS



HMI INDICATOR INDEX:

- LAH — LEVEL ALARM HIGH
- PAH — PRESSURE ALARM HIGH
- pHA — pH ALARM HIGH OR LOW
- VFDF P–1 — VARIABLE FREQUENCY DRIVE FAULT
- MSF P–2 — MOTOR STARTER FAULT
- ON — MOTOR RUN INDICATOR

INTERLOCK SCHEDULE:

1. PLC TO CONTROL VFD TO MAINTAIN GROUNDWATER LEVEL SETPOINT.
2. HIGH LEVEL IN T–1 – SEND ALARM NOTIFICATION, DISABLE P–1, P–2, & P–3 OUTLET.
3. LEVEL AT LSH – TURN ON P–2.
4. LEVEL BELOW LSL – TURN OFF P–2.
5. INTEGRAL SUMP PUMP FLOAT SWITCH ENGAGED – SUMP PUMP TURNS ON AUTOMATICALLY.
   INTEGRAL SUMP PUMP FLOAT SWITCH DISENGAGED – SUMP PUMP TURNS OFF AUTOMATICALLY,
6. HIGH LEVEL IN FLOOR SUMP – SEND ALARM NOTIFICATION, DISABLE P–1, P–2, & P–3 OUTLET.
7. HIGH DIFFERENTIAL PRESSURE ACROSS BAG FILTERS – SEND ALARM NOTIFICATION, DISABLE P–1 & P–2.
8. HIGH OR LOW AVERAGE DISCHARGE pH – SEND WARNING NOTIFICATION.
9. HIGH OR LOW AVERAGE DISCHARGE pH – SEND ALARM NOTIFICATION, DISABLE P–1 & P–2.

EnviroTrac
ENVIRONMENTAL SERVICES
5 OLD DOCK ROAD, YAPHANK, NEW YORK 11980
PHONE: (631)924–3001 FAX: (631)924–5001

REVISION DATE: 5/30/2023

REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

PUMP AND TREAT SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE # 1

Submittal #5 EQ Tank Float Switches (Qty. 3)

FLOAT SWITCH

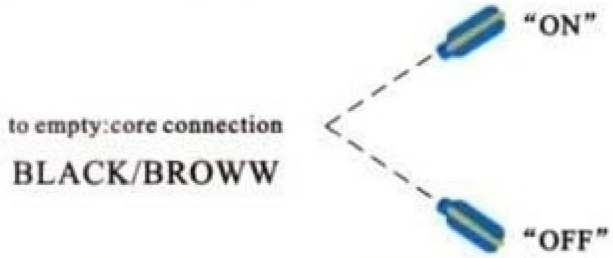
AUTOMATIC ADJUSTABLE
EASYTOINSTALL
RELIABLE
MAINTENANCE FREE
ENVIRONMENTALPROTECTION

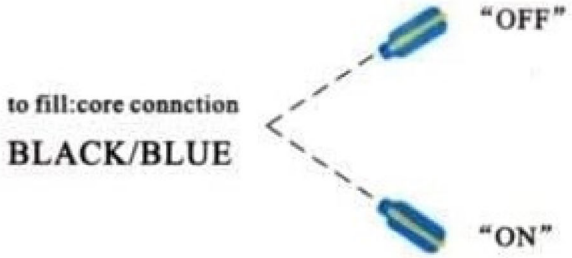
WIRING CONNECTION

Blue=the "ON" switch action below is to fill

Black

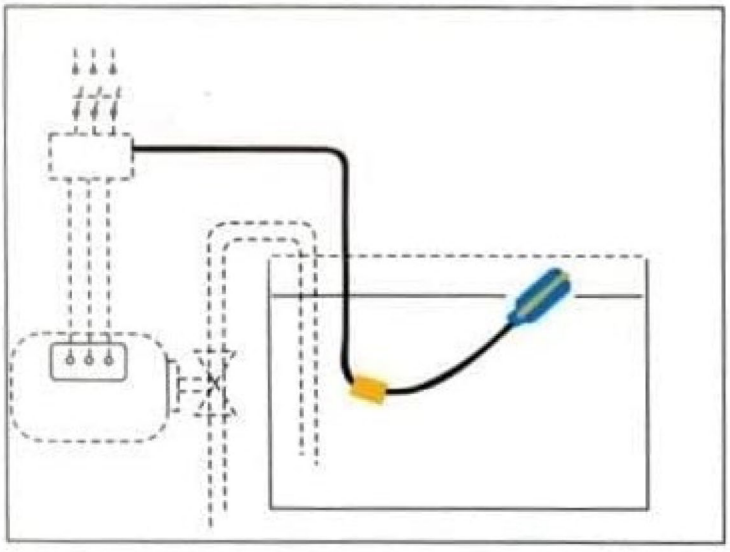
brown=the "ON" switch on high is to empty

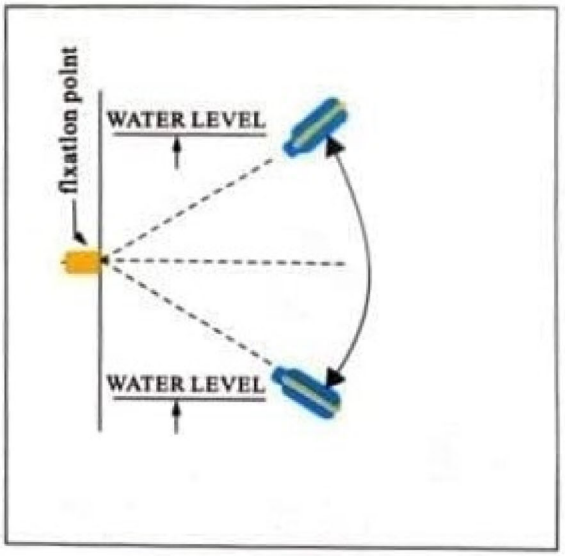




TECHNICALCALDATES

Microswitch:	10(8)A250V~10（4）A380V
Switch currency:	⊣⊢
	≥50 000 switch workings
Protective connection:	□T70U" ⑧
Protection:	Waterproof"
Max.temperature:	70℃
Working pressure:	max.1bar
Circuitbreaking capacity:	directly 2KW with 250V





EASY OPERATION

The desired "ON"or"OFF"differential is obtained by simply lengthening or shortening the free cord fixation point. "ON"and"OFF"switch action may be adjusted to any desired liquid level by moving the cord fixation in up or down direction.

APPLICATION

The float switch "HUTO"is a switch which regulates fluid level in the tank or well etc, The float switch is resistant to water(sewage water),it is relative capable of being used for oil,most acids and alkalis.The float switch is not exploaion proof.

ProSense® SPT25 Series Pressure Transmitters

The ProSense SPT25 pressure transmitter series is engineered to meet many industrial, commercial, and OEM pressure measurement applications. The all stainless steel welded thin film sensing element provides very fast response time and is compatible with many different media sensing applications. With a robust design resistant to vibration, shock, and EMI/RFI, the SPT25 series provides high accuracy over a wide compensated temperature range. Pressure sensing ranges from vacuum to 5000 psig are available along with a ¼ inch NPT male threaded process connection. Choose from linear outputs of 4-20 mA or 0-10VDC with electrical connections of either a DIN 175301-803C L-connector or 6.6 foot (2 m) integral shielded cable.

Applications

- Process control & automation
- Pump & compressor control
- Hydraulic systems
- Pneumatic systems
- Engine monitoring
- Refrigeration equipment
- Presses
- Machine tools

Features

- All stainless steel welded sensing element
- Fast response time
- Pressure sensing ranges from vacuum to 5000 psig
- 1/4 inch NPT male threaded process connection
- Output options: 4-20 mA or 0-10 VDC
- Integral 6.6 foot shielded cable or DIN form C electrical connections
- Made in the USA
- CE marked
- 3-year warranty

Click on the thumbnail or go to https://www.automationdirect.com/VID-PR-0001 for a short video on ProSense Air Differential and Pressure Transmitters

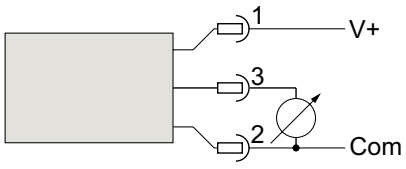
ProSense SPT25 Series Pressure Transmitters (Shielded Cable)

Part Number	Description	Electrical Connection	Input Voltage	Wt(lb)	Price
SPT25-20-V30A	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	Integral 6.6 ft (2m) shielded cable	9 - 36 VDC	0.38	$153.00
SPT25-20-0030A	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-20-0060A	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-20-0100A	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-20-0150A	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-20-0200A	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-20-0300A	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-20-0500A	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-20-1000A	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-20-1500A	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-20-2000A	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-20-3000A	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-20-5000A	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$153.00
SPT25-10-V30A	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$153.00
SPT25-10-0030A	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-10-0060A	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-10-0100A	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-10-0150A	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-10-0200A	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-10-0300A	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-10-0500A	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-10-1000A	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-10-1500A	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-10-2000A	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-10-3000A	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-10-5000A	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$153.00

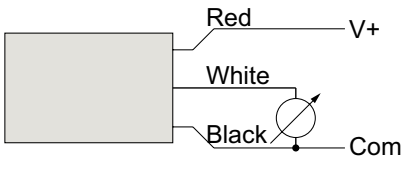
ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series Pressure Transmitters (DIN Connector)					
Part Number	*Description*	*Electrical Connection*	*Input Voltage*	*Wt(lb)*	*Price*
SPT25-20-V30D	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	DIN 175301-803C L-connector	9 - 36 VDC	0.30	$147.00
SPT25-20-0030D	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-20-0060D	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-20-0100D	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-20-0150D	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-20-0200D	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-20-0300D	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-20-0500D	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-20-1000D	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-20-1500D	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-20-2000D	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-20-3000D	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-20-5000D	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$147.00
SPT25-10-V30D	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$147.00
SPT25-10-0030D	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-10-0060D	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-10-0100D	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-10-0150D	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-10-0200D	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-10-0300D	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-10-0500D	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-10-1000D	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-10-1500D	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-10-2000D	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-10-3000D	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-10-5000D	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$147.00

0 to 10 VDC Output Wiring Diagram

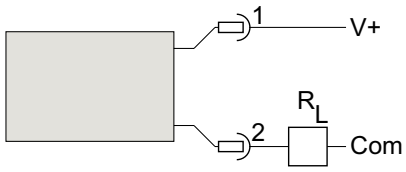


With DIN Connector

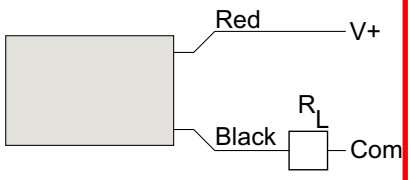


With Integral Cable

4 to 20 mA Output Wiring Diagrams



With DIN Connector



With Integral Cable

Shielded Cable Models Wire Designation		
Wire Color	*0 - 10 VDC Output*	*4 - 20 mA Output*
Red	V +	V +
Black	Com	Output
White	Output	None
*Bare**	Shield Drain Wire	Shield Drain Wire

** Where shielded wiring is being used; Connect the drain wire to the guard terminal on the read out device or measuring instrument if available. In all other cases connect to the power supply negative terminal.*

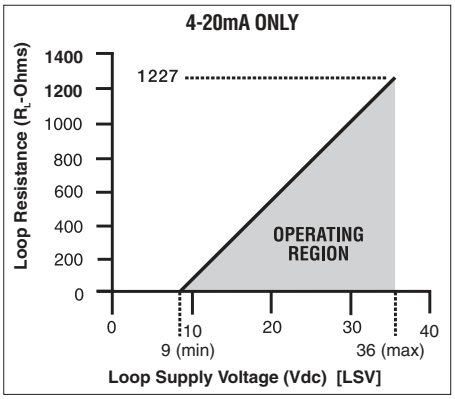
DIN Form C Models Pin Designation		
Pin No.	*0 - 10 VDC Output*	*4 - 20 mA Output*
1	V+	V+
2	Com	Output
3	Output	None
4	Case Ground	Case Ground

ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series General Specifications	
Housing Material	20% Glass Reinforced Nylon, Fire retardant to UL94 V1 / 304 Series Stainless steel
Materials (wetted parts)**	304 Series Stainless steel / 17-4PH Stainless Steel
Operating Temperature	–40 to 257°F (–40 to 125°C)
Medium Temperature	–40 to 257°F (–40 to 125°C)
Storage Temperature	–40 to 257°F (–40 to 125°C)
Protection	IP 67 for cabled models IP 65 For DIN connector models
Accuracy*	± 0.50% of full range
Temperature Coefficient	0.15% of full range / 10°F (0.25% of full range / 10°C)
Reference Temperature	70°F ± 1°F (21°C ± 1°C)
Compensated Temperature	–4 to 185°F (–20 to 85°C)
Insulation Resistance	Greater than 100 megohms at 100 VDC
Shock Resistance	100 gs, 6 ms
Vibration Resistance	Random vibration (20 g) over temperature range (-40° to 125°C). Exceeds typical MIL. STD. requirements
Drop Test	Withstands 1 meter on concrete 3 axis
Response Time	Less than 1 msec
Warm-up time	Less than 500 msec
Position Effect	Less than ±0.01% span, typical
Insulation Breakdown Voltage	100 VAC
Reverse Polarity & Miswired Protected	Yes
Durability	Tested to 50 million cycles
Humidity	0 to 100% R.H., no effect
Stability	Less than ±0.25% full range / year
Agency Approvals	CE
****Note - Includes non-linearity, hysteresis & non-repeatability.***	
***** Not cleaned for oxygen service***	

ProSense SPT25 Series Technical Specifications	
Technical Specifications SPT25-20-xxxx	
Operating Voltage	9 – 36 VDC
Analog Output	4 – 20 mA
Maximum Load	Determine Maximum Loop Resistances $\frac{V_L - 9\ VDC}{0.022\ amps} = R_L$ For example [(24 VDC – 9 VDC) / 0.022 amps] = 681Ω
Technical Specifications SPT25-10-xxxx	
Operating Voltage	14 – 36 VDC
Current Consumption	4 mA
Minimum Load	10 kΩ

Power Supply Voltage vs Loop Resistance



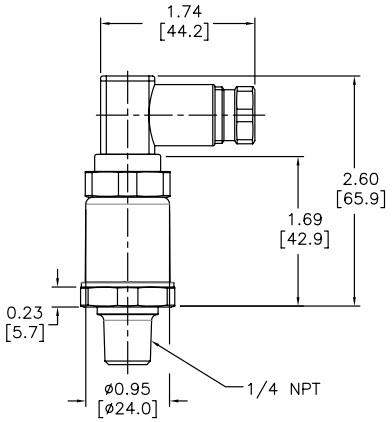
DIN Connector Specifications	
Number of contacts	3 + PE
Cable glands	PG 7
Conductor size max.	0.75 mm² / 18AWG
Type of termination	Screw
Suitable cables	4.5 mm to 6mm
Standard DIN	EN 175 301-803-C

ProSense SPT25 Proof & Burst Pressures		
	Proof	***Burst***
500 psig & below	200% full scale	1000% full scale
1000 – 2000 psig	200% full scale	500% full scale
3000 psig	200% full scale	500% full scale
5000 psig	150% full scale	500% full scale

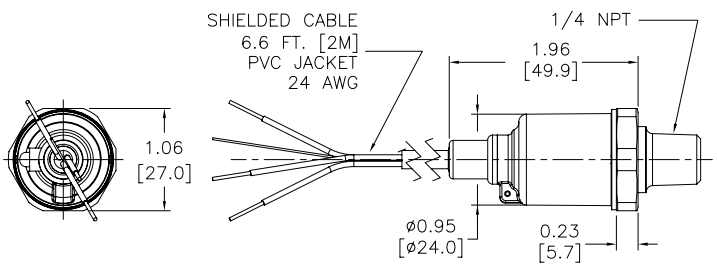
See our website www.AutomationDirect.com for complete Engineering drawings.

Dimensions

inches [mm]



DIN Connector Models



Shielded Cable Models

3 Inch Totalizing Water Meter with Pulse Output

PRMFiltration

Cast Iron Flanged Water Meters for indicating flow totalization of water with pulse output. Woltmann Helix style water meter for industrial use. Designed for long service life and maintenance-free operation, even under harsh conditions.

Features:

- Pulse Output Components
- All Meters have Hydrocarbon Resistant Seals and will not be damaged by dissolved amounts of free product
- Sealed Dry Dial for Clear Readings

Specifications:

- Woltmann Helix Style Water Meter
- 150# Flange
- Pulse Rate: 100 gal/pulse
- Accuracy Class: B
  Transitional Flow: ± 5%
  Nominal Flow: ± 2%
- 6 Digit Mechanical Roller Counter
- Maximum Water Temperature: 86°F
- Maximum Water Pressure: 150 psi
- Mounting Orientation: Horizontal

Materials:

- Body: Cast Iron Body, Epoxy Coated
- Measuring Components: Polyethylene
- Seals: Viton

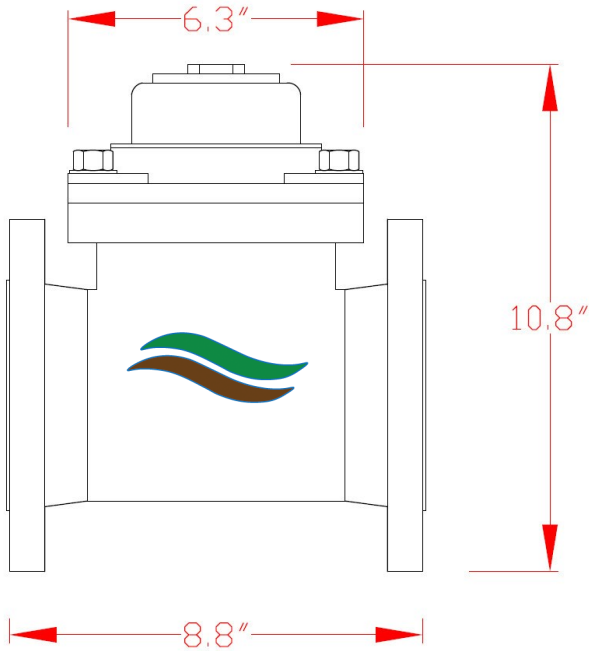
PRM meters are ideal for Environmental and Industrial companies to measure process water for environmental treatment, manufacturing, or irrigation. These meters are for any application that does not require potable water measurement and are excluded from federal Lead Free Standards for drinking water.

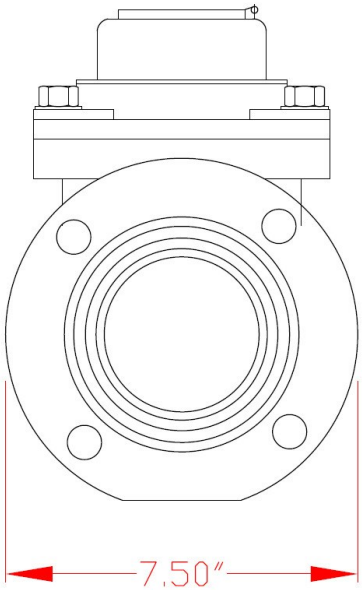
PRM Part Number:

WM300PVX: 3” Flanged Multi-Jet Water Meter

3 Inch Totalizing Water Meter with Pulse Output

Information in this drawing is provided for reference only.





WM300PVX:

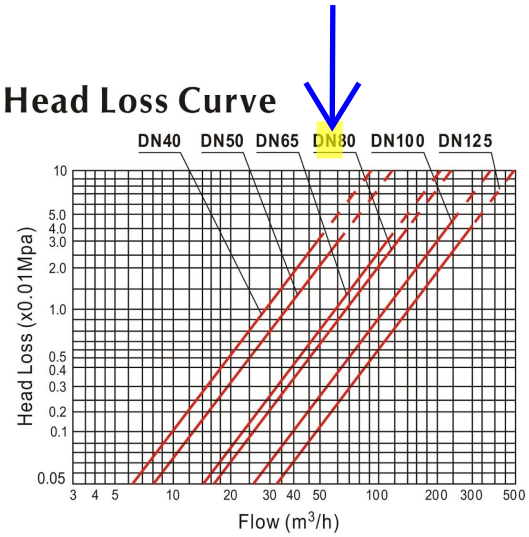
Materials:
Body: Cast Iron
Measuring Chamber: Polyethylene
Paint: Epoxy Coated
Seal: Viton
Mounting Orientation: Horizontal

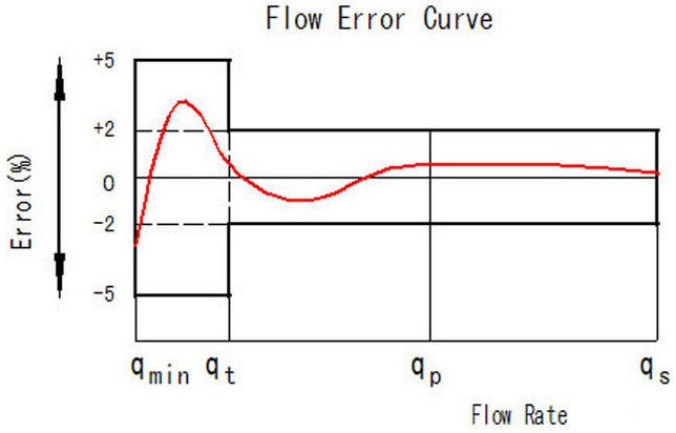
Not for use with Potable Water

Connection: 3 Inch 150# Flange
Pulse Rate: 100 gallons/pulse

Height: 10.8 Inches
Length: 8.8 Inches
Weight: 31 lbs.

Flow Specifications:
Qmin: 5.3 GPM
Qt: 35 GPM
Qp: 176 GPM
Qmax: 352 GPM





(888-TREAT-IT) • www.prmfiltration.com • sales@prmfiltration.com

PRMFiltration

Water Meter Manual

The PRM Multi-Jet Water Meter is ideal for commercial and industrial applications. PRM water meters are based on a vertical axis turbine. The water enters the meter body and is directed to a chamber around the measuring insert. The water then flows to the turbine via multiple passages spaced at intervals around the circumference of the insert. These passages form the “multiple” jets of water that act to rotate the turbine. This rotation is transferred to the counter dials via the counter gearing. The multi-jet design allows for simplicity and accuracy with wide flow ranges, even in low flow applications. The hermetically sealed register will not leak or fog and is completely separated from the water. These water meters are designed for long service life and maintenance-free operation. Brass water meters not for potable water use.

Specifications:

Brass Cold Water Meters: (Blue)
Wetted Materials: Body: Brass, polyethylene; Couplings: Brass; Measuring Chamber: Polyethylene.
O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal (pulse output units only): Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon; 1” to 2” 1 pulse per 10 gallons
Mounting Orientation: Horizontal with register facing up.

Stainless Steel Cold Water Meters: (Silver)
Wetted Materials: Body: 304 Stainless Steel, polyethylene; Couplings: 304 Stainless Steel;
Measuring Chamber: Polyethylene; O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal (pulse output units only): Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon; 1” to 2” 1 pulse per 10 gallons
Mounting Orientation: Horizontal with register facing up.

Brass Hot Water Meters: (Red)
Wetted Materials: Body: Brass, heat resistant polymer; Couplings: Brass;
Measuring Chamber: Heat resistant polymer;O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 194°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal: Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon
Mounting Orientation: Horizontal with register facing up.

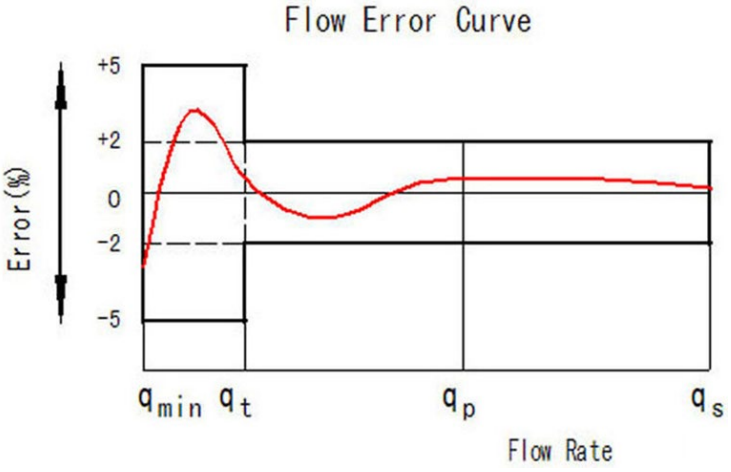
Nylon Cold Water Meters: (Black)
Wetted Materials: Body: Nylon 66; Couplings: Nylon 66; Measuring Chamber: ABS Plastic.
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Mounting Orientation: Horizontal with register facing up.

Water Meter Classification and Accuracy

Water meters are primarily classified by size, or the nominal diameter of the water meter is matched to the size of the pipe to which it is being connected. However, it should always be confirmed that the expected flow rates through the meter fall within the accurate flow range of the meter. The meters flow range is defined as follows:

Nominal flow rate	Qp	The designation flow rate of the meter. This is the ideal amount of water flow through the meter.
Maximum flow rate	Qmax	The highest flow rate at which the meter accuracy will be within the Maximum permitted error
Minimum flow rate	Qmin	The lowest flow at which the meter accuracy will be within the maximum permitted error.
Transitional flow Rate	Qt	The flow rate at which the maximum permitted error of the meter changes from +/-5% to +/-2%.

Max. permitted error from Qmin to Qt: +/-5%
Max. permitted error from Qt to Qmax: +/-2%



PRM Meters are Class B meters and conform to AWWA Standards.

Nominal Diameter	Qmin (GPM)	Qt (GPM)	Qp (GPM)	Qmax (GPM)
0.5 Inch	0.25	1	5	10
0.75 Inch	0.5	2	10	20
1 Inch	0.75	3	15	30
1.25 Inch	0.75	3	25	50
1.5 Inch	1.5	5	40	75
2 Inch	2	8	65	130

PRM Woltmann Style Flanged Meters

Nominal Diameter	Qmin (GPM)	Qt (GPM)	Qp (GPM)	Qmax (GPM)
3 Inch	5	35	176	352
4 Inch	8	53	264	528
6 Inch	20	132	660	1320

Water Meter Reading
Turbine type meters use a combination of inline digits and clock dials to show the volume of water that has been measured. The inline digits are in black and show the whole gallons. The clock dials have pointers that indicate the fractions of the gallons. On the larger meters this may change as often there is a x100 multiplier on the counter so the dial will show the whole gallons to give you an accurate reading.

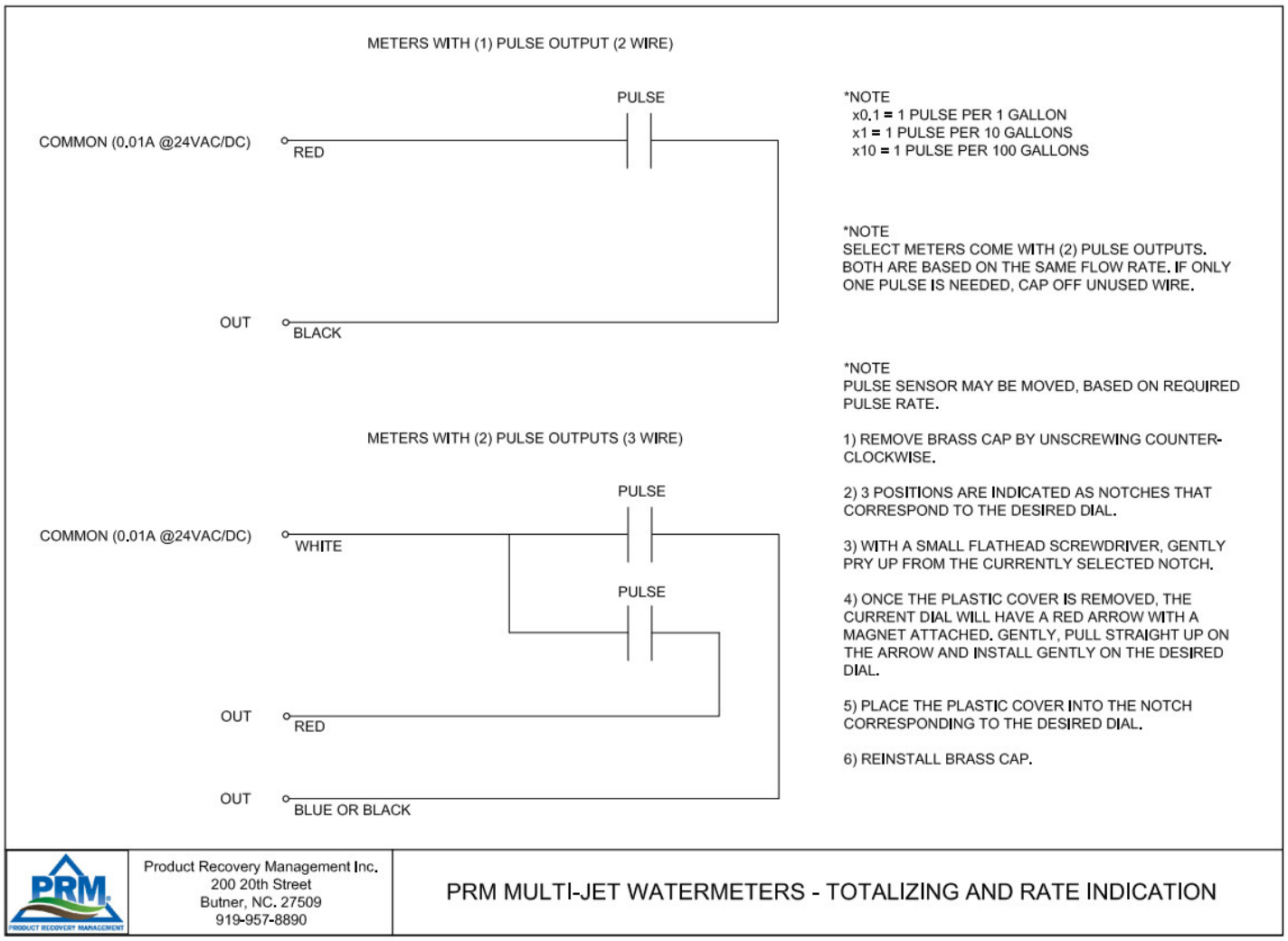
Maintenance/Repair
Preventative maintenance consists of periodic inspections and cleaning procedures.
The procedures should be performed at regular intervals, and any defects discovered should be corrected before further operation of the meter.
All water meters with registers should be protected from weather and not be exposed to direct sunlight.
Visually inspect the meter for missing hardware, broken resistor glass, or other signs of wear or deterioration.
Verify proper flow rate and pressure for meter. A loss in pressure, with the resulting flow rate decrease, may indicate the meter screen is clogged and requires cleaning.
Clean the strainer yearly, or as required, depending on water condition. Pull out the strainer or back flush the meter to loosen trapped particulates.

Installation Instructions

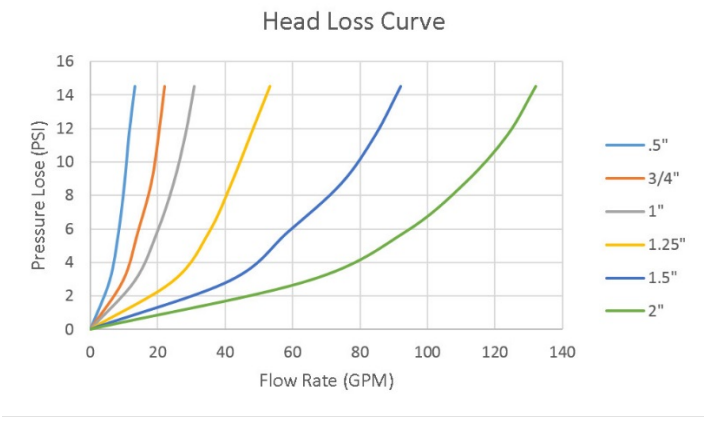
1. Thoroughly flush the service line upstream of the meter to remove dirt and debris.
2. Remove meter thread protectors. Note: To protect meter spud threads, store the meter with thread protectors in place. Attach included NPT adapters for easy connection to piping.
3. Set the meter in the line. Install in a horizontal plane, with the register upright, in a location accessible for reading, service and inspection. Arrows on the side of the meter and above the outlet indicate the direction of flow.

4. For accurate measurement, the tap height should be higher than the meter.
5. Do not over-tighten connections; tighten only as required to seal.
6. With upstream shut-off valve only: Open shut-off valve slowly to remove air from meter and service line. Open a valve slowly to allow entrapped air to escape. Close the valve.
7. With both upstream and downstream shut-off valves installed, test the installation for leaks: Close the outlet (downstream) shutoff valve. Open the inlet (upstream) shut-off slowly until meter is full of water. Open the outlet (downstream) valve slowly until air is out of the meter and service line. Open valve slowly to allow entrapped air to escape. Close the valve.

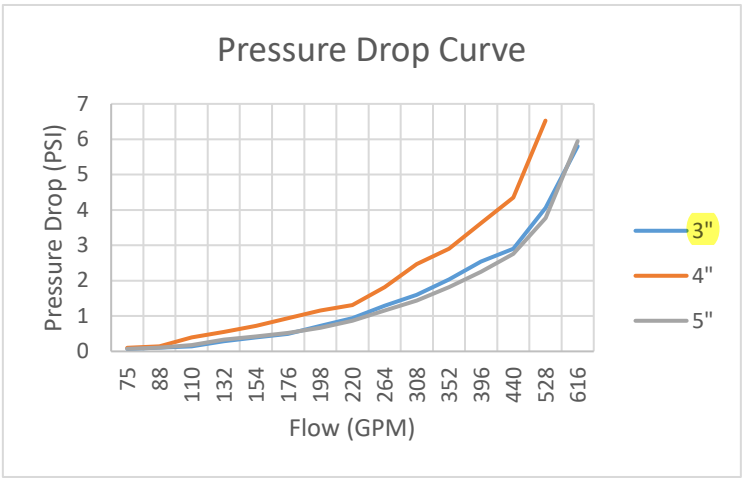
Wiring Diagram (Pulse Units)



Head Loss Curves



½ Inch to 2 Inch Multi Jet Meters



3, 4, and 6 inch Flanged Meters

pH and ORP Monitor and Probe

Measurement and control of pH is important in a wide variety of industries.

The pH Transmitter provides the combination of durability, accuracy, and versatility required for virtually any pH monitoring application.

The ORP Transmitter provides the same reliable monitoring system for Oxidation-Reduction Potential (ORP) applications.

PRM offers pH/ORP monitors and probes for accurate measurement and diagnostics of process water.

Features:

- White backlight LCD screen
- Compatible for six kinds of buffer solutions
- 4~20 mA output
- Double relay high/low and delay control function

PRM PART #:

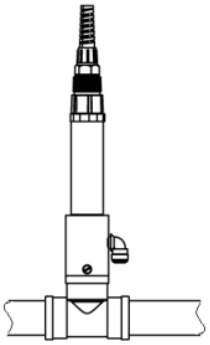
pH Probe:
MISCPHMONITOR5500X

ORP Transmitter:
MISCORPMONITOR5500X

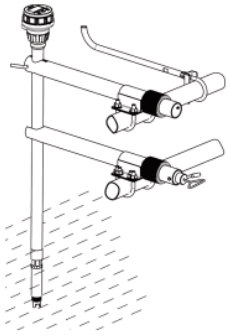
Contact sales@prmfiltration.com to find more information on pH and ORP Monitoring Applications.

www.prmfiltration.com

Installation method



P34A adjustment flow device



Immersion installation

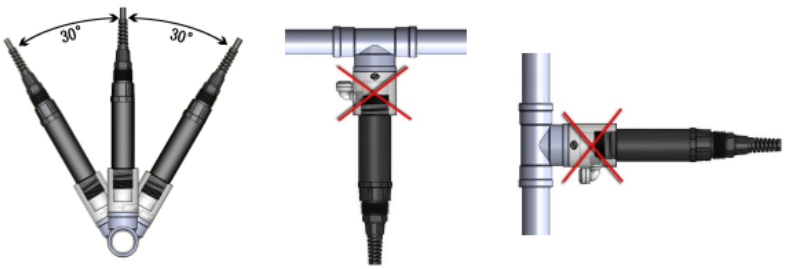
Regarding installation method

1. User should cut off the flow before replacing sensor.
2. Fast flow and air bulbs will cause instable measurement.
3. Higher pipeline pressure will damage the sensor
4. There will be big error when testing pure water or ultra pure water.
5. The sensor will fail very soon if for testing pure water.
6. Conductivity will rise if electrode electrolyte diffuses in water through liquid junction.
7. Negative pressure will damage the sensor.
8. Water particles and fibrous material will damage the sensor.

Measurement equipment

1. The patented product P34,installed between pipeline and sensor.
2. The sensor can be replaced without cutting off water flow.
3. The reading will be accurate and stable when testing pure water and the working life is longer.
4. There is no electrode electrolyte diffuses in water

[NOTE 2]: Installation notes



• Installation angle is Less than 30 degree

Inverse installation is incorrect

Horizontal installation is incorrect

pH/ORP-5500
pH/ORP Transmitting controller

Operation manual

V1.1

Introduction

Thanks for choosing pH/ORP-5500 series pH/ORP meter manufactured by Hebei Create Instrumentation Technologies Co., Ltd. Proper sensor installation and parameter setting would give maxium performance and advantage of this instrument for your good usage. So please carefully read this manual before installation.

This instrument is a precise electrochemical analysis Dosing &Control Integration System, which should be operated by technicians with relevant professional knowledge.

Please contact technical backup of CREATE when you meet any problems during installation and usage.

Check the actual product with complete set after you receive the package, and contact us if any missing or damage.

Our serious promise:

1. The meter's quality guarantee is one year from the date of purchasing. During this period, if the meter has quality problems, manufacturer is responsible for maintenance for free or replacement.

2. We provide lifelong maintenance service for the product whatever you purchase from us or distributors.

3. If the damage of the meter is caused by the following reasons, it is out of the maintenance service:

A).The meter is burned caused by misconnection with high voltage power supply or soggy.

B).The meter is refitted or misused without permission.

C).The meter is damaged under the condition out of use environment.

D).The relevant damage caused by choosing the wrong type.

E).The physical damage caused by ultimate load

F).The meter is out of operation caused by improper storage and transportation (refer to SJ/T10463-93 standard)

G).Consumable material is out of maintenance service.

Please take care of the items which with this sign.!

*Without the influence on the operation, any small change or improvement on the products by the manufacturer will not be notified separately. Please make the object as the standard

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1、conception

pH/ORP-5500 series is a kind of popular and cost-effective online pH and ORP controller , with plug-in pH/ORP-1220 sensor, which have good measurement accuracy, anti-interference,easy to install and operation features.

- White backlight LCD screen,several operations, easy for operation
- Be compatible for six kinds of buffer solution which suitable for international standard.
- Selectable temperature sensor which reduce the replacement cost；
- Manual calibration is easy for on-site calibration.
- EMC enhancement type could run smoothly under kinds of industry environment.
- （4~20）mA output support instrument/transmitter modes and satisfy all 4-20mA receiving unit.
- Double relay high/low and delay control function could fulfill pH or ORP interval control and adjustment.
- Several power supply to be selection according to the different models.Input AC/DC power, no polarity connection.

1.1 Working principle

The weak voltage change is generated when H^+affected the inserted sensor, the changeable value will transmit to the instrument. After converting and calculating the generated pH/ORP signal, the instrument will show the values on the screen.

1.2 Application

This series instruments are widely used for online pH/ORP monitoring in environment protection water treatment, pure water treatment, industrial process and so on.

1.3 Classification

Model	Power supply	Frequency（Hz）	Current mode	Sensor selection
pH/ORP-5500	DC 24V	-------	Instrument/transmitter	pH-1220A plug-in sensor; ORP-1220A plug-in sensor or other sensors; TE-1230-14temperature sensor
pH/ORP-5510	AC 110V	50/60	Instrument/transmitter	
pH/ORP-5520	AC 220V	50/60	Instrument/transmitter	

【NOTE】

1、Put the instrument in dry environment and the water-drop or mositure will cause the damage or measurement error；

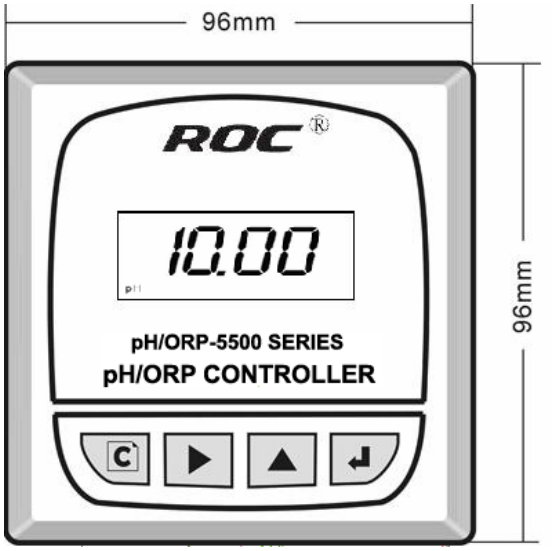
2、Pay more attention on the power supply before wiring connection.

1.4 Technique index

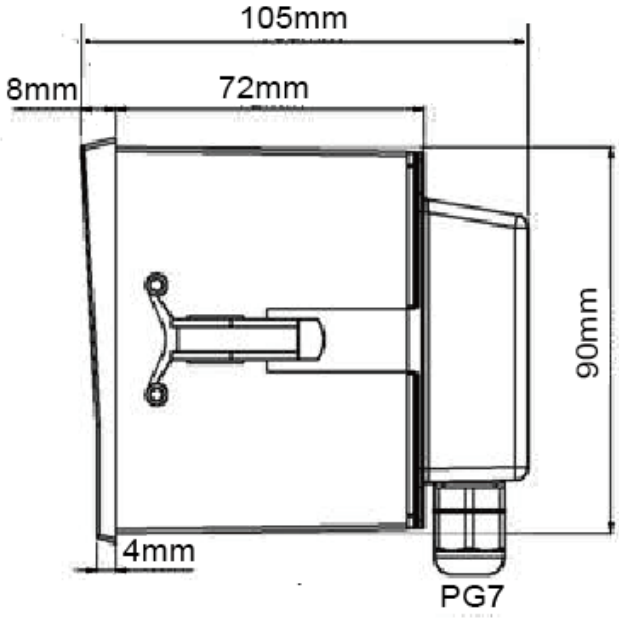
model		pH/ORP-5500 series pH/ORP online transmitting controller
Measurement range	pH	0.00~14.00
	ORP	-2000mV~2000mV
	Temp.	（ 0.0~50.0 ） ℃ （ temperature compensation component:NTC10K）
Resolution	pH	0.01
	ORP	1mV
	Temp.	0.1℃
accuracy	pH	0.1
	ORP	±5mV（electronic unit）
	Temp.	±0.5℃
Approximate input impedance		$3\times10^{11}\Omega$
Buffer solution		pH value: 10.00；9.18；7.00；6.86；4.01；4.00
Temp. compensation range		（0~50）℃（with 25℃ as standard） Manual and automatic temperature compensation
(4~20)mA	characteristics	Isolated,fully adjustable,reverible,instrument/transmitter for selection
	Loop resistance	500Ω（Max），DC 24V
	accuracy	±0.1mA
Control contact	Electrical contacts	Double relay SPST-NO,return model
	Loop capacity	AC 220V/AC 110V 2A(Max)；DC 24V 2A(Max)

Power consumption		＜3W
Working environment	temperature	(0~50)℃
	humidity	≤85％RH(none condensation)
Storage environment		Temp.(-20-60) ℃;relative humidity:≤85%RH(none
Outline dimension		96mm×96mm×105mm（H×W×D）
Hole dimension		91mm×91mm(H×W)
installation		Panel mounted,fast installation

2、Installation



Top view

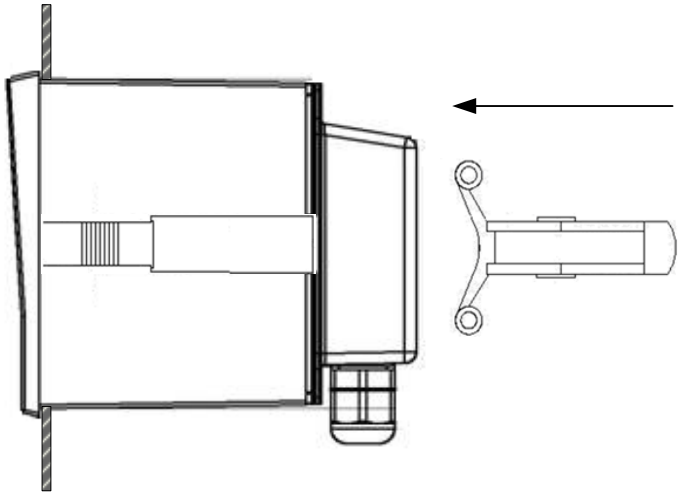


Side view

2.1 InstALLATION OF INSTRUMENT

pH/ORP-5500 series is adopted panel mounted type, which could be installed easily. Please follow the steps:

1. Put the instrument into the fixed hole 44mmX92mm(HxW)
2. Then push the quick clamp along with the trench and fasten the instrument.



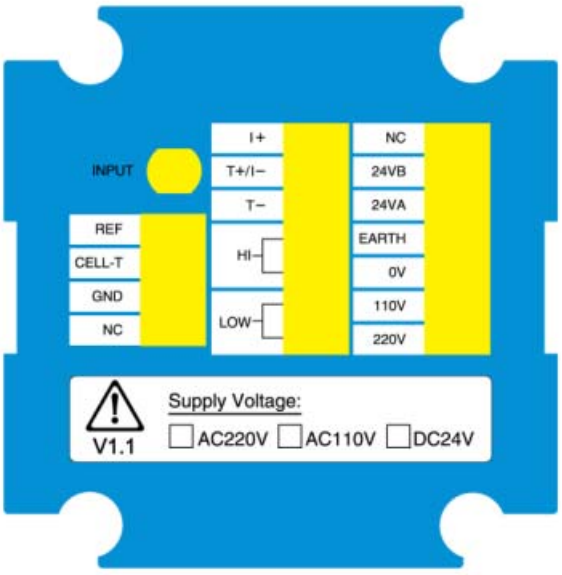
3. Do not let the instrument drop on the floor when dismounting the meter.Withdraw the quick clamp and take the instrument down.

Do not put the instrument under the sun since the UV will damage the LED screen.

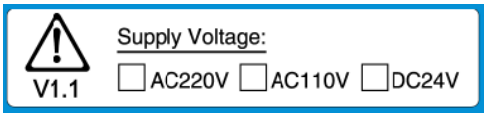
2.2 Electrical CONNECTION

The measurement cable can not be mixed with high-pressure and high frequency cable. To avoid any interference, the cables should be 30cm distance and connect with the ground.

Connect the power line and signal line according to the below diagrams：.



The actual power supply must be the same

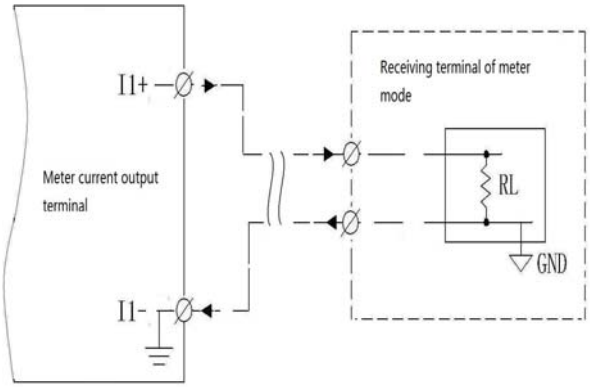


with marked power supply !

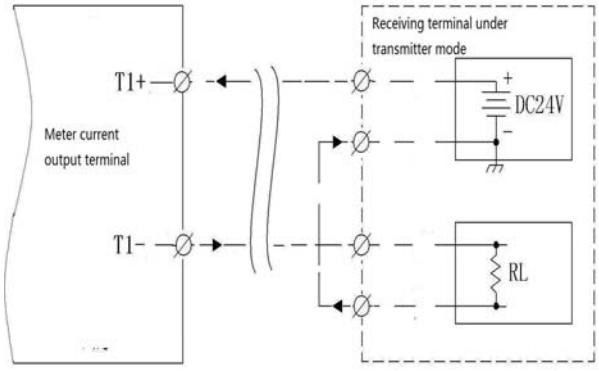
Wiring connection：

INPUT	Connect pH/ORP measuring sensor（transparent line）
REF	Connect pH/ORP reference sensor（shielded line）
CELL-T	Connect the receiving terminal of the temp.sensor(red)
GND	Connect grounding terminal of the temp. sensor (black)
I+/I-	Instrument mode (powered by instrument)
T+/T-	Transmitting model（external feed）
Hi	High limit alarm control terminal blocks
Low	Low limit alarm control terminal blocks
24VA/B	DC 24V input interface (pH/ORP-5500) （ Internal automatic recognition of polarity ）
0V/110V	AC 110V input interface(pH/ORP-5510)
0V/220V	AC 220V input interface(pH/ORP-5520)
NC	Empty terminal
EARTH	Electromagnetic compatibility group protection terminal

2.3 Diagram of 4-20mA output

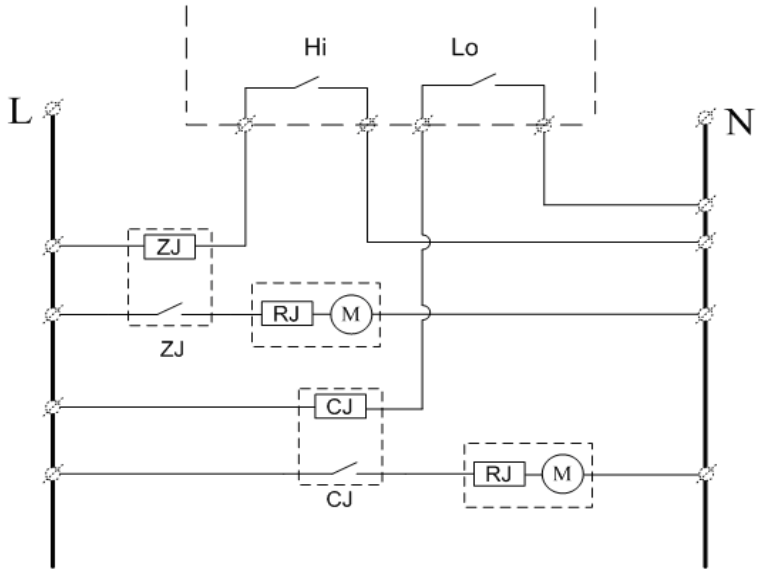


Instrument mode



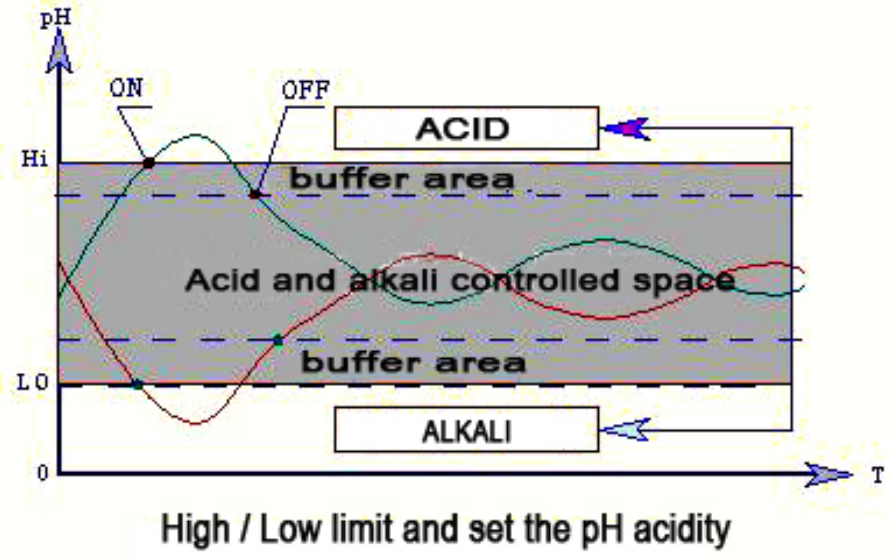
Transmitting mode

2.4 Relay control connection



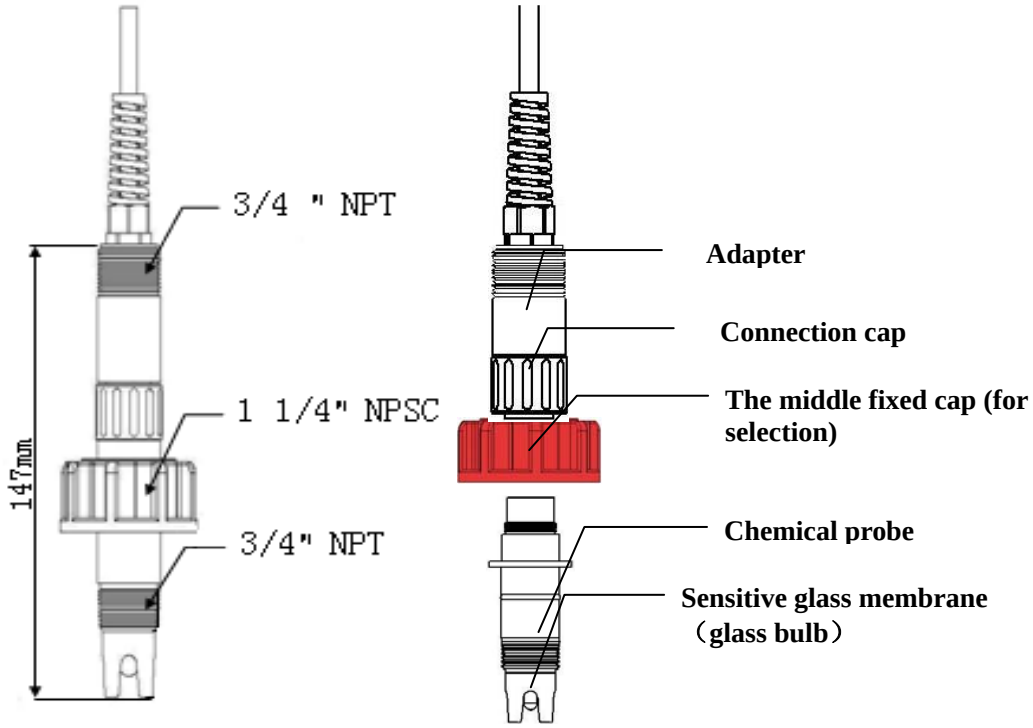
Relay ON/OFF contact component control wiring diagram

2.5 Control mode

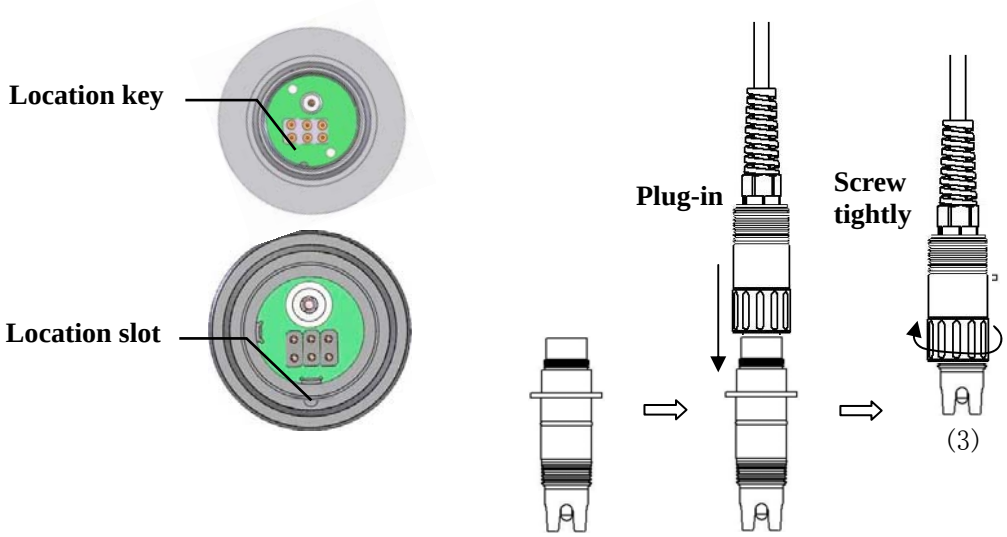


High / Low limit and set the pH acidity

2.6 Installation of sensor

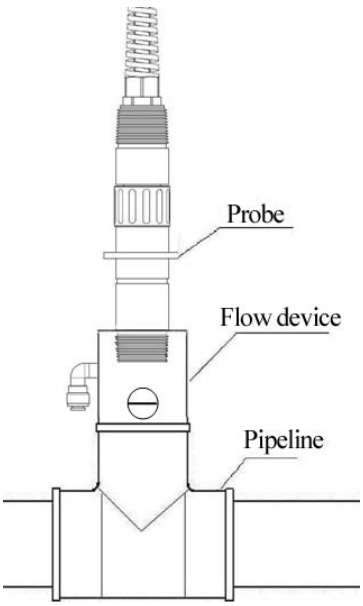


2.6.1Assembling and replacement

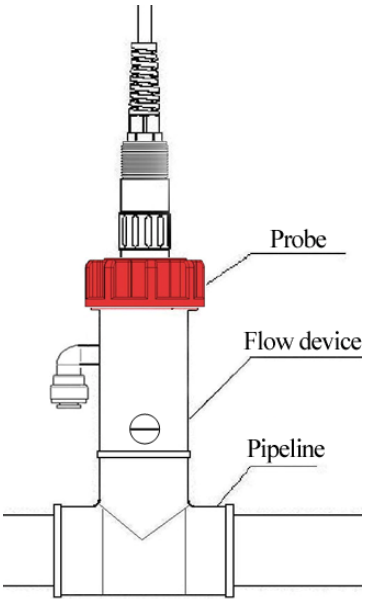


The location key and location slot must be occlusive exactly. No rough installation.

2.6.2 Installation method of sensor



Flow device P34A



Flow device P34B

⚠ **[Note] :** Recommend using the flow device with needle valve (P34)

1. Needle valve flow device (model P34A/B) is recommended when pipeline installation，which can change probe under pressure-bearing、continue condition；
2. Round sensitive glass steep pH probe direct install in the pipeline, it will threaten the probe when the pipeline pressure change, water hammer or siphon effect，after using flow device, the probe and atmosphere will communicate, operational states safe and measure stability
3. When direct install pipeline，pure water measurement value will instability because the water is weak electrolyte，sensitive glass film（glass bubble）and salt bridge present discontinuity open circuit，result the measure value instability
4. When direct install the pipeline to measure pure water，high concentration KCL of pH probe and pure water form huge concentration difference，trough liquid abutment spread into the water largely. Cause the probe lose effectiveness，pollute the pure water meantime.，make the conductivity under probe downstream of pH probe rise hugely.

2.6.3 Installation requirement

Middle 1 1/4 " NPSC straight pipe thread fitting Upright install or slant install no more than 30 º

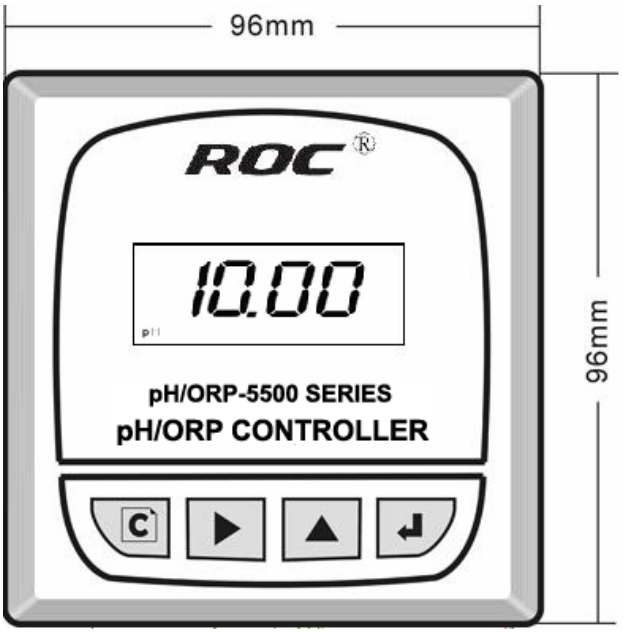
bottom 3/4 " NPT taper thread fitting；Upright install or slant install no more than30 º

Horizontal installation does not work

Backward installation does not work

3、Settings

You could set the relative parameter after connect the instrument and sensor. Please enter into the setting mode to check and set the relative parameters for your first use. These parameters are in different menus.

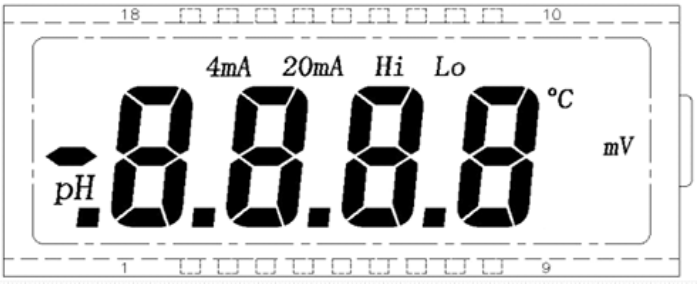


Main menu

Please operate the meter with the keys. Under the different mode, the function will be different.：

Sign	Name	Function
	ESC	1.Check the temperature compensation value under pH measurement status. 2.Exit or skip the setting parameter.
	Select	1. select thousand, hundred ,ten and unit circularly under parameter setting interface； 2. long-time press the key under pH measurement status, it will enter into pH mV calibration interface;
	Add key	**1.** set the 0-9 figure under parameter setting status 2. long-press the key under pH measurement status, it will enter into the buffer calibration interface； 3. check mV value under pH measurement status.
	Enter key	1.Enter into the main function menu 2. save the parameter settings

Three functions shows on the main interface: the upper area is menu bar which guide the operation; the right area displays the measurement unit of the current time; the figures means the measurement data or menu items.

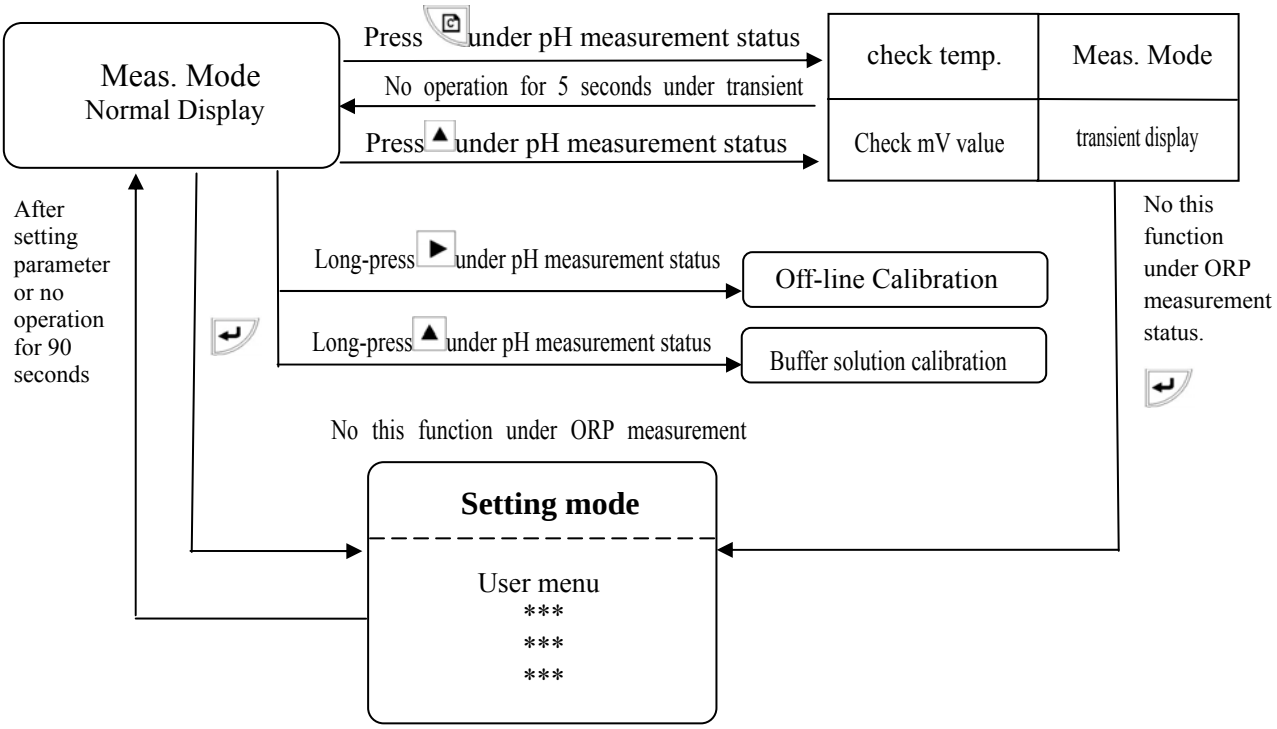


pH/ORP-5500 working mode：

◆Measurement mode：Normal display、transient display

◆Setting mode：Parameter setting

Switch the mode as following：



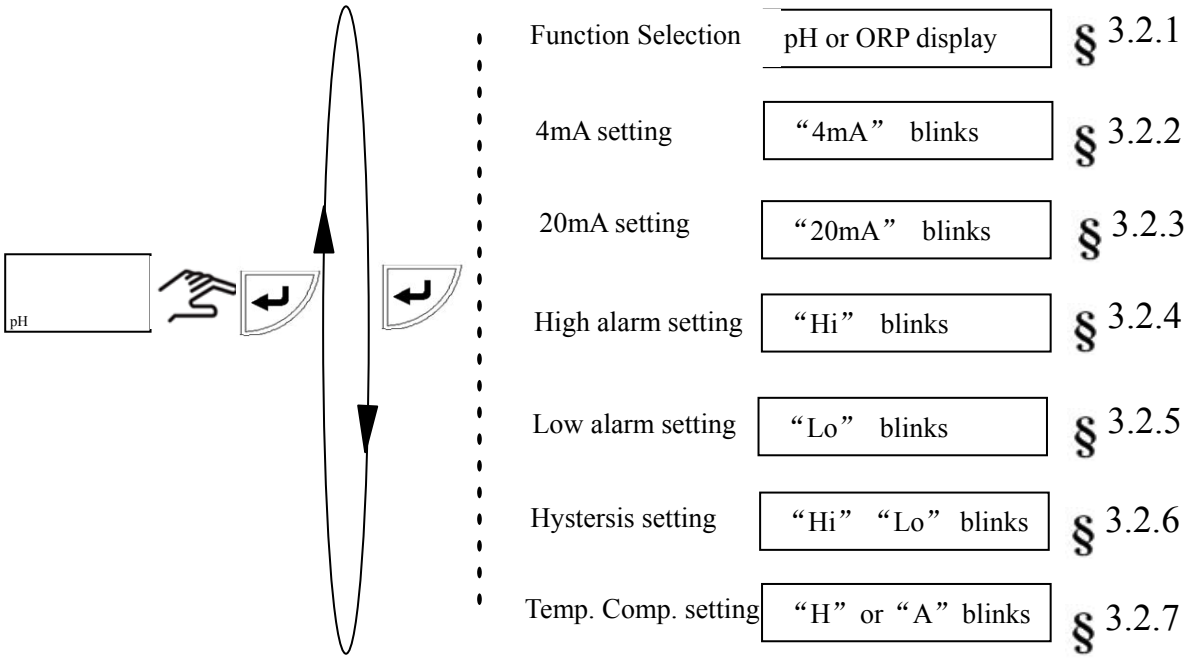
3.1 Measurement mode

3.1.1 Normal display

The instrument will display the current pH/ORP value after powered on.

3.1.2 Transient display

Check the current temp. value by pressing under pH measurement status and check current mV value by pressing ▲ . The instrument will return to normal display without any operation in five seconds.



3.2 Setting mode

Some parameters have been set before ex-factory. If the test environment changes (such as replacement of electrode, reset the alarm setting), please check the parameter which is in different menus. The specific content and operations as following

3.2.1 Function selection

Choose “pH” or “ORP” function selection by pressing ▲ press ↵ for saving the setting and enter into the next parameter setting.

3.2.2 4mA setting

When the screen displays “4mA”,press ▶ to select the position of input figures.Then press ▲ to input the actual pH/ORP value, press ↵ to save the settings and enter into the next menu setting.

3.2.3 20mA setting

When the screen displays “20mA”,press ▶ to select the position of input figures.Then press ▲ to input the actual pH/ORP value, press ↵ to save the settings and enter into the next menu setting.

3.2.4 High-limit alarm setting

The screen will displays “Hi” after entering the interface of high-limit alarm setting, press ▶ to select the digital position and input the actual value by pressing ▲, and save and enter into the next menu setting by pressing ↵ .

3.2.5 Low-limit alarm setting

Same operation as the high-limit alarm setting, and press ↵ after setting.

3.2.6 Alarm Hystersis setting

When “Hi”and“Lo”appear at the same time, set the pH/ORP hystersis value by pressing“ ▶ ” and“ ▲ ”, and press ↵ save and enter into the next menu.

⚠ THE MIN VALUE: PH≥0.1; ORP≥10MV!

3.2.7 Temperature setting

When“H”or“A”blinks，press “ ▲ ” to do the manual temperature compensation （H25.0℃） or automatic temperature compensation (A25.0℃) (automatic temperature compensation need to connect a temp. sensor NTC10K.). Then press ↵ save and return to measurement status.

⚠ **No this operation for ORP measurement!**

3.3 Sensor calibration

3.3.1 System Calibration

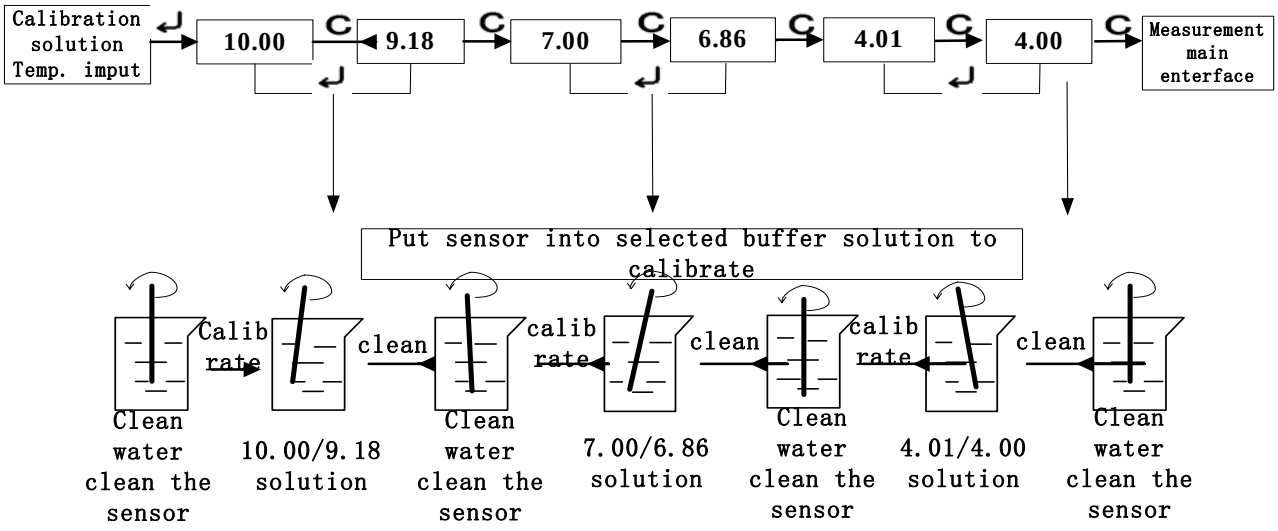
pH/ORP sensors are electrochemical and their sensitivity decreases with influence of time and medium. In order to get an accurate measurement, it is suggested to often calibrate sensor's slope. The calibration period relays on the influence from the measured medium.

1. Normal buffer solution ,10.00\9.18\7.00\6.86\4.00\4.01
2. If the medium are acid or alkali, please choose two point slope calibration, use two kind buffer solution.;
3. Before the calibration, please read the instruction carefully , and prepare the standard buffer solution;
4. The meter with directly input calibration method, please reference the calibration steps.;
5. If the sensor with long time storage, please put it in the water or KCL solution for 12 hours , and then calibrate it。

3.3.2 Buffer solution calibration

1. Choose the correct buffer solution to calibrate.;
2. Press the ▲ for 3 seconds and enter into buffer solution calibration interface under pH measurement interface, input the current temperature , Press ↵ save and enter into buffer solution calibration by pressing
3. When the "C10.0" and pH blinks，it means to enter into the buffer solution selection; press " C " and enter into the next calibration menu.
4. Put the clean sensor into the buffer solution for 3-5 minutes.
5. Press" ↵ "to save the settings and enter into the next calibration，fetch the sensor out and clean, then put it into the suggestive buffer solution and finish the calibration in turn.
6. Check the buffer solution and recalibrated when"ERRO" comes out and then recalibrate.

Please follow the below detailed calibration process:

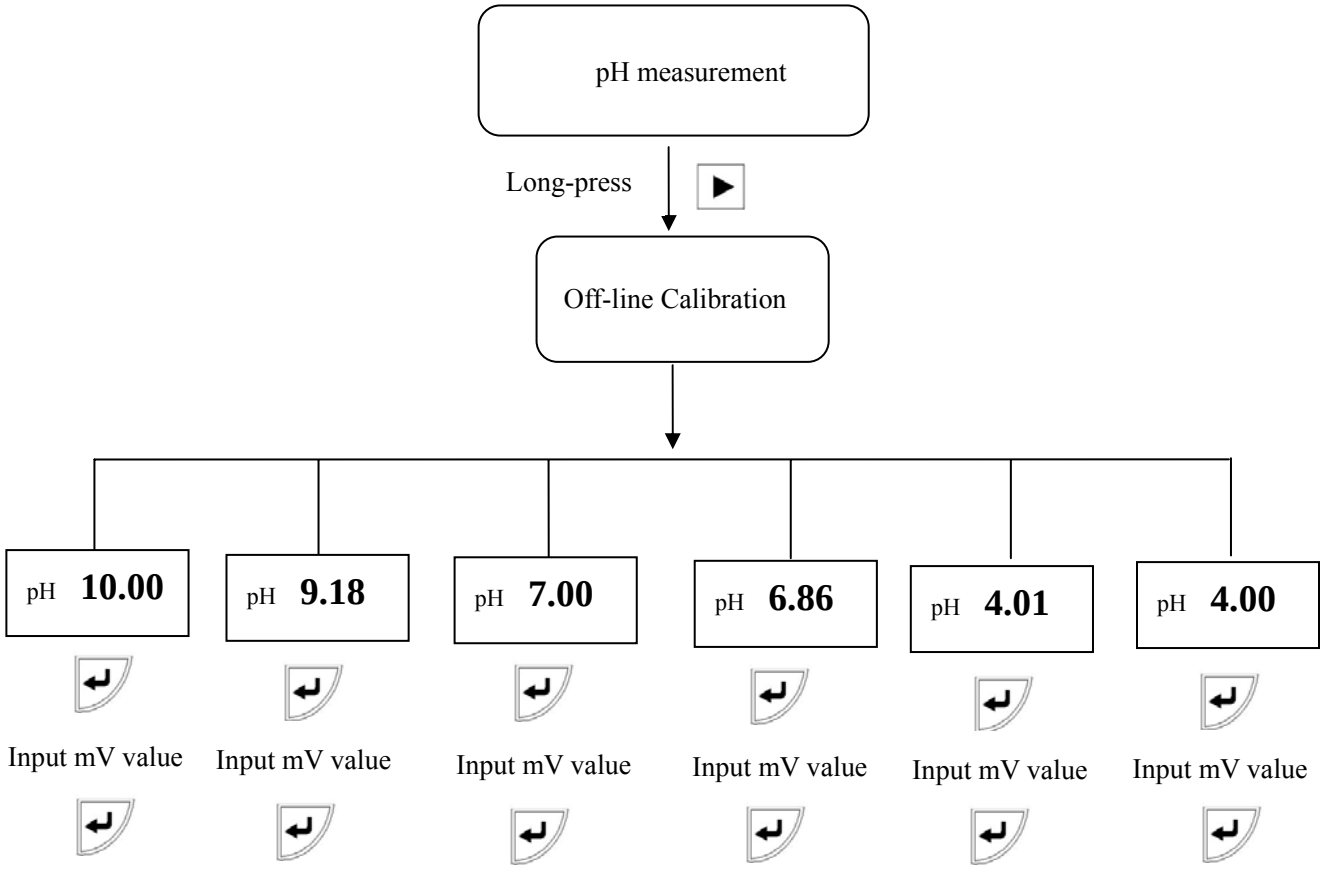


means skip this operation； and “ ”means enter the operation.

3.3.3 Off-line calibration

When field calibration is not good to carry on ,the calibration to sensor’s slope by using lab devices and buffer solution is recommended .Take notes of corresponding mV value of buffer solution in room temperature.Input of this record value to off-line calibration is called as manual input calibration.

Press “ ”for 3 seconds under pH measurement status,input the corresponding mV value in different buffer solution, press “ ”to save and enter into the main menu.



Incorrect mV value input during calibration process, the screen will display “Err”.

Press “ ” to continue the calibration, and press “ ”to enter into the next calibration.

4. Maintenance

4.1 Sensor Maintenance

1. To avoid long time dry store, the sensor should be kept in the protection cap with KCl solution in 3.0mol/L.;
2. Clean the sensor and calibrate the same on the indicator regularly.;
3. In case of suspended stuff attached, wash it with HCl or NaOH solution in 0.01mol/L and rinse with clean water;
4. If the above methods are invalid to reset slope, it means that the sensor should be replaced.;
5. The platinum surface of ORP sensor should be shining. In case of smudginess, wash it with HCl or NaOH solution in 0.01mol/L and rinse with distilled water. If the surface of platinum is polluted and formed oxidation film, the platinum could be polished with sand paper and toothpaste, then clean it with distilled water;
6. Place the senor into 3.5 mol/L KCl solution for 6 hours before usage;
7. Buffer solution gets different value at different temperature so please confirm the temperature of buffer solution at calibration。

4.2 Usage of sensors

1. pH/ORP sensors are consumables .Long time storage is not suggested;
2. Sensitive glass film (glass bubble) is forbidden to use when the medium with hydrofluoric acid, fluorion and high-concentration sulfion.
3. pH/ORP sensors are not allowed to measure any organic solution which will damage or dissolve PC or ABS(such as carbon tetrachloride, trichloro ethylene or tetrahydrofuran etc….);
4. The chemical part of the sensor is glass, please protect carefully during transportation and storage.
5. Please clean the sensor at a regular time by using swab and neutral cleanser; do not use the acid and corrosive solution to clean the sensor。
6. High-temp. pH glass sensor is recommended for biopharmacy and high-pressure autoclaved sterilization. The protection part is optional;
7. pH signal is weak signal, the collecting cable should run separately. Do not mix the cable together.
8. Measurement cable is for special use, it’s not allowed to cut or lengthened privately or replaced by other cables.

9. Install a filter before sensor when there is molecule in the medium to protect the pH glass bubble.

5. Instrument and probe fault common trouble shooting

Problem	Possible causes	Trouble shooting
No display when powered on	A. Bad connection of power supply B. Instrument fault	A check to see if there is 24Vvoltage between power terminals 24VA and 24VB. B. Check by professional technicians.
Unstable display	A. Improper wire connection of sensor B. Air bubbles in the pipeline C. Unstable water quality D.badness connection	A. refer to the instruction manuals B. select the proper measurement point or change the pipeline C. stabilizing the water quality D. Check the connector to be connected
Big deviation	Sensor fault The cable is damaged incorrect installation setting problem	A. Take out the sensor from the pipeline and calibrate B. replace the sensor which can not be calibrated C. find the correct measurement point and use the flow device D. reset the parameter of the instrument
Difference at transmitting data	loop resistance is too large incorrect connection mode unusual power supply wrong transfer volume	replace the cable to reduce the loop resistance check the connection right or not powered by the standard reset the transferred volume

6. Complete set

Transmitter	1pc（including quick clamp）
Ph/ORP-1220A sensor	1pc (cable length 10m)
Operation manual	1pc
Certificate	1pc

7. Order directory

Choose the right power supply,sensor and flow device to meet the requirements before ordering according to the below table：

7.1 Sensor selection

Model	Power supply	sensor	Cable length
pH/ORP-5500	DC 24V	pH-1220A sensor ORP-1220A sensor TE-1230-14 temp. sensor	1m 5m 10m（standard） 20m
pH/ORP-5510	AC 110V		
pH/ORP-5520	AC 220V		
Other sensor selection	High-temp. glass sensor High-pure glass sensor		

7.2 Flow device selection

Quote the instrument/sensor/flow device separately, different price for different selection.。

Flow device	sensors	applications
P33flow device	glass sensor	Automatically controller or lab system
P34A flow device	pH/ORP1220A sensor	Pipeline installation
P34B flow device	pH/ORP1220A sensor	Pipeline installation
P16 used for submersible installation	pH/ORP1110A sensor	Channel or reservoir
P17 used for flange installation	pH/ORP1110A sensor	reaction still or material tank
Accessories for fold submersible installation	pH/ORP1110A sensor	Wastewater pool oraeration tank
Floating accessories	pH/ORP1110A sensor	Channel, river oraquaculture
Jacket (protection part)accessories	High temp. glass sensor	Bio-pharmaceuticals and food fermentation
Noble metal protection	pH/ORP1110A sensor	Metallurgy orfloatation system

*Without the influence on the operation, any small change or improvement on the products by the manufacturer will not be notified separately. Please make the object as the standard.

*DURA*PULSE GS20(X) AC Drives – Introduction

*DURA*PULSE GS20(X) AC Drives													
Motor Rating	*HP*	1/4	1/2	1	2	3	5	7.5	10	15	20	25	30
	kW	0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22
120V Single-phase		✓	✓	✓									
230V Single-phase		✓	★	★	★	★							
230V Three-phase		✓	★	★	★	★	★	★	✓	✓	✓		
460V Three-phase			★	★	★	★	★	★	★	✓	✓	✓	✓
575V Three phase				✓	✓	✓	✓	✓	✓				

✓ = GS20 model available ★ = GS20 and GS20X models available

Overview

The DuraPulse GS20(X) new generation high performance vector control drives provide many standard and advanced functions—all in a compact unit that has been reduced 40% in size. A NEMA 4X version provides service in the harshest of environments.

The drives include many of the same standard features as our GS family of drives including dynamic braking, PID, removable keypad, and RS-485 Modbus communication.

The GS20(X) drive expands the *DURA*PULSE family by adding single-phase input capability (ALL 230VAC drives can be supplied single-phase), a built-in PLC, and optional EtherNet/IP and ModbusTCP communication card. The drive supports up to four (4) independent IM motor parameter sets or supports control of a single AC PM motor.

*DURA*PULSE GS20(X) AC drives offer several different speed control modes: standard V/Hz with pulse input feedback, sensorless vector (SVC) for Induction Motors (IM) and Permanent Motors (PM), and ultra precise Field Oriented Vector control (FOC) for maximum open loop speed regulation control.

*DURA*PULSE GS20(X) offers two analog inputs, one analog output, one frequency output, seven digital inputs (including one pulse train input up to 33kHz), two digital outputs, one SPDT relay output, and two STO inputs. All of the analog and digital I/O can be configured for a wide variety of input or output functions. One option card slot is available for either the backup control power option card or Ethernet/IP and Modbus TCP communication option card.

Features

- Broad offering from 1/4 to 30 hp
- NEMA 4X available up to 10hp
- Single-phase 120VAC up to 1hp
- Single-phase/three-Phase 230VAC up to 20HP
- Three-phase 460VAC and 575VAC
- Single-phase UL Ratings – 230VAC input for 1 to 20 hp models (see selection tables for derated output)
- Dual rating design – CT/VT Ratings (Light & Heavy Duty)
- "Zero Stack" side-by-side zero gap installation
- Compact Design
- Spring clamp terminal blocks
- Speed control potentiometer built in
- Flexible carrier frequency to 15khz and output frequency to 600Hz
- STO – Safe Torque Off (TUV Certified)
- Built-in PLC to support up to 2K steps
- Built-in USB port for fast & easy programming
- Free downloadable software for drive configuration and PLC programming
- Field-upgradable firmware (drive & communication option card)
- Optional LCD text-based advanced keypad (IP66/NEMA 1) can be remotely mounted
- Local/Remote control mode selection or digital/comm input with Hand/Off/Auto control
- Display custom values on keypad
- Momentary power loss restarts
- 100kA Short Circuit Current Rating
- DC Bus Connection Terminals (except 120VAC models)
- Conduit Box(s) for NEMA 1
- Analog I/O – configurable 2 Inputs and 1 Output
- Multi-Motor Control (4 total)
- Built-in Dynamic Braking – optional resistors
- PID Controller – including sleep and wake
- Password protection
- RTD and/or PTC input motor protection
- GS2 mode duplicates exact parameter configuration of GS2
- Modularized design eases maintenance and expansion, including quick replacement of cooling fan
- High speed communication interfaces with MODBUS RTU built in, with optional EtherNet/IP and ModbusTCP Communication Card
- Circuit boards have conformal coating for improved environmental tolerance
- Excellent heat-sink design; able to operate at 50°C ambient temperature
- Fire Mode – Run fire mode during emergencies to have uninterrupted smoke removal and system pressure
- Two-year warranty
- CE, TUV, UL, cUL

Accessories

- AC line reactors
- dV/dT output filters
- EMI filters
- RF filter
- Braking resistors
- Fuses
- Conduit boxes
- Mounting Kits
- Replacement cooling fans
- Replacement keypad
- Extension cable for remote keypad placement
- Optional advanced LCD keypad (and remote-mount bezel kit)
- EtherNet/IP and ModbusTCP comm card
- Four and eight-port RS-485 multi-drop termination boards
- GSoft2 drive configuration software
- GSLogic PLC programming software
- Type A to B USB cable
- Detailed descriptions and specifications for GS accessories are available in the "GS/DURApulse Accessories" section.

Typical Applications

- Conveyors
- Compressors
- Material handling
- Extruding
- Grinding
- Shop tools
- Fans
- Pumps
- HVAC
- Mixing

DURAPULSE GS20(X) AC Drives – Selection

Selecting the Proper Drive Rating

Selecting the Proper Drive Rating

Determine Motor Voltage and Full-Load Amperage (FLA)

Motor voltage and FLA are located on the nameplate of the motor.
NOTE: FLA of motors that have been rewound may be higher than stated.

Determine Motor Overload Requirements

Many applications experience temporary overload conditions due to starting requirements or impact loading. Most AC drives are designed to operate at 150% overload for 60 seconds. If the application requires an overload greater than 150% or longer than 60 seconds, the AC drive must be oversized.
NOTE: Applications that require replacement of existing motor starters with AC drives may require up to 600% overload.

Determine Application Type: Constant Torque or Variable Torque

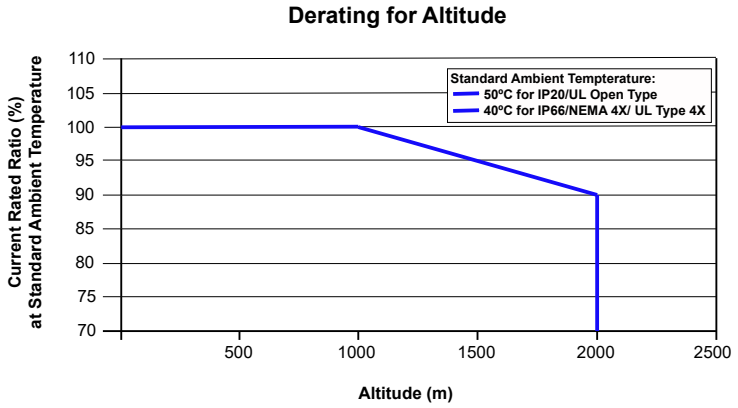
This torque requirement has a direct effect on which drive to select. Variable Torque applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Constant Torque category (machine control, conveyors, etc.). If you are unsure of the application, assume Constant Torque. The specification, derating, and selection tables are generally segregated by Constant Torque and Variable Torque.

Installation Altitude

AC drives rely on air flow for cooling. As the altitude increases, the air becomes less dense, and this drop in air density decreases the cooling properties of the air. Therefore, the AC drive must be oversized to compensate for the decrease in cooling. GS20(X) drives are designed to operate at 100% capacity at altitudes up to 1000 meters.
NOTE: For use above 1000m, the AC drive must be derated as described below.

Derate Output Current Based on Altitude Above 1000 Meters

- If the AC drive is installed at an altitude of 0–1000m, follow normal operation restrictions.
- If installed at an altitude of 1000–2000m, decrease 1% of the rated current or lower 0.5°C of temperature for every 100m increase in altitude.
- Maximum altitude for Corner Grounded is 2000m. If installation at an altitude higher than 2000m is required, please contact AutomationDirect.



DURAPULSE GS20(X) AC Drives – Selection

Selecting the Proper Drive Rating, continued

Determine Maximum Enclosure Internal Temperature

AC drives generate a significant amount of heat and can cause the internal temperature of an enclosure to exceed the rating of the GS20(X) drive, even when the ambient temperature is less than 104°F (40°C). Enclosure ventilation and/or cooling may be required to reduce maximum internal temperature to 104°F (40°C) or less. Ambient temperature measurements/calculations should be made for the maximum expected temperature.

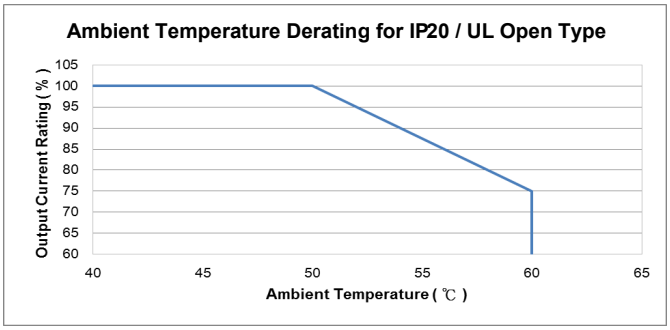
NOTE: For use above 104°F (40°C), the AC drive must be derated as described below.

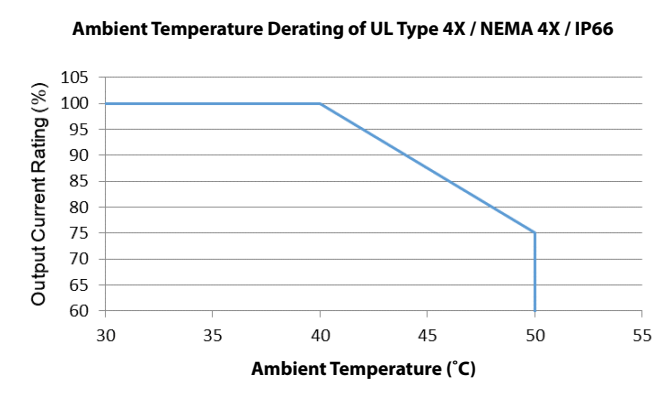
Derate Output Current Based on Temperature Above 104°F (40°C) or 122°F (50°C)

Drive Derating by Temperature and Protection Level

Protection Level	*Derating*
*UL Open Type / IP20**	When the GS20(X) drive is operating at rated current, the ambient temperature has to be between -10°C and +50°C. When ambient temperature exceeds 50°C, decrease the rated current by 2.5% for every 1°C temperature increase. Maximum allowable temperature is 60°C.
*UL Type 4X / NEMA 4X / IP66**	When the GS20(X) drive is operating at rated current, the ambient temperature has to be between -10°C and +40°C. When ambient temperature exceeds 40°C, decrease the rated current by 2.5% for every 1°C temperature increase. Maximum allowable temperature is 50°C.

** For more information about environmental ratings, refer to the "Operating Temperature and Protection Level" table (pg.tGSX-37).*





DURAPULSE GS20(X) AC Drives – Selection

Selecting the Proper Drive Rating, continued

Derate Output Current Based on Carrier Frequency (if necessary)

Carrier Frequency Effects

AC Drives rectify the incoming 50 or 60Hz line power resulting in DC power at 0Hz. The resulting DC power is then pulse-width modulated and supplied to the motor by the drive's power electronics. IGBTs invert the DC power, simulating a sine wave at the desired frequency (that's what allows variable speed in AC induction motors). The speed at which the IGBTs are turned ON and OFF is called Carrier Frequency. In GS20(X) drives, the Carrier Frequency can range from 2kHz to 15kHz. Though Carrier Frequency can be adjusted, there are trade-offs between high Carrier Frequencies and low Carrier Frequencies.

Benefits of Higher Carrier Frequencies:

- Better efficiency (lower harmonic losses) in the motor
- Lower audible noise

Benefits of Lower Carrier Frequencies:

- Better efficiency in the drive
- Lower EMI (electrical noise)
- Reduced reflective wave peak voltage

As a general rule, the Carrier Frequency should be set as low as possible without creating unacceptable audible noise in the motor. Smaller systems can have higher Carrier Frequencies, but larger drives (>20 or 30hp) should not have Carrier Frequencies set higher than 6kHz. Heavy duty applications typically run around 2–4 kHz.

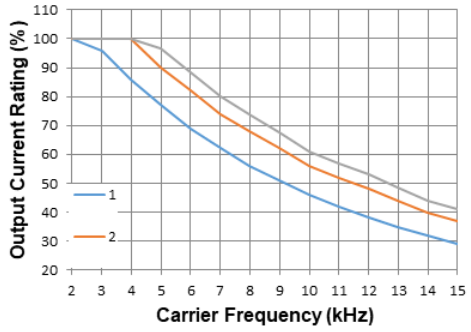
Derating Tables

The tables below show the derating curves for both GS20 and GS20X drives running in two different modes under variable torque and constant torque conditions.
Line 1: Ta = 50°C / Load = 100%
Line 2: Ta = 50°C / Load = 75% or Ta = 40°C / Load = 100%
Line 3: Ta = 50°C / Load = 50% or Ta = 35°C / Load = 100%

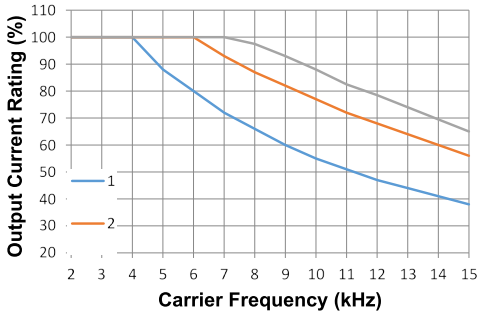
Set PWM mode via P11.41.
SVPWM = Space Vector Pulse Width Modulation mode
DPWM = Two Phase Pulse Width Modulation mode

Variable Torque Carrier Frequency Derating

SVPWM Mode

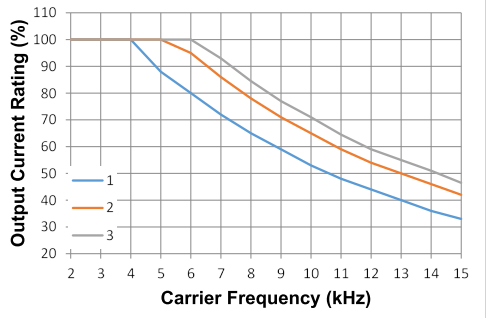


DPWM Mode

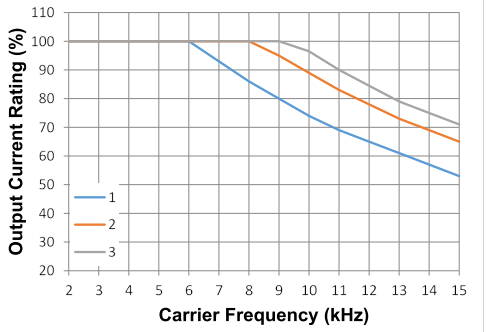


Constant Torque Carrier Frequency Derating

SVPWM Mode



DPWM Mode



DURAPULSE GS20 AC Drives – Selection Specifications

GS20 Drive Model Selection Tables, continued

GS20 460V[1] 3-Phase Specifications – Frame Sizes A, B, C

Model Name				GS23-40P5	GS23-41P0	GS23-42P0	GS23-43P0	GS23-45P0
Price				$193.00	$198.00	$228.00	$255.00	$310.00
Frame Size				A	A	B	C	C
Drawing				PDF	PDF	PDF	PDF	PDF
Output Rating	Max Motor Output		hp	1/2	1	2	3	5
			kW	0.4	0.75	1.5	2.2	3.7
	CT	Rated Output Capacity	kVA	1.1	2.1	3.2	4.2	6.9
		Rated Output Current	A	1.5	2.7	4.2	5.5	9
		Carrier Frequency[3]	kHz	2–15 (default 4)				
	VT	Rated Output Capacity	kVA	1.4	2.3	3.5	5	8
		Rated Output Current	A	1.8	3	4.2	6.5	10.5
		Carrier Frequency[3]	kHz	2–15 (default 4)				
Input Rating[2]	CT	Rated Input Current	A	1.7	3	5.6	6.1	9.9
	VT	Rated Input Current	A	2	3.3	5.1	7.2	11.6
	Rated Voltage/Frequency			Three-phase 380-480 VAC (-15% to +10%), 50/60 Hz				
	Operating Voltage Range (VAC)			323–528				
	Frequency Tolerance (Hz)			47–63				
IE2 Efficiency - Relative Power Loss				4.0%	2.6%	2.3%	2.3%	2.0%
Weight (kg [lb])				0.75 [1.65]	0.81 [1.79]	1 [2.20]	1.24 [2.73]	1.24 [2.73]
Cooling Method				Convective		Fan		
IP Rating				IP20				

1 - For Use With Three-Phase Motors Only.
2- If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS20(X) AC Drives User Manual, Chapter 2.
Please refer to "GS20(X) DURApulse Accessories – Fusing" (pg.tGSX-55) for input fusing information.
3 - The carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency".

GS20 460V[1] 3-Phase Specifications – Frame Sizes D, E, F

Model Name				GS23-47P5	GS23-4010	GS23-4015	GS23-4020	GS23-4025	GS23-4030
Frame Size				D	D	E	E	F	F
Drawing				PDF	PDF	PDF	PDF	PDF	PDF
Output Rating	Max Motor Output		hp	7 1/2	10	15	20	25	30
			kW	5.5	7.5	11	15	18.5	22
	CT	Rated Output Capacity	kVA	9.9	13	19.1	24.4	29	34.3
		Rated Output Current	A	12	17	25	32	38	45
		Carrier Frequency[3]	kHz	2–15 (default 4)					
	VT	Rated Output Capacity	kVA	12	15.6	21.3	27.4	31.6	37.3
		Rated Output Current	A	15.7	20.5	28	36	41.5	49
		Carrier Frequency[3]	kHz	2–15 (default 4)					
Input Rating[2]	CT	Rated Input Current	A	14.3	18.7	27.5	35.2	41.8	49.5
	VT	Rated Input Current	A	17.3	22.6	30.8	39.6	45.7	53.9
	Rated Voltage/Frequency			Three-phase 380-480 VAC (-15% to +10%), 50/60 Hz					
	Operating Voltage Range (VAC)			323–528					
	Frequency Tolerance (Hz)			47–63					
IE2 Efficiency - Relative Power Loss				2.0%	1.9%	1.8%	1.7%	1.5%	1.5%
Weight (kg [lb])				2.07 [4.56]	2.07 [4.56]	3.97 [8.75]	3.97 [8.75]	6.25 [13.78]	6.25 [13.78]
Cooling Method				Fan					
IP Rating				IP20					

1 - For Use With Three-Phase Motors Only.
2- If 3-phase power source is non-symmetrical, refer to "Circuit Connections – RFI Jumper" in the GS20(X) AC Drives User Manual, Chapter 2.
Please refer to "GS20(X) DURApulse Accessories – Fusing" (pg.tGSX-55) for input fusing information.
3 - The carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency".

DURAPULSE GS20(X) AC Drives – General Specifications

GS20(X) Drive Model Selection Tables, continued

GS20(X) General Specifications (Applicable to All Models)				
Control Characteristics	Control Method		V/F, Sensorless Vector (SVC), Field Oriented Control (FOC) Sensorless, Volt/Frequency with Pulse Generator intput (VFPG), Torque (TQC Sensorless)	
	Applicable Motor		3-phase AC Induction Motor, 3-phase Permanent Magnet AC motor	
	Starting Torque[1]		150% / 3Hz 100% / (motor rated frequency/20) 200% / 0.5 Hz	(V/F, SVC control for IM, CT, rated) (SVC control for PM, CT, rated) (FOC control for IM, CT, rated)
	Torque Accuracy		± 15% TQC Sensorless	
	Torque Limits	120/230/460V	VT: 160% of output current, max CT: 180% of output current, max	
		575V	200% of output current, max	
	Speed Control Range[1]		1: 50 (V/F, SVC control for IM, CT, rated) 1: 20 (SVC control for PM, CT, rated) 1: 100 (FOC control for IM, CT, rated)	
	Max. Output Frequency		0.00–599.00 Hz	
	Overload Capacity		VT: rated output current of 120% 60 sec, 150% 3 sec. CT: rated output current of 150% 60 sec, 200% 3 sec.	
	Frequency Setting Signal		0–10 V / -10–10 V 4–20 mA / 0–10 V 1 channel pulse input (33kHz), 1 channel pulse output (33kHz)	
	Digital Inputs		Seven (7) - 24VDC NPN or PNP, includes 1 pulse train frequency input 33kHz	
	Digital Outputs		Three (3) - (2)-48VDC, (1) Relay-250VAC/30VDC	
	Analog Inputs		Two (2) - (1) voltage, (1) selectable Voltage or Current	
	Analog Outputs		One (1) - selectable voltage or current	
	Frequency Output		One (1) - 30VDC, 33kHz	
	Safe Torque Off		STO1 and STO2 inputs- 24VDC	
	Main Functions		Multiple motor switching (a maximum of four independent motor parameter settings), Fast start-up, Deceleration Energy Back (DEB) function, Wobble frequency function, Fast deceleration function, Master and Auxiliary frequency source selectable, Restart after momentary power loss, Speed tracking, Over-torque detection, 16-step speed (including the master speed), Accel./decel. time switch, S-curve accel./decel., three-wire operation control, JOG frequency, Frequency upper/lower limit settings, DC brake at start-up and stop, PID control, Built-in PLC (2000 steps), and Simple positioning function.	
	Application Macro		Built-in application parameter groups (selected by industry) and user-defined application parameter groups.	
Protection Characteristics	Motor Protection		Over-current, over-voltage, over-heating, phase loss.	
	Stall Prevention		Stall prevention during acceleration, deceleration, and running (independent settings).	
Accessory	Communication Card		GS20A-CM-ENETIP (EtherNet/IP and Modbus TCP)	
	External DC Power Supply		GS20A-BPS (24V power backup supply card)	
Agency Approvals			*UL, CE[2], TUV (SIL 2), RoHS, REACH*	

1: Control accuracy may vary depending on the environment, application conditions, or different motors. For more information, contact AutomationDirect.
2: See CE declaration here: https://support.automationdirect.com/docs/GS20A-GS20AX-CE.pdf

DURAPULSE GS20(X) AC Drives – Environmental Specifications

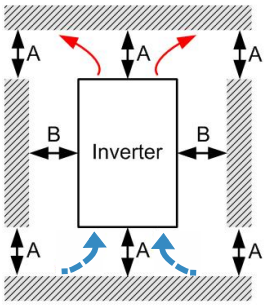
GS20(X) Environmental Specifications

Environmental Conditions for GS20 AC Drives			
Condition	Operation	Storage	Transportation
Installation Location	IEC 60364-1/ IEC 60664-1 Pollution degree 2, Indoor use only.	n/a	n/a
Ambient Temperature	IP20/UL Open Type: -20–50°C (-20–60°C w/derating)	-40–85°C	-20–70°C
	Non-condensing, non-freezing		
Relative Humidity	90%, no water condensation	95%, no water condensation	
Air Pressure	86–106 kPa	70–106 kPA	
Pollution Level	IEC 60721-3, concentrate prohibited		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Environmental Air	No corrosive/inflammable gases permitted		
Altitude	<1000 m (For altitudes > 1000 m, derate to use it.)		
Package Drop	n/a	ISTA procedure 1A (according to weight) IEC 60068-2-31	
Vibration	1.0 mm, peak to peak value range from 2–13.2 Hz; 0.7–2.0 G range from 13.2–55 Hz; 2.0 G range from 55–512 Hz. Compliance with IEC 60068-2-6	2.5 G peak, 5 Hz–2 kHz 0.015" maximum displacement	
Impact	15G, 11ms Compliance with IEC/EN60068-2-27	30G	
DO NOT expose the GS20 AC Drive to harsh environments such as dust, direct sunlight, corrosive/flammable gases, humidity, liquid, or vibrations. The salts in the air must be less than 0.01 mg/cm^2 every year.			

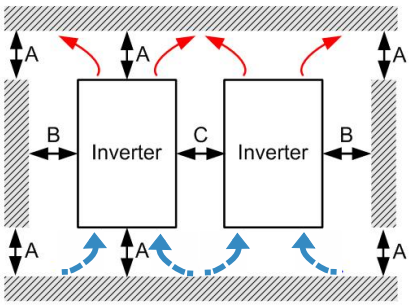
Environmental Conditions for GS20X AC Drives			
Condition	Operation	Storage	Transportation
Installation Location	PCB design is compliant with IEC 60364-1 / IEC 60664-1 Pollution Degree 2. The outer case meets IP66 standard for indoor use. If the drive is for outdoor application, avoid direct sunlight.	n/a	n/a
Ambient Temperature	IP66 / NEMA 4X / UL Type 4X: -20–40°C (-20–50°C w/derating)	-40–85°C	-20–70°C
	Non-condensing, non-freezing		
Relative Humidity	0-100%, no water condensation	95%, no water condensation	
Air Pressure	86–106 kPa	70–106 kPA	
Pollution Level	IEC 60721-3, concentrate prohibited		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Altitude	<1000m (For altitudes > 1000m, derate to use it.)		
Package Drop	n/a	ISTA procedure 1A (according to weight) IEC 60068-2-31	
Vibration	1.0 mm, peak to peak value range from 2–13.2 Hz; 0.7–2.0 G range from 13.2–55 Hz; 2.0 G range from 55–512 Hz; complies with IEC 60068-2-6.	2.5 G peak, 5 Hz–2 kHz 0.015" maximum displacement	
Impact	15G, 11ms Compliance with IEC/EN60068-2-27	30G	
DO NOT expose the GS20X AC Drive to harsh environments such as direct contact with chemical substance and solvent, and exposure to direct sunlight.			

DURAPULSE GS20(X) AC Drives Specifications – Air Flow and Power (Heat) Dissipation

Minimum Clearances and Air Flow for GS20 Series Drives



Single Drive Installation



Side by Side Drive Installation

GS20 Minimum Mounting Clearances*

Installation Method	A (mm)	B (mm)	C (mm)	Operation Temperature (°C) Max (w/out derating)	Operation Temperature (°C) Max (Derating)
Single drive installation	50	30	–	50	60
Side-by-side horizontal installation	50	30	30	50	60
Zero stack installation	50	30	0	40	50

** Failure to follow the minimum mounting clearances may cause the fan to malfunction and cause a heat dissipation problem.*

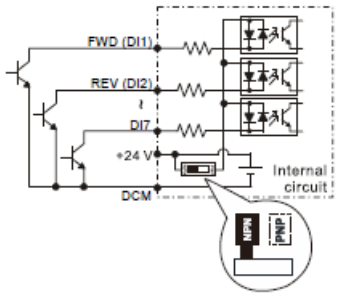
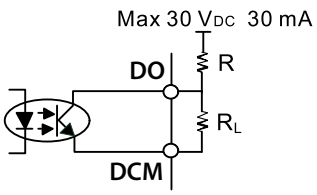
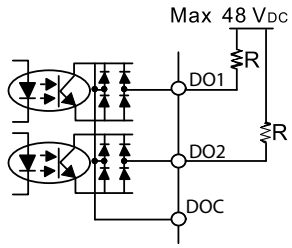
GS20 Airflow and Power Dissipation

Model Number	Frame Size	Airflow Rate for Cooling		Power Dissipation (Watts)		
		Flow Rate (cfm)	Flow Rate (m^3/hr)	Loss External (Heat sink)	Internal	Total
GS21-10P2	A	0.0	0.0	8.0	10.0	18.0
GS21-10P5				14.2	13.1	27.3
GS21-11P0	C	16.0	27.2	29.1	23.9	53.0
GS21-20P2	A	0.0	0.0	8.0	10.3	18.3
GS21-20P5				16.3	14.5	30.8
GS21-21P0	B			29.1	20.1	49.2
GS21-22P0	C	16.0	27.2	29.1	23.9	53.0
GS21-23P0				70.0	35	105
GS23-2010	E	53.7	91.2	244.5	79.6	324.1
GS23-2015				374.2	86.2	460.4
GS23-2020	F	67.9	115.2	492.0	198.2	690.2
GS23-20P2	A	0.0	0.0	8.6	10.0	18.6
GS23-20P5				16.5	12.6	29.1
GS23-21P0				31.0	13.2	44.2
GS23-22P0	B	10.0	16.99	50.1	24.2	74.3
GS23-23P0	C	16.0	27.2	76.0	30.7	106.7
GS23-25P0				108.2	40.1	148.3
GS23-27P5	D	23.4	39.7	192.8	53.3	246.1
GS23-4010				164.7	55.8	220.5
GS23-4015	E	53.7	91.2	234.5	69.8	304.3
GS23-4020				319.8	74.3	394.1
GS23-4025	F	67.9	115.2	423.5	181.6	605.1
GS23-4030				501.1	200.3	701.4
GS23-40P5	A	10.0	16.99	17.6	11.1	28.7
GS23-41P0				30.5	17.8	48.3
GS23-42P0	B			45.9	21.7	67.6
GS23-43P0	C	16.0	27.2	60.6	22.8	83.4
GS23-45P0				93.1	42	135.1
GS23-47P5	D	23.4	39.7	132.8	39.5	172.3
GS23-5010				108.4	51	159.4
GS23-51P0	A	0.0	0.0	23.5	12.5	36
GS23-52P0	B	10.0	16.99	38.1	19	57.1
GS23-53P0	C	16.0	27.2	56.6	22.2	68.8
GS23-55P0				76.1	30	106.1
GS23-57P5	D	23.4	39.7	93.9	37	130.9

- Published flow rates are the result of active cooling using factory installed fans.
- Flow rates of (0.0) are the result of passive cooling in drives without fans.
- The required airflow shown in the chart is for installing a single GS20 drive in a confined space.
- When installing multiple GS20 drives, the required air volume would be the required air volume for a single GS20 drive multiplied by the number of GS20 drives.
- When calculating power dissipation (Watt Loss), use the Total value. Heat dissipation shown in the chart is for installing a single GS20 drive in a confined space.
- When installing multiple drives, the volume of heat/power dissipation should be the heat/power dissipated by a single GS20 drive multiplied by the number of GS20 drives.
- Heat dissipation for each model is calculated by rated voltage, current and default carrier frequency.

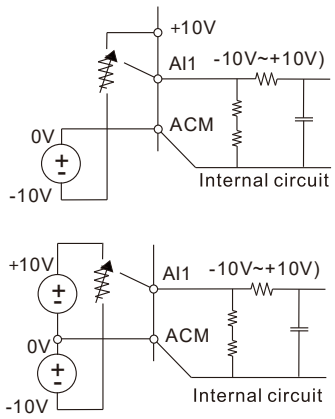
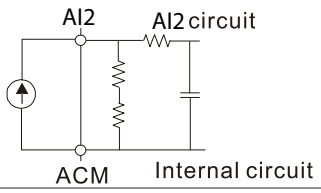
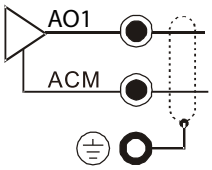
DURAPULSE GS20(X) AC Drives Specifications – Terminals

Control Circuit Terminal Names and Definitions

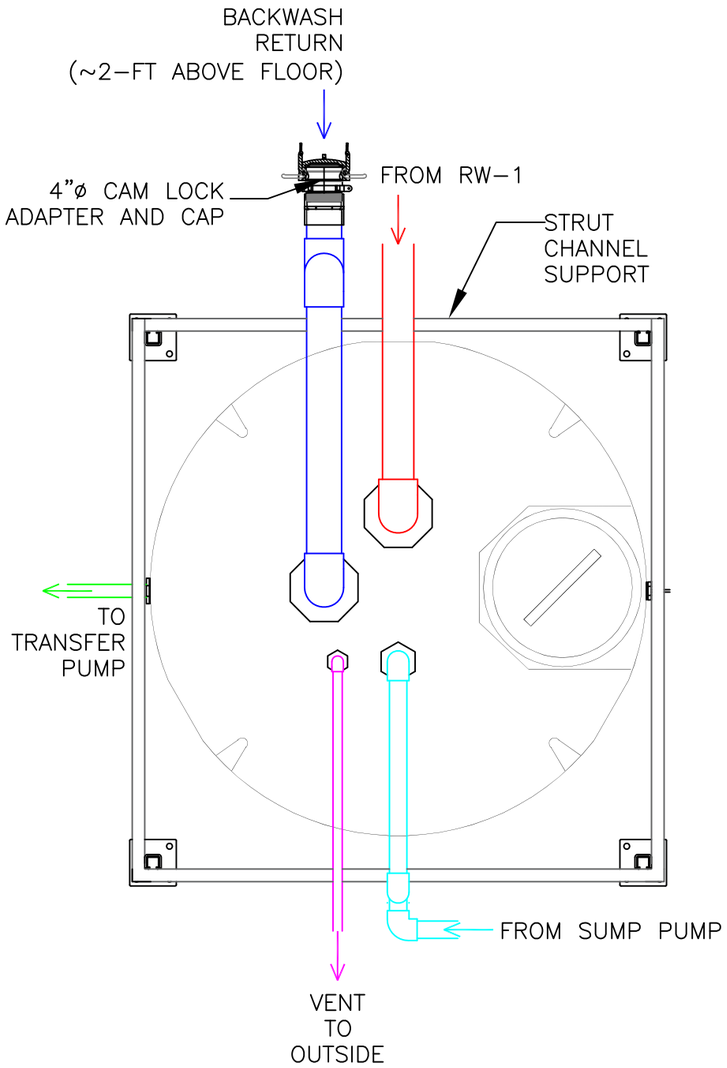
Control Circuit Terminals		
Terminal Symbol	***Terminal Function***	***Description***
+24V	Digital control signal common (Source)	+24V ± 10% 100mA
FWD (DI1) ***REV (DI2)*** ***DI3 - DI7***	Digital input 1–7 ① Sink Mode with internal power (+24 VDC)  See pg.tGSX-42 for sinking/sourcing wiring examples.	**Source Mode:** ON: activation current 3.3 mA ≥ 11VDC OFF: cut-off voltage ≤ 5VDC **Sink Mode:** ON: activation current 3.3 mA ≤ 13VDC OFF: cut-off voltage ≥ 19VDC DI7: Single pulse input, maximum input frequency=33kHz. Digital inputs can be configured by the user for many different functions. Refer to P02.01–02.07 to program the digital inputs FWD (DI1), REV (DI2), DI3–DI7. When P02.00=0, FWD (DI1) and REV (DI2) can be programmed. • When P02.00≠0, the functions of FWD (DI1) and REV (DI2) act according to P02.00 setting. • When P02.07=0, DI7 is pulse input terminal. • DI7 uses pulse input can be used as frequency command source or connect it to the encoder for motor closed-loop control. • DI7 motor closed-loop control only supports VFPG control mode.
DO	Digital frequency signal output 	DO uses pulse voltage as an output monitoring signal; Duty-cycle: 50% Min. load impedance RL: 1kΩ / 100pF Max. current endurance: 30 mA Max. voltage: 30VDC ± 1% (when 30VDC / 30mA / RL=100pF) Max. output frequency: 33kHz Current-limiting resistor R: ≥ 1KΩ Output load impedance RL Capacitive load ≤ 100pF Resistive load ≥ 1kΩ, resistance determines the output voltage value. DO-DCM voltage = external voltage * (RL/ (RL+R))
DCM	Digital control / Frequency signal common (Sink)	
DO1	Digital Output 1 (photo coupler)	The AC motor drive outputs various monitoring signals, such as drive in operation, frequency reached, and overload indication through a transistor (open collector). Outputs can be wired as sinking or sourcing. See User manual Appendix D for wiring examples. 
DO2	Digital Output 2 (photo coupler)	
DOC	Digital Output Common (photo coupler)	
R1O	Relay Output 1 (N.O.)	**Resistive Load** • 3A (N.O.) / 3A (N.C.) 250VAC • 5A (N.O.) / 3A (N.C.) 30VDC **Inductive Load (COS 0.4)** • 1.2 A (N.O.) / 1.2 A (N.C.) 250VAC • 2.0 A (N.O.) / 1.2 A (N.C.) 30VDC To output different kinds of monitoring signals such as motor drive in operation, frequency reached, and overload indication.
R1C	Relay Output 1 (N.C.)	
R1	Relay Output 1 Common	
+10V	Potentiometer power supply	Power supply for analog frequency setting: +10.5 ± 0.5 VDC / 20mA

DURAPULSE GS20(X) AC Drives Specifications – Terminals

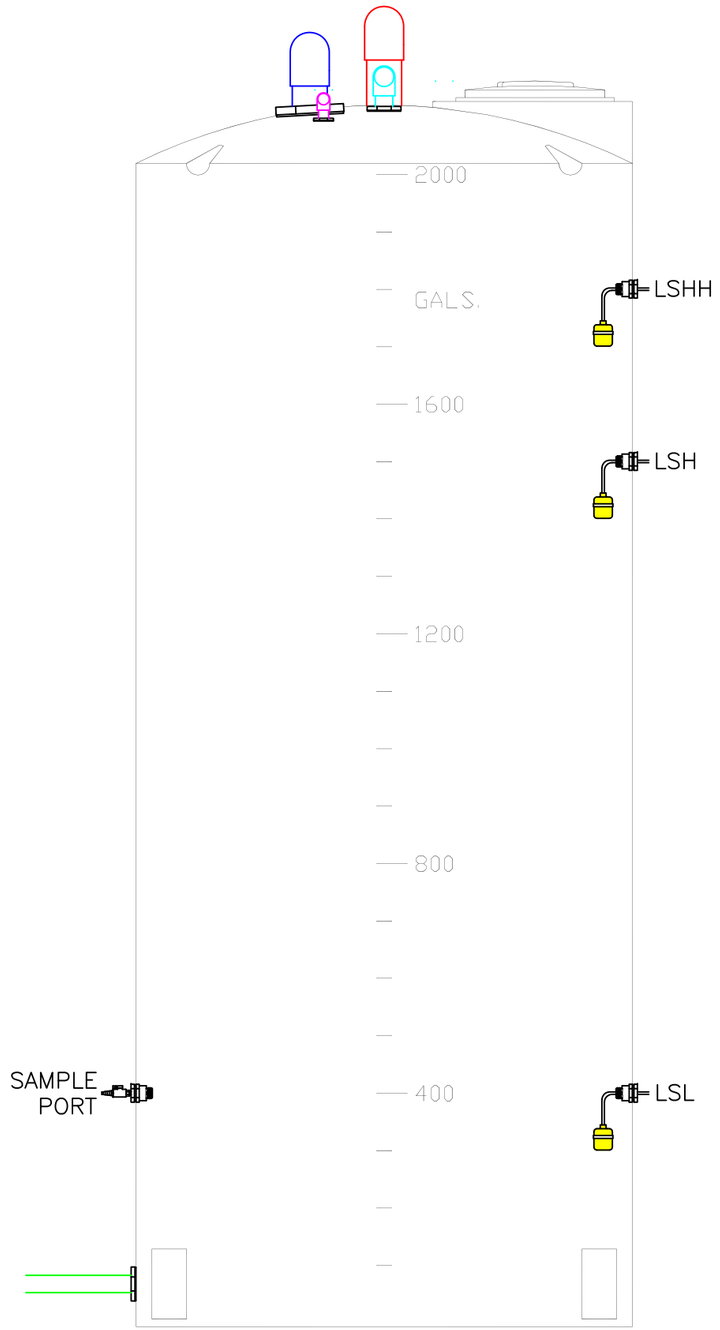
Control Circuit Terminal Names and Definitions

Control Circuit Terminals (continued)		
Terminal Symbol	***Terminal Function***	***Description***
AI1	Analog voltage frequency command 	Impedance: 20kΩ Range: 0–10 V / -10–10 V = 0–Maximum Operation Frequency (P01.00) Mode switching by setting P03.00, P03.28 AI1 resolution=10 bits
AI2	Analog current frequency command 	Impedance: Current mode=250 Ω, Voltage mode=20kΩ Range: 0–20 mA / 4–20 mA / 0–10 V = 0–Maximum Operation Frequency (P01.00) Mode switching by setting P03.01, P03.29 Switch: The AI2 default is 0–20 mA / 4–20 mA (current mode) AI2 resolution = 12 bits
AO1	Multi-function analog voltage output 	Switch: The AO1 default is 0–10 V (voltage mode). To switch to the current mode, two steps are required: 1. A dip switch must be configured (follow the instructions on the inner side of the front cover. 2. Change P03.31 to 1 or 2 (see Chapter 4 of the GS20(X) User Manual). **Voltage mode** Range: 0–10 V (P03.31=0) corresponds to the maximum operating range of the control target Max. output current: 2mA Max. Load: 5kΩ **Current mode** Range: 0–20 mA (P03.31=1) / 4–20 mA (P03.31=2) corresponds to the maximum operating range of the control target, maximum load 500Ω AO1 resolution=10 bits
ACM	Analog Signal Common	Analog signal common terminal
+24V (red)	STO 24V power terminal	
STO1, STO2 (red)	Default: STO1 / STO2 short-circuited to +24V Rated voltage: 24VDC ± 10 %; maximum voltage: 30VDC ±10 % Rated current: 6.67 mA ± 10 % **STO activation mode** Input voltage level: 0VDC < STO1-SCM or STO2-SCM < 5VDC STO response time ≤ 20ms (STO1 / STO2 operates until the AC motor drive stops outputting current) **STO cut-off mode** Input voltage level: 11VDC < STO1-SCM and STO2-SCM < 30VDC Power removal safety function per EN 954-1 and IEC / EN 61508 **Note:** Refer to Chapter 17 SAFE TORQUE OFF FUNCTION for details.	
SCM (red)	STO Common - Signal Terminal	
SG+ ***SG-*** ***SGND***	Modbus RS-485 **Note:** Refer to GS20(X) User Manual Chapter 4 Descriptions of Parameter Settings, Parameter Group 09: Communication Parameters for details.	
RJ45	PIN 1, 2, 6: Reserved PIN 3, 7: SGND PIN 4: SG- PIN 5: SG+ PIN 8: +10V supply GS4-KPD (provides (optional) power supply)	The RJ45 port provides a serial communications connection. Max Baud Rate = 115.2 kbps

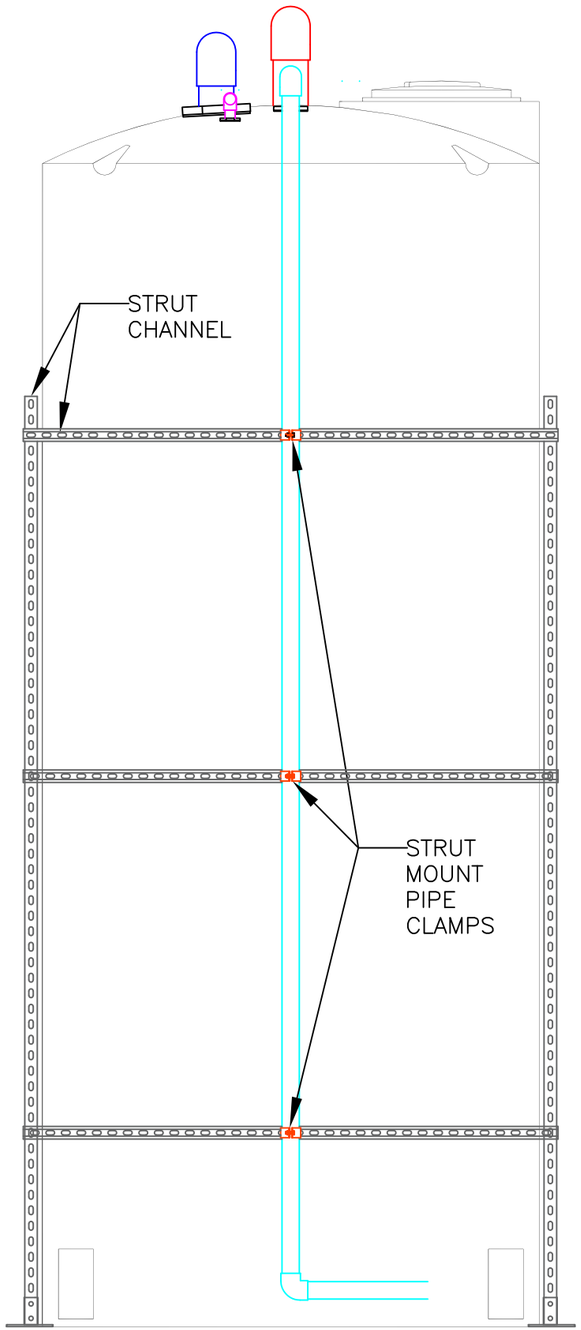
TOP VIEW



SIDE VIEW



TYPICAL VERTICAL PIPE SUPPORT



EnviroTrac
ENVIRONMENTAL SERVICES
5 OLD DOCK ROAD, YAPHANK, NEW YORK 11980
PHONE: (631)924-3001 FAX: (631)924-5001

REVISION DATE: 5/30/2023

REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

EQ TANK CONNECTION DETAILS

FIGURE # 2

SUBMITTAL #26 LGAC Media (4,000-lbs)

"CLEANING THE WORLD WITH ACTIVATED CARBON"

GENERAL CARBON CORP.

GC 8 x 30R

regenerated activated carbon

GC 8x30R is a regenerated carbon which is granular in form. Made from bituminous coal, it is ideal for many liquid phase applications including the removal of organic contaminants from liquid streams. Its size makes it appealing where low pressure drop is needed. It is not recommended for use in the purification of drinking water or other food grade applications.

Specifications

Mesh size – 8 x 30, %:	90 (min)
Less than No. 8, %:	5 (max)
Greater than No. 30, %:	5 (max)
Iodine No., mg/g:	800 (min)
Surface Area, m^2/g:	800 (min)
Moisture, % (as packaged):	5 (max)
Typical Density, lbs./cu.ft.:	28-32
g/cc:	0.45-0.51

*Standard packaging is in 1,000lb vinyl bags. Other packaging is available upon request with an additional cost.

Caution!

Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels. Confined space/low oxygen procedures should be put in place before any entry is made. Such procedures should comply with all applicable Local, State and Federal guidelines.

33 Paterson Street, Paterson, New Jersey 07501 Tel: 973 523 2223 Fax: 973 523 1494
www.generalcarbon.com sales@generalcarbon.com

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 06/07/23**
TO:	**TRC** 3 Corporate Drive Suite 202 Clifton Park, NY 12065 Attn: Jeffrey LaRock	***DATE RECEIVED:_____***

PROJECT:

Remedial System Optimization (RSO) RFP
Former Chromalloy Facility, West Nyack, New York

We are transmitting (Herewith ☒, Under separate cover ☐, Electronic ☒, Hard copy ☐), the following:

Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	Figure 1 – Pump and Treat System P&ID	01	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

Copy to: File

Signed:

TRC Comments w/ ET Responses

- Change TRC address to 3 Corporate Drive, Suite 202, Clifton Park, NY 12065 Attn: Jeffrey LaRock

  Acknowledged. Address has been changed

- Interlock 2 – If high-high switch is triggered, send alarm notification, and disable pumps P1 and P3

  Figure 1 P&ID is revised to note this. EnviroTrac recommends shutting down P2 also. The LSHH may also trigger in the event something is wrong with P-2 or any downstream component from this pump.

- Interlock 6 – If high-high, the high switch turns on the sump pump.

  Figure 2 has been clarified. The intent of the HH switch is to act as a safety interlock. The pump control of P-3 is done through its own integrated float switch, which is now noted as LSHL-02 (Level Switch High-Low). The high-high safety switch is noted as LSHH-02.

ET Comments

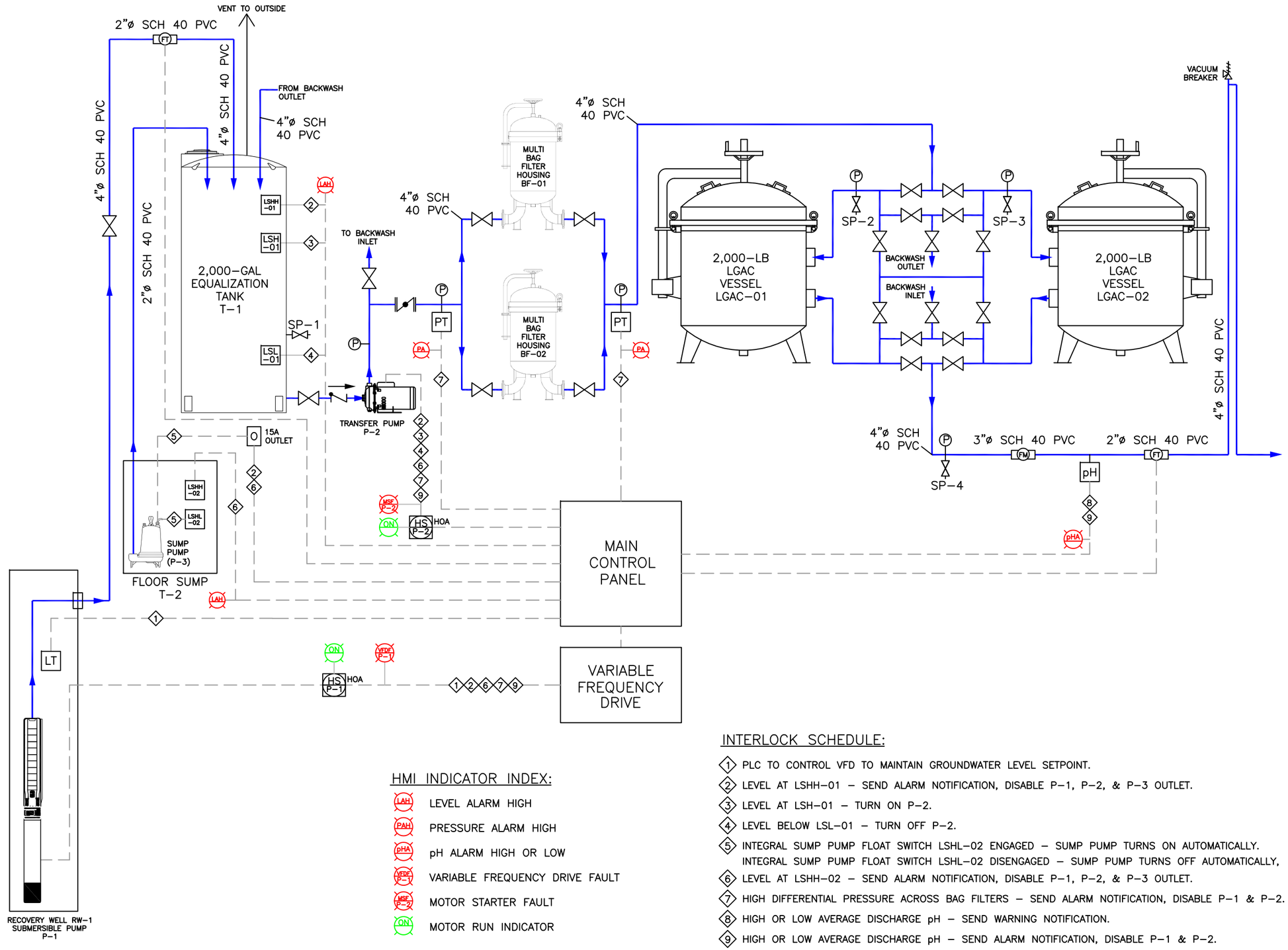
None

EnviroTrac

NOTES:
1. 10–PIPE DIAMETERS OF STRAIGHT PIPE RUN TO BE INSTALLED BEFORE EACH FLOW METER OR FLOW TRANSMITTER.
2. 5–PIPE DIAMETERS OF STRAIGHT PIPE RUN TO BE INSTALLED AFTER EACH FLOW METER/TRANSMIITTER.

SYSTEM LEGEND:

- PRESSURE GAUGE
- LS — LEVEL SWITCH
- LT — LEVEL TRANSMITTER
- PT — PRESSURE TRANSMITTER
- pH — pH TRANSMITTER
- FM — FLOW METER/TOTALIZER
- FT — FLOW TRANSMITTER
- BALL VALVE
- BUTTERFLY VALVE
- SP — SAMPLE PORT
- CHECK VALVE
- HS — HMI SWITCH
- CONTROL PANEL INTERLOCK
- ELECTRIC LINE
- AIR FLOW DIRECTION
- WATER FLOW DIRECTION
- ENCLOSURE LIMITS



HMI INDICATOR INDEX:

- LAH — LEVEL ALARM HIGH
- PAH — PRESSURE ALARM HIGH
- pHA — pH ALARM HIGH OR LOW
- VFDF P–1 — VARIABLE FREQUENCY DRIVE FAULT
- MSF P–2 — MOTOR STARTER FAULT
- ON — MOTOR RUN INDICATOR

INTERLOCK SCHEDULE:

1. PLC TO CONTROL VFD TO MAINTAIN GROUNDWATER LEVEL SETPOINT.
2. LEVEL AT LSHH–01 – SEND ALARM NOTIFICATION, DISABLE P–1, P–2, & P–3 OUTLET.
3. LEVEL AT LSH–01 – TURN ON P–2.
4. LEVEL BELOW LSL–01 – TURN OFF P–2.
5. INTEGRAL SUMP PUMP FLOAT SWITCH LSHL–02 ENGAGED – SUMP PUMP TURNS ON AUTOMATICALLY.
   INTEGRAL SUMP PUMP FLOAT SWITCH LSHL–02 DISENGAGED – SUMP PUMP TURNS OFF AUTOMATICALLY,
6. LEVEL AT LSHH–02 – SEND ALARM NOTIFICATION, DISABLE P–1, P–2, & P–3 OUTLET.
7. HIGH DIFFERENTIAL PRESSURE ACROSS BAG FILTERS – SEND ALARM NOTIFICATION, DISABLE P–1 & P–2.
8. HIGH OR LOW AVERAGE DISCHARGE pH – SEND WARNING NOTIFICATION.
9. HIGH OR LOW AVERAGE DISCHARGE pH – SEND ALARM NOTIFICATION, DISABLE P–1 & P–2.

EnviroTrac
ENVIRONMENTAL SERVICES
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REVISION DATE: 6/5/2023 | REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

PUMP AND TREAT SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE # 1

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 06/15/23**
TO:	**TRC** 3 Corporate Drive Suite 202 Clifton Park, NY 12065 Attn: Jeffrey LaRock	***DATE RECEIVED:_____***

PROJECT:

Remedial System Optimization (RSO) RFP
Former Chromalloy Facility, West Nyack, New York

We are transmitting (Herewith ☒, Under separate cover ☐, Electronic ☒, Hard copy ☐), the following:

Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	Figure 3 – Proposed System Layout	27	☐ Yes ☒ No
2	Figure 2 – EQ Tank Connection Details - Resubmittal	25	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

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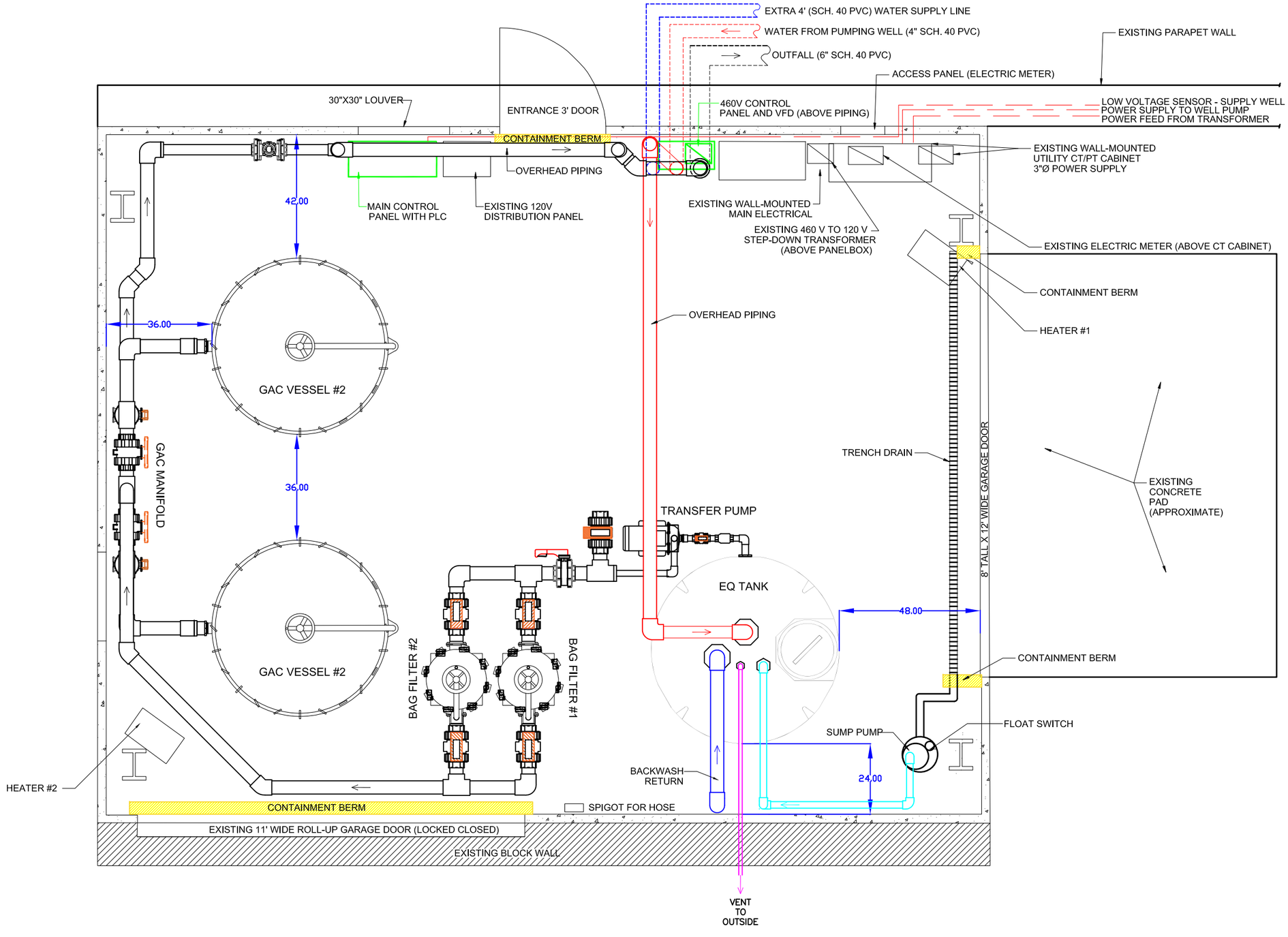
Signed:



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0 3 6
APPROXIMATE SCALE IN FEET

REVISION DATE: 6/14/2023

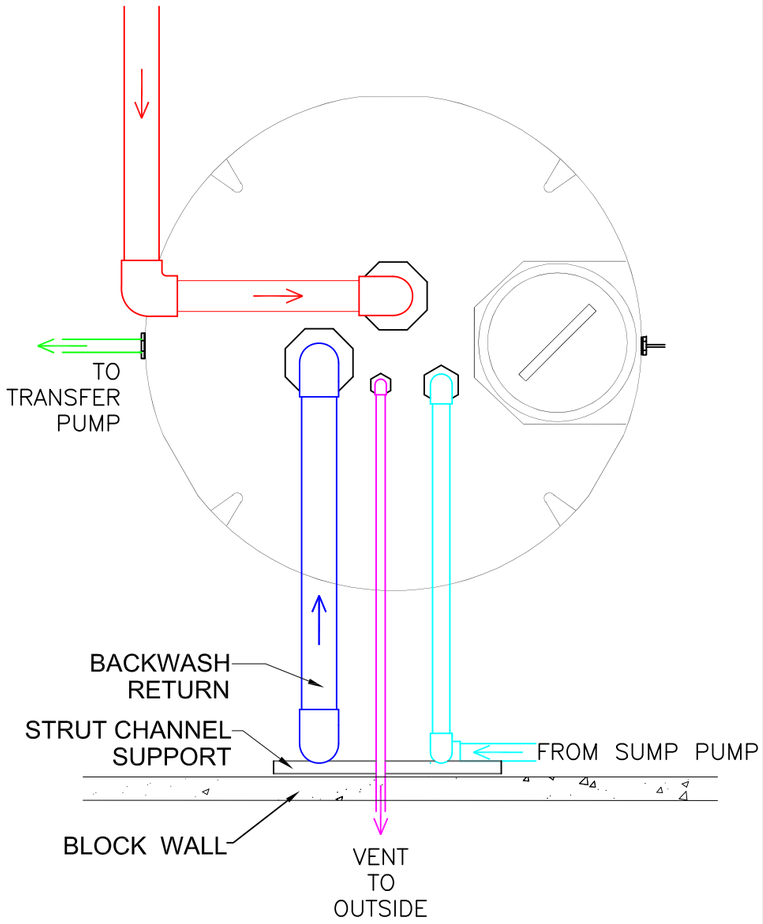
REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

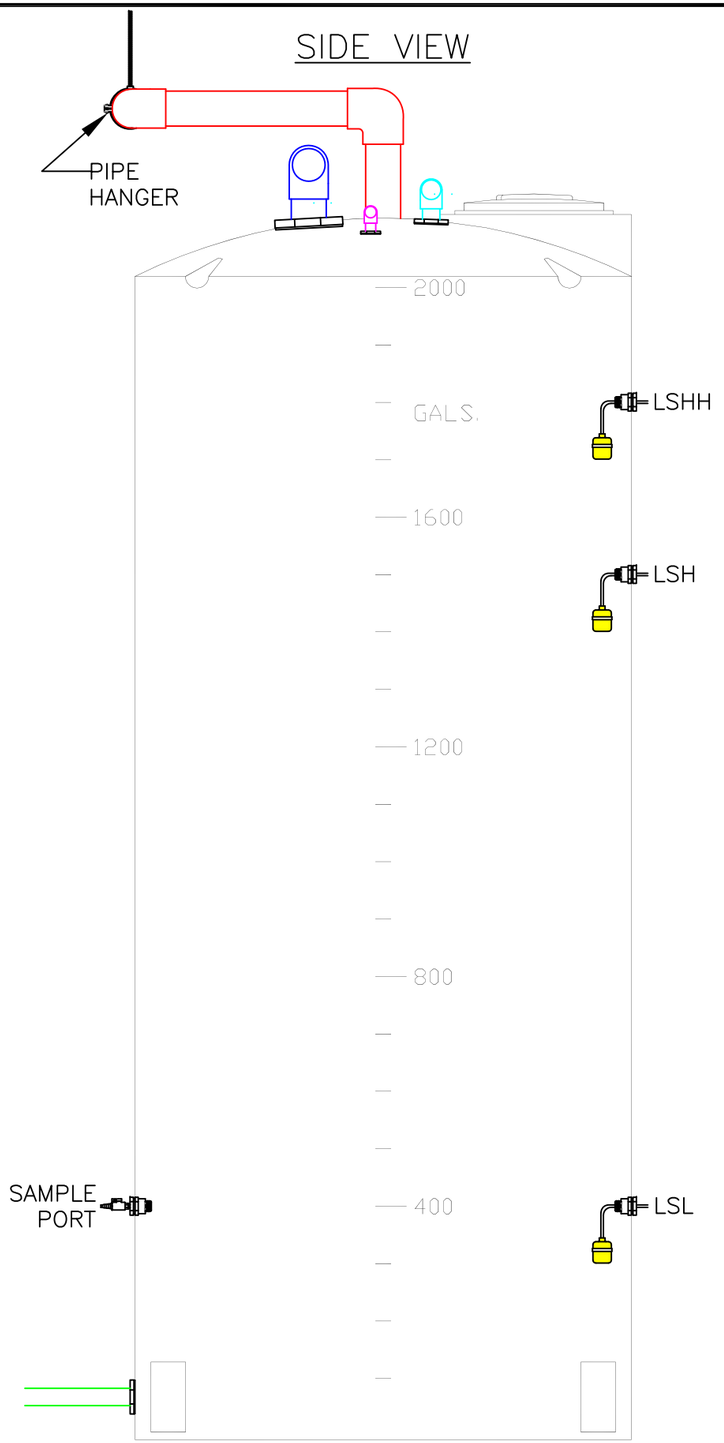
PROPOSED SYSTEM LAYOUT

FIGURE # 3

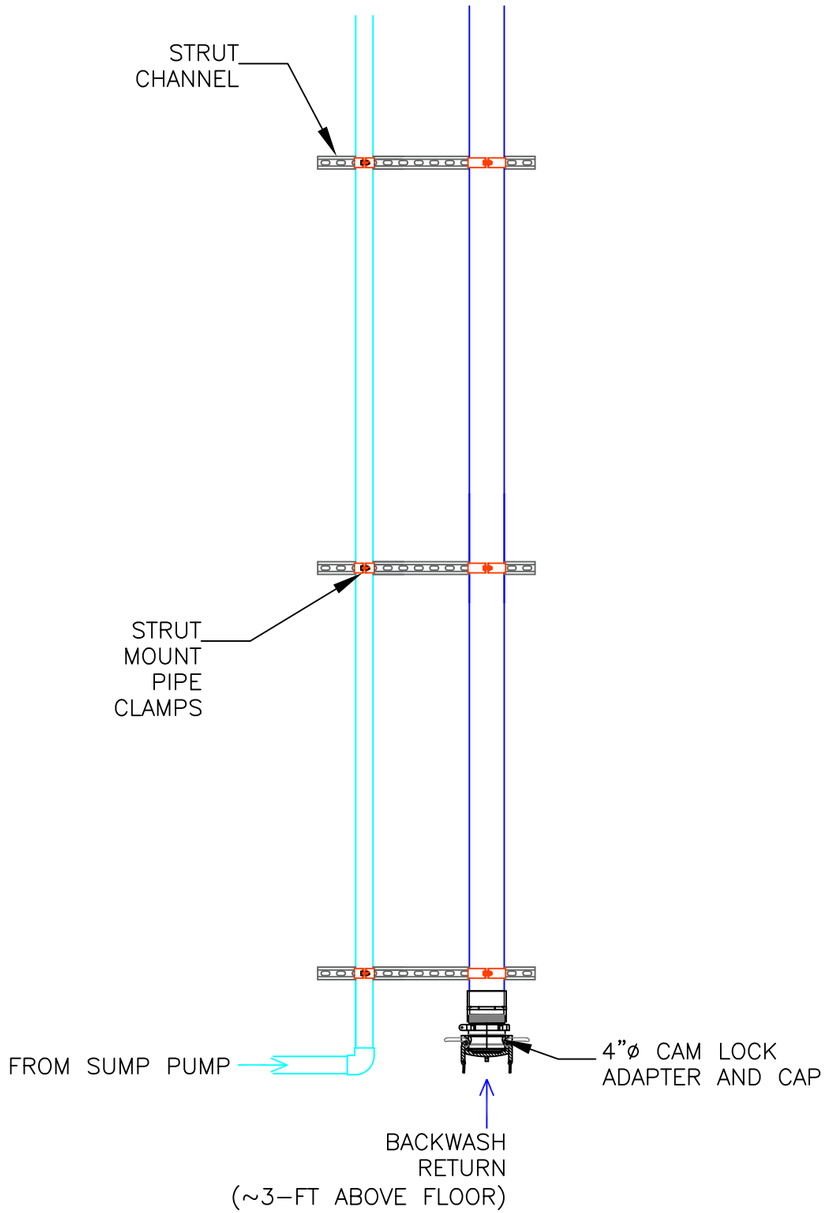
TOP VIEW



SIDE VIEW



TYPICAL VERTICAL PIPE SUPPORT ON BLOCK WALL



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FORMER CHROMALLOY FACILITY
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EQ TANK CONNECTION DETAILS

FIGURE #
2

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 08/03/23**
TO:	**TRC** 3 Corporate Drive Suite 202 Clifton Park, NY 12065 Attn: Jeffrey LaRock	***DATE RECEIVED:_____***

PROJECT:

Remedial System Optimization (RSO) RFP
Former Chromalloy Facility, West Nyack, New York

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Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	**Figure 3 – Re-submittal Proposed System Layout**	27	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

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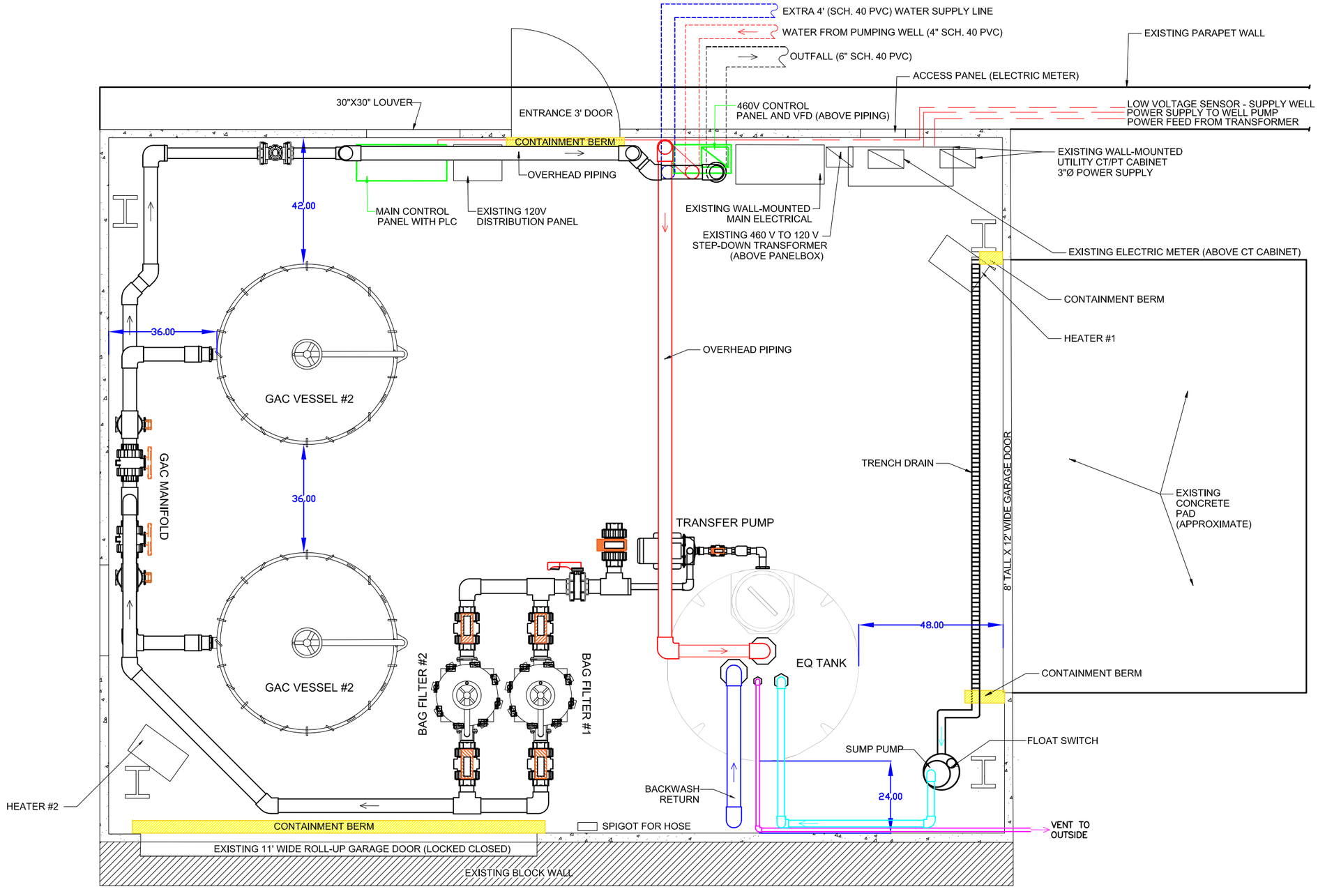

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ENVIRONMENTAL SERVICES
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APPROXIMATE SCALE IN FEET

REVISION DATE: 8/2/2023

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PROPOSED SYSTEM LAYOUT

FIGURE # 3

SUBMITTAL/TRANSMITTAL FORM

FROM:	EnviroTrac Ltd. 5 Old Dock Road Yaphank, New York 11980 Phone: (631) 924-3001 Fax: (631) 924-5001	**DATE SENT: 08/17/23**
TO:	**TRC** 3 Corporate Drive Suite 202 Clifton Park, NY 12065 Attn: Jeffrey LaRock	***DATE RECEIVED:_____***

PROJECT:

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Former Chromalloy Facility, West Nyack, New York

We are transmitting (Herewith ☒, Under separate cover ☐, Electronic ☒, Hard copy ☐), the following:

Item No.(s)	Submittal Description	Submittal No.	Revision to Previous Submittal:
1	Transfer Pump	3	☒ Yes ☐ No
2	Water Flow Transmitter Specifications	11	☒ Yes ☐ No
3	pH Probe Specifications	12	☒ Yes ☐ No
4	pH Sensor Specifications	13	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

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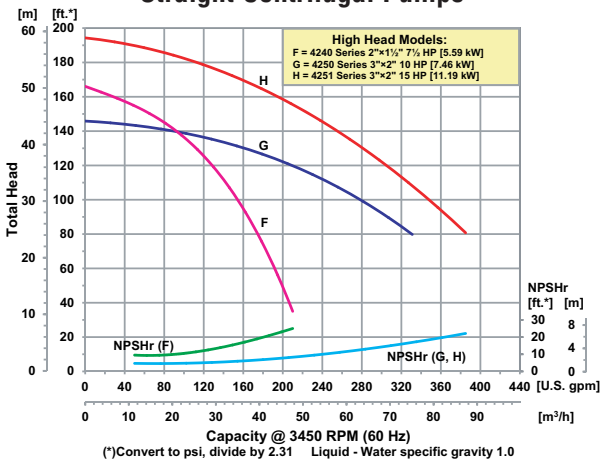
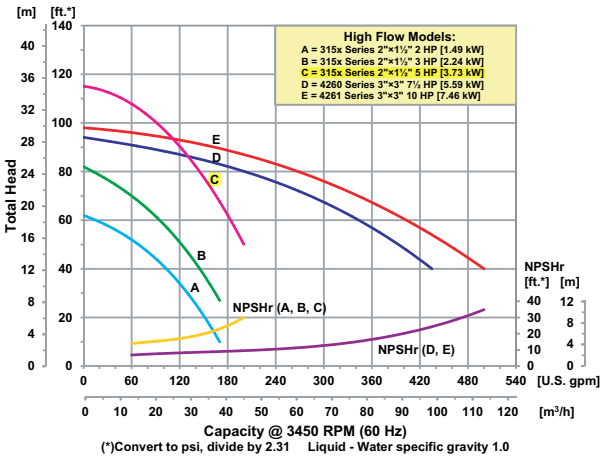
Signed: Dale C. Kr

Heavy Duty Straight Centrifugal Pumps

- **Available in: 300 Series Investment Cast Stainless Steel, Cast Bronze and Cast Iron Construction with Stainless Steel Impeller**
- **Buna-N Mechanical Seal and O-Ring on Cast Iron Models**
- **Viton® Mechanical Seal and O-Ring on Stainless Steel and Bronze Models**
- **Optional Silicon Carbide Seals Available**
- **Front Drain Plugs Located 90° Apart**
- **Maximum Head 194 Feet (84 PSI)**
- **Maximum Flow 500 GPM**
- **2 HP to 15 HP NEMA Motors, Single and Three Phase**
- **Optional Mounting Base Available**

Performance of Heavy Duty Straight Centrifugal Pumps





AMT Heavy Duty Solids Handling End Suction Centrifugal pumps are suited for liquid and chemical transfer, heating and cooling, recirculation, booster service, dirty water and other industrial applications. Stainless steel units are especially effective in applications where rust and/or corrosion can develop in systems. Semi-open impeller features self-cleaning ability that makes the unit useful in applications involving up to 1/8" diameter solids and muddy or dirty liquids, as well as clean, clear fluids. Discharge position can be adjusted in 90° increments with vent and drain plugs for all positions. Type 21 mechanical seal and O-ring casing seal. Pumps are close coupled to Totally Enclosed Fan Cooled (TEFC) motors. **Pumps are not self-priming and require flooded suction.**

AMT®
A Gorman-Rupp Company

400 Spring Street • Royersford, PA 19468 USA

www.amtpump.com • 888-amt-pump (268-7867)

For use with nonflammable liquids compatible with pump component materials. Viton® and Teflon® are registered trademarks of E. I. Dupont.

Heavy Duty Straight Centrifugal Pumps

Pump Dimensional & Specification Data

Model ‡	Curve	HP	PH	Frame	ENC	Voltage @ 60 Hz +	Full Load Amps	SUC*	DIS*	A**	B**	C**	D**	E	F**	G	J**	K	L**	W**	H	‡ Ship Wt. (Lbs.)
3156			1	56J		115/230	22/11			5.4 [13.8]	5.0 [12.7]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.4 [44.2]	10.6 [26.9]	9.6 [24.4]	78
3150	A	2	3	145JM	TEFC	230/460	6/3	2	1½	6.1 [15.5]	3.5 [8.9]	10.7 [27.1]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	2.7 [7.0]	1.3 [3.5]	19.2 [48.7]	11.4 [28.9]	9.6 [24.4]	84
3157			3	56J		230/460	6/3			5.4 [13.8]	3.6 [9.1]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	16.9 [42.9]	10.6 [26.9]	9.6 [24.4]	71
315A			1	56J		230	12			5.4 [13.8]	5.0 [12.7]	8.6 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.9 [45.4]	10.6 [26.9]	9.6 [24.4]	87
3151	B	3	3	182JM	TEFC	230/460	8/4	2	1½	7.1 [18.0]	6.6 [16.8]	10.9 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	20.0 [50.8]	12.8 [32.5]	9.6 [24.4]	137
315B			3	56J		230/460	8/4			5.4 [13.8]	3.6 [9.1]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.4 [44.2]	10.6 [26.9]	9.6 [24.4]	75
315E	C	5	1	184JM	TEFC	230	16	2	1½	7.8 [19.9]	6.6 [16.8]	10.8 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	24.2 [61.4]	13.9 [35.3]	9.6 [24.4]	143
3152			3	184JM		230/460	17/9			7.1 [18.0]	6.6 [16.8]	10.8 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	21.7 [55.1]	12.8 [32.5]	9.6 [24.4]	145
4264	D	7½	1	213JM	TEFC	230	32	3	3	9.0 [22.9]	7.3 [18.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	27.0 [68.6]	16.2 [41.1]	12.0 [30.4]	205
4260			3	184JM		230/460	22/11			7.0 [18.0]	6.6 [16.8]	11.6 [29.5]	4.5 [11.4]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	3.7 [9.5]	1.0 [2.6]	22.5 [57.1]	14.3 [36.3]	12.0 [30.4]	172
4265	E	10	1	215JM	TEFC	230	40	3	3	9.0 [22.9]	6.2 [15.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	27.0 [68.5]	16.2 [41.1]	12.0 [30.4]	213
4261			3	215JM		230/460	26/13			8.1 [20.7]	7.3 [18.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	26.0 [66.0]	15.0 [38.1]	12.0 [30.4]	204
4242	F	7½	1	213JM	TEFC	230	32	2	1½	9.0 [22.9]	7.3 [18.7]	11.3 [28.9]	5.2 [13.3]	2.4 [6.2]	3.8 [9.7]	4.4 [11.3]	4.2 [10.8]	N/A	26.0 [66.0]	14.6 [37.1]	11.1 [28.1]	196
4240			3	184JM		230/460	22/11			7.1 [18.0]	6.6 [16.8]	10.6 [27.0]	4.5 [11.4]	2.4 [6.2]	4.5 [11.4]	4.5 [11.4]	3.7 [9.5]	0.1 [0.3]	21.5 [54.6]	12.6 [32.0]	10.5 [30.6]	163
4253	G	10	1	215JM	TEFC	230	40	3	2	9.0 [22.9]	5.5 [14.2]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	26.1 [66.3]	15.9 [40.4]	10.6 [26.9]	217
4250			3	215JM		230/460	26/13			8.1 [20.7]	7.3 [18.7]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	25.2 [64.0]	14.7 [37.3]	10.6 [26.9]	208
4251	H	15	3	215JM	TEFC	230/460	47/24	3	2	8.1 [20.7]	7.3 [18.7]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	25.2 [64.0]	14.7 [37.3]	10.6 [26.9]	218

(*) Standard NPT (Female) pipe thread.
(**) This dimension may vary due to motor manufacturer's specifications.
(+) 3-Phase motors can also operate on 50 Hz. (This will change full load amps, service factor and RPM)
NOTE: Dimensions are in inches (centimeters) and have a tolerance of ± 1/4".
NOTE: Electric supply for **ALL** motors must be within ±10% of nameplate voltage rating (e.g. 230V ±10%= 207 to 253).

NOTE: Check Price Book for Specific Pump Construction/Material Availability.
Maximum Solids Handling Capacity: 1/4" Diameter

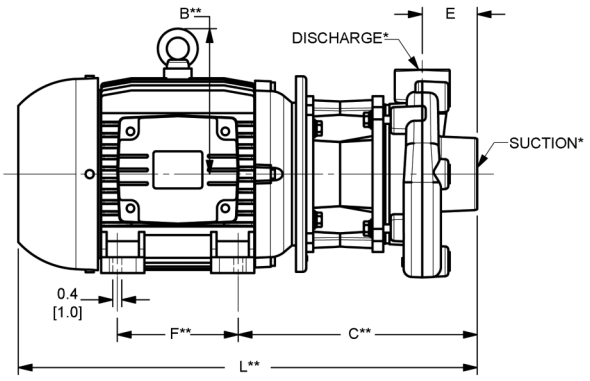
‡ When Ordering, Add the Correct (-9X) Suffix to Model Number Indicating Material Selection (Ex. 315A-95)

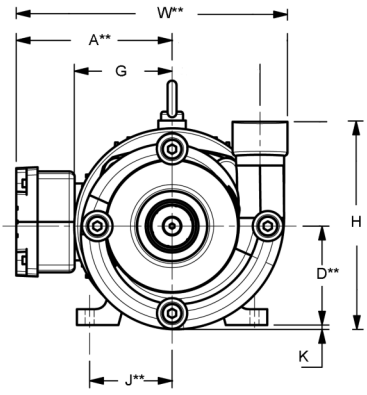
XCI (-95) Cast Iron Construction with Buna-N Seals

XB (-94) Cast Bronze Construction with Viton® Seals

XSS (-98) Cast Stainless Steel Construction with Viton® Seals

(All Models Come Standard with Stainless Steel Impeller)





Standard Features

- Stainless Steel, Bronze and Cast Bronze Construction
- Buna-N or Viton® Mechanical Seal and O-ring, Depending on Model
- Optional Silicon Carbide Mechanical Seals Available
- Stainless Steel Motor Shaft and Hardware
- NEMA TEFC Single and Three Phase Motors, Depending on Model
- Optional Mounting Base Available for 182/184/215 JM Frames
- Self-cleaning Stainless Steel Impeller
- Maximum Working Pressure 150 PSI
- Maximum Temperature
  - Viton® 200° F
  - Buna-N 180° F
- Optional Seal Wash Port and Hose Available on All Models
- Pedestal Version Models Available for Frame Models 145/182/184JM
- QSP – Quick Ship Pump for Many Models

Hazardous Duty/Xplosion Proof motors available from stock ranging from 1 to 10 HP; *CALL FOR QUOTATION & LEAD TIME!*

Manufacturer of AMT & IPT Pumps
400 Spring Street • Royersford, PA 19468 USA
www.amtpump.com • 888-amt-pump (268-7867)

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1212

Signet 2537 Paddlewheel Flowmeter

The Signet 2537 Flowmeter is the next generation in fluid measurement technology from the inventor of the original paddlewheel flowmeter. This sensor is an improvement on what's already an industry standard. It has the added functionality of various output options including flow switch, multi-functional pulse, digital (S^3L) or 4 to 20 mA. Additionally, it offers low flow, low power and high resolution and can be configured on-site directly through the built-in user interface.

Installation is simple because the Signet 2537 utilizes the same fittings as the popular Signet 515 and 2536 Paddlewheel Sensors and fits into pipe sizes ranging from DN15 to DN200 (½ to 8 inches). Available in Polypropylene and PVDF, it is ideal for a variety of applications including chemical processing, water and wastewater monitoring and scrubber control.

Features

- **Digital (S^3L) or 4 to 20 mA outputs or (Multi-function)**
- **Allows for up to six sensors to Signet 8900 Controller**
- **Low flow capabilities down to 0.1 m/s (0.3 ft/s)**
- **Polypropylene or PVDF sensor bodies**
- **Polypropylene or PVDF retaining nuts**
- **Installs into pipe sizes DN15 to DN200 (½ to 8 in.)**
- **Test certificate included for -X0, -X1**
- **Low power and high resolution**

Applications

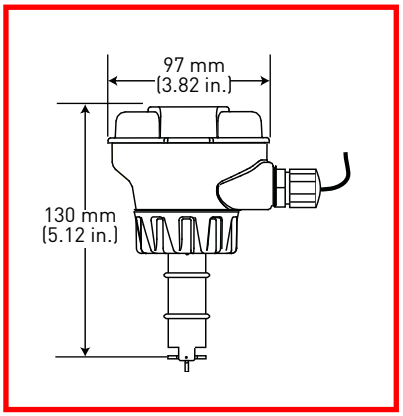
- **Process Flow Monitoring**
- **Pump Protection**
- **Pure Water Production**
- **Filtration Systems**
- **Chemical Production**
- **Reverse Osmosis**
- **Demineralization/Regeneration**
- **Fume Scrubbers**
- **Cooling Towers**
- **Proportional Metering Pump**

Specifications

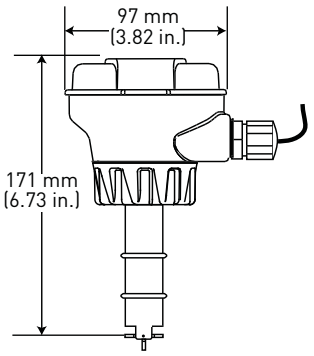
General			
Operating Range		0.1 m/s to 6 m/s	0.3 ft/s to 20 ft/s
Pipe Size Range		DN15 to DN200	½ to 8 in.
Linearity		±1% of max. range @ 25 °C (77 °F)	
Repeatability		±0.5% of max. range @ 25 °C (77 °F)	
System Response		100 ms update rate nominal	
Wetted Materials			
Sensor Body	Glass-filled PP (black) or PVDF (natural)		
O-rings	FPM (std) optional EPR (EPDM) or FFPM		
Rotor Pin	Titanium, Hastelloy-C or PVDF; optional Ceramic, Tantalum or Stainless Steel		
Rotor	Black PVDF or Natural PVDF; optional ETFE, with or w/o carbon fiber reinforced PTFE sleeve for rotor pin		
Electrical			
Multi	With Dry-Contact Relay	24 VDC nominal, ±10%, regulated, 30 mA max current	
	With Solid-State Relay	6 V to 24 VDC, ±10%, regulated, 30 mA max current	
	Digital (S^3L)	5.0 VDC min to 6.5 VDC max., 30 mA max current (1.5 mA nominal)	
	4 to 20 mA	400 mV max ripple voltage, 30 mA max current	
	Maximum Pulse Rate	300 Hz	
	Maximum Pulse Width	50 ms	
	Minimum Pulse Rate	0.5 Hz	
	Compatible with PLC, PC or similar equipment		
	Compatible with customer supplied metering pump		
Digital (S^3L) Version		5 VDC nominal, regulated, 3 mA max current	
	Type	Serial ASCII, TTL level 9600 bps	
	Max. Cable Length	Refer to Signet 8900 wiring specifications.	
	Compatible with Model Signet 8900 controller		
4 to 20 mA Version		12 to 32 VDC nominal, ±10%, regulated, 21 mA max current	
	Loop Accuracy	±32 µA @ 25 °C @ 24 VDC)	
	Loop Resolution	5 µA	
	Temp. Drift	±1µA per °C max.	
	Power Supply Rejection	±1µA per V	
	Max. Cable	305 m	1000 ft
	Maximum Loop Resistance	600 Ω @ 24 VDC	1 KΩ @ 32 VDC
	Load Impedance	375 Ω	
Reverse Polarity and Short Circuit Protected		Up to 40 V, 1 hour	
Over-voltage Protection		> 40 VDC over 1 hour	
Relay Specifications			
	Mechanical SPDT	5 A @ 30 VDC, 5 A @ 250 VAC	
	Solid-State Relay	100 mA @ 40 VDC, 70 mA @ 33 VAC	
	Relay Modes	Low, High	
	Time Delay	0.0 to 6400.0 seconds	
	Hysteresis	Adjustable for exiting alarm condition	
Max. Temperature/Pressure Rating			
Storage Temperature		-10 °C to 75 °C	14 °F to 167 °F
Operating Temperature		0 °C to 65 °C	32 °F to 149 °F
Relative Humidity		0 to 90%, non-condensing	
Flow Sensor/ Retaining Nut	PP	12.5 bar @ 20 °C	181 psi @ 68 °F
		1.7 bar @ 85 °C	25 psi @185 °F
	PVDF	14 bar @ 20 °C	203 psi @ 68 °F
		1.7 bar @ 85 °C	25 psi @ 185 °F
Operating Temperature			
	PP	-18 °C to 85 °C	0 °F to 185 °F
	PVDF	-18 °C to 85 °C	0 °F to 185 °F
Environmental			
Enclosure	NEMA 4X/IP65		
Shipping Weight			
	0.640 kg	1.41 lb	
Standards and Approvals			
	CE, FCC, UL		
	RoHS compliant, China RoHS		
	Manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.		

Dimensions

½ in. to 4 in. pipe



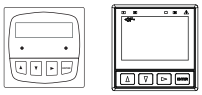
~~5 to 8 in. pipe~~

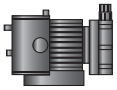


In-Line Installation

System Overview

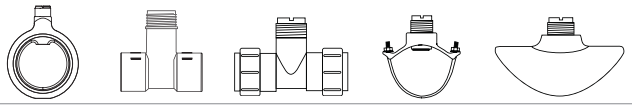
Panel Mount	4 to 20 mA Input	4 to 20 mA Dry Contact, Solid State
Signet Instruments 8900 9900	Customer Supplied Chart Recorder or Programmable Logic Controller	Customer supplied Metering Pump





Signet 2537 Paddlewheel Flowmeter

Signet Fittings



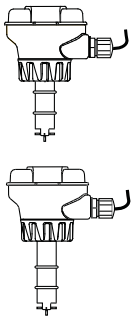
All sold separately

Application Tips

- Select PVDF Rotor Pin for use in Deionized Water.
- Use a sleeved rotor in abrasive liquids to reduce wear.
- Sensor plug is used to plug installation fitting after extraction of sensor from pipe.
- For liquids containing ferrous particles, use Signet Magmeters.
- For systems with components of more than one material, the maximum temperature/pressure specification must always be referenced to the component with the lowest rating.

Please refer to Wiring, Installation, and Accessories sections for more information.

Ordering Information



Mfr. Part No.	Code	Output
Paddlewheel Flowmeter - Integral Mount (8512 sensors)		
DN15 to DN100 - ½ to 4 in.		
Polypropylene body, black Polypropylene retaining nut, black PVDF rotor, Titanium pin, FPM O-rings		
~~3-2537-1C-P0~~	~~**159 001 291**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-P0~~	~~**159 001 292**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-P0~~	~~**159 001 295**~~	~~Digital (S^3L)~~
3-2537-6C-P0	**159 001 296**	4 to 20 mA
Natural PVDF body, Natural PVDF retaining nut, rotor and pin, FPM O-rings		
~~3-2537-1C-T0~~	~~**159 001 315**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-T0~~	~~**159 001 316**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-T0~~	~~**159 001 319**~~	~~Digital (S^3L)~~
~~3-2537-6C-T0~~	~~**159 001 320**~~	~~4 to 20 mA~~
DN125 to DN200 - 5 to 8 in.*		
Polypropylene body, black Polypropylene retaining nut, black PVDF rotor, Titanium pin, FPM O-rings		
~~3-2537-1C-P1~~	~~**159 001 303**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-P1~~	~~**159 001 304**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-P1~~	~~**159 001 307**~~	~~Digital (S^3L)~~
~~3-2537-6C-P1~~	~~**159 001 308**~~	~~4 to 20 mA~~

*PVDF available ½ in. to 4 in. only

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
Rotors		
3-2536.320-1	**198 820 052**	Rotor, PVDF Black
3-2536.320-2	**159 000 272**	Rotor, PVDF Natural
3-2536.320-3	**159 000 273**	Rotor, ETFE
3-2536.322-1	**198 820 056**	Sleeved rotor, PVDF Black
3-2536.322-2	**198 820 057**	Sleeved rotor, PVDF Natural
3-2536.322-3	**198 820 058**	Sleeved rotor, ETFE
Rotor Pins		
M1546-1	**198 801 182**	Pin, Titanium
M1546-2	**198 801 183**	Pin, Hastelloy-C
M1546-3	**198 820 014**	Pin, Tantalum
M1546-4	**198 820 015**	Pin, Stainless Steel
P51545	**198 820 016**	Pin, Ceramic
O-Rings		
1220-0021	**198 801 186**	O-ring, FPM (2 required per sensor)
1224-0021	**198 820 006**	O-ring, EPR (EPDM) (2 required per sensor)
1228-0021	**198 820 007**	O-ring, FFPM (2 required per sensor)
Miscellaneous		
P31536	**198 840 201**	Sensor plug, Polypropylene
3-2536.321	**198 820 054**	PVDF Natural, Rotor kit
3-8050.391	**159 001 703**	Retaining Nut Replacement Kit, NPT, Stainless Steel
3-8050.390-1	**159 001 702**	Retaining Nut Replacement Kit, NPT, Valox
3-8050.390-3	**159 310 116**	Retaining Nut Replacement Kit, NPT, PP
3-8050.390-4	**159 310 117**	Retaining Nut Replacement Kit, NPT, PVDF
3-8050.396	**159 000 617**	RC Filter kit (for relay use)
3-9000.392-1	**159 000 839**	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	**159 000 841**	Liquid tight connector kit, PG13.5 (1 piece)
7310-1024	**159 873 004**	24 VDC Power Supply, 10W, 0.42 A
7310-2024	**159 873 005**	24 VDC Power Supply, 24W, 1.0 A
7310-4024	**159 873 006**	24 VDC Power Supply, 40W, 1.7 A
7310-6024	**159 873 007**	24 VDC Power Supply, 60W, 2.5 A
7310-7024	**159 873 008**	24 VDC Power Supply, 96W, 4.0 A

3-2537.099 Rev G (4/13)
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GF 2724-2726 pH/ORP Electrodes

General Purpose

Compatible with ALL GF pH/ORP instruments and SmartPro transmitters

The 2724-2726 pH and ORP electrodes are general purpose sensors ideal for a wide range of applications. These feature a patented reference design and uses the unique foul-proof patented DryLoc® connector. The large area PE reference junction and pathway is constructed to increase the total reference effectiveness and ensures long service life.

The DryLoc® connector with corrosion resistant gold plated contacts readily connects the sensor to the mating 2751 pH/ORP Smart Sensor Electronics or the 2760 Preamplifier. The robust PPS threaded sensor body and choice of flat pH, bulb pH, or flat ORP sensing elements allows a broad range of chemical and mechanical compatibility for a wide variety of applications.

There are two optional pH sensing versions available, HF and LC. The HF version is for applications where traces of hydrofluoric acid (2% or less) will attack standard pH glass. The LC version can be used for low conductivity fluids 20 - 100 µS/cm nominal and below 20 µS/cm when mounted under controlled conditions.

The quick temperature response is available in either a Pt1000 or 3 KΩ temperature sensor and allows compatibility with all pH/ORP instruments. The 2724-2726 electrodes incorporate ¾ inch NPT or ISO 7/1-R 3/4 threads for installing into GF standard pipe-tees. They can also be mounted directly into standard fittings, DN15 to DN100 (½ to 4 inch).

Features

- **Patented reference design for exceptional performance and prolonged life in harsh environments***
- **Memory chip enabled for access to a wide range of unique features when connected to the 2751 pH/ORP Smart Sensor Electronics**
- **PPS body for broad range of chemical compatibility**
- **Patented DryLoc® connector with gold plated contacts**
- **Special design allows for installation at any angle, even inverted or horizontal**
- **¾" NPT or ISO 7/1-R 3/4 threaded sensors for use with reducing tees DN15 to DN100 (½ to 4 in.)**
- **Mounts in GF standard fittings from DN15 to DN100 (½ to 4 in.)**
- **Quick temperature response**
- **Bulb and flat HF resistant glass available for trace HF, in less than 2% concentration applications**
- **Low conductivity sensor available for liquids down to 20 µS/cm**

Applications

- **Water & Wastewater Treatment**
- **Neutralization Systems**
- **Effluent Monitoring**
- **Sanitization Systems**
- **Pool & Spa Control**
- **Aquatic Animal Life Support Systems**
- **Process Control**
- **Cooling Towers**

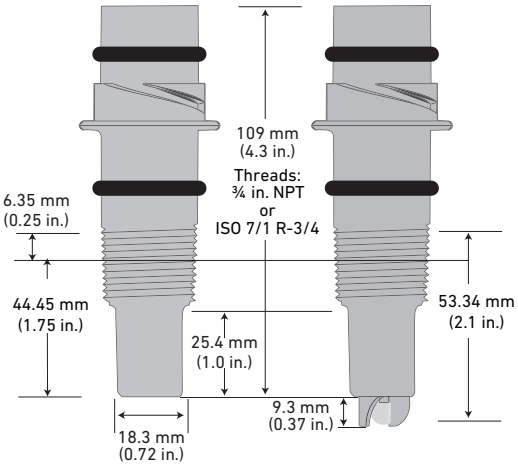
*U.S. Patent Nos.: 6,666,701, 7,799,193 B2, 7,867,371 B2 and 8,211,282 B2

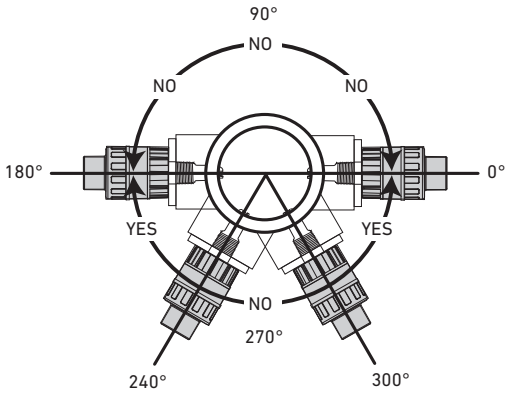
Specifications

General			
Performance	Efficiency	>97% @ 25 °C (77 ° F)	
Operating Range	pH	0 to 14 pH	
	ORP	±2000 mV	
	3-2726-LC	Low conductivity fluids; 20 - 100 µS/cm nominal < 20 µS; flow must be less than 150 ml/min in a properly grounded system	
	3-2724-HF, 3-2726-HF	Hydrofluoric acid resistant glass, pH 6 or below; trace HF ≤2%	
Compatibility			
	2751 Smart Sensor Electronics (for 8900, 9900, 9950, 4 to 20 mA or Profibus Concentrator), 2760 Preamplifier		
Temperature Sensor			
	Pt1000 versions	Compatible with 2751 pH/ORP Smart Sensor Electronics for connection to a PLC or to the 8900, 9900 or 9950 instruments	
	3 KΩ Balco versions	Compatible with 2751 pH/ORP Smart Sensor Electronics or with 2760 pH/ORP Preamplifier for connection to the 8750 pH/ORP Transmitter	
Process Connection			
	¾ in. NPT	ISO 7/1-R 3/4	Mounts into fittings
Wetted Materials			
	pH	PPS, glass, UHMW PE, FKM	
	ORP	PPS, glass, UHMW PE, FKM, Platinum	
Max. Temperature/Pressure Rating			
Operating Temperature Range*	bulb tip design	0 °C to 85 °C	32 °F to 185 °F
	flat tip design	10 °C to 85 °C	50 °F to 185 °F
Operating Pressure Range		6.8 bar @ 0 to 65 °C (100 psi @ 32 to 150 °F)	
		4 bar @ 65 to 85 °C (58 psi @ 150 to 185 °F)	
*Best performance for 2724-HF, 2726-HF sensors is above 10 °C (50 °F)			
Recommended Storage Temperature			
		0 °C to 50 °C	32 °F to 122 °F
The electrode glass will shatter if shipped or stored at temperature below 0 °C (32 °F)			
The performance life of the electrode will shorten if stored at temperatures above 50 °C (122 °F)			
Mounting			
In-line Mounting	Use the sensor threads		
	Use a standard fitting up to 4 in.		
	Sensor can be mounted at any angle		
Submersible Mounting	Use threads on models 2751 or 2760		
	Requires ¾ inch NPT or ISO 7/1-R 3/4 male threaded liquid tight extension conduit.		
Shipping Weight			
	0.25 kg	0.55 lb	
Standards and Approvals			
	RoHS compliant, China RoHS		
	Manufactured under ISO 9001, ISO 14001 and ISO 45001		

See Temperature and Pressure graphs for more information

Dimensions



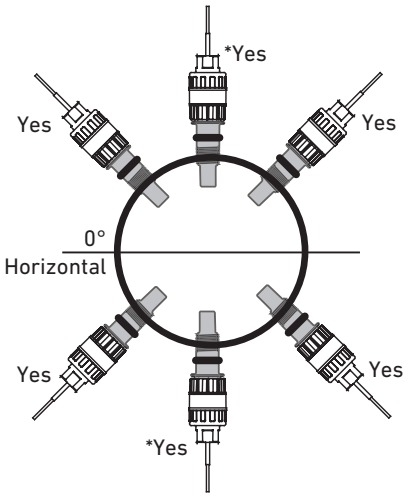


Mounting Angle

Models 2724-2726 may be mounted at any angle without affecting the performance.

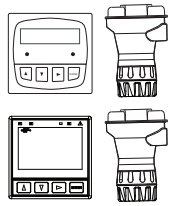
*Avoid locations with air pockets and sediment

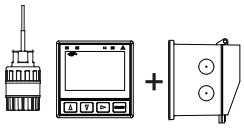
When mounting in standard threaded fittings the electrode must be mounted horizontally to 60 degrees below horizontal position only.

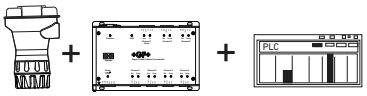


System Overview

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Output	Automation System
GF Instruments with 2751 Smart Sensor Electronics - 8900 - 9900 - 9950	GF Instruments with 2751 Smart Sensor Electronics - 9900 and Rear Enclosure	2751 Smart Sensor Electronics with - Customer Supplied Chart Recorder or Programmable Logic Controller or - Programmable Automation Controller	2751 Smart Sensor Electronics with - 0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or - Programmable Automation Controller



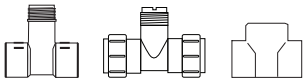




GF 2724-2726
DryLoc® pH/ORP
Electrodes

All sold separately

In-Line Installation -
GF and threaded 1/2 in to 4 in fittings only



Submersible Installation -
Customer supplied pipe extension
or conduit with 3/4 in. NPT or ISO 7/1-R 3/4 threads

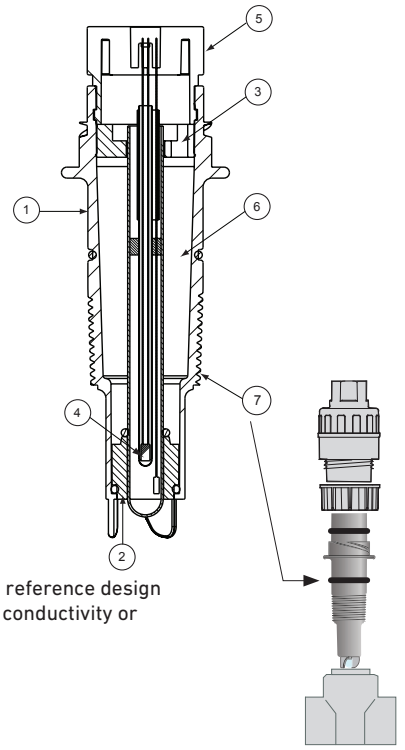
Electrode Key Features and Benefits:

1. PPS body for chemical compatibility with most harsh chemicals.
2. Porous UHMW PE (ultra high molecular weight polyethylene) junction resists fouling and build-up.
3. Memory chip enabled for convenient data storage and access (calibration data, operational data, and manufacturing data), electrode health monitoring via glass impedance measurement when used in connection with the 2751 pH/ORP Smart Sensor Electronics.
4. Internal temperature sensor located in the glass stem for a quick temperature response.
5. DryLoc® connector with corrosion resistant gold plated pins for quick and easy sensor removal. Resists moisture and dirt intrusion.
6. Dual-patented reference design with a 406 mm (16 in.) reference pathway for prolonged life in harsh environments. This enables the sensor to last significantly longer than other standard pH/ORP electrodes in most applications.

6a. With the patented reference design, the 2726-LC version performs better in low conductivity water between 20 - 100 µS and lasts longer than previous "DI" electrodes.

6b. The 2726-LC sensor also performs in applications with extremely low (less than 20 µS/cm) conductivity. Special precautions must be taken to avoid measurement complications. Please note the following.
   - Electrostatic charges (streaming potentials) can cause dramatic offsets in a system with very low conductivity water. To minimize this, sensors should be placed in a well grounded system.
   - To enhance performance, a low flow cell is recommended to provide a steady flow rate (150 ml/minute). Sensors placed in high flow applications will experience noisier readings due to streaming potential.

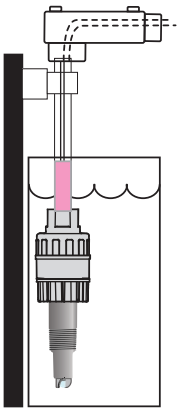
7. Threads for NPT or ISO process connection into reducing tees
   - Use off-the-shelf GF reducing tees DN20 to DN100 (¾ to 4 in.).
8. Mounts directly into fittings (½ to 4 in.) for easy sensor retrofitting.
9. Mount submersed into a tank via the 2751 or 2760 back threads.



Dual-patented reference design for long life in conductivity or chemicals.

Sensor in threaded reducing tee

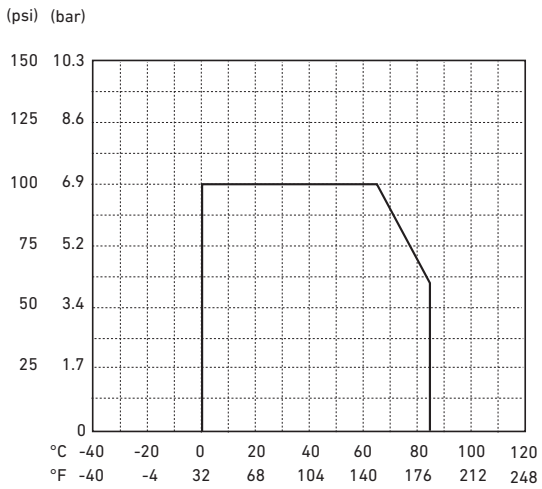
⑧ Sensor in fitting



⑨ Sensor submersible installation

Temperature/Pressure Graph

Note:
The pressure/temperature graphs are specifically for the GF sensor. During system design the specifications of all components must be considered. In the case of a metal piping system, a plastic sensor will reduce the system specification.



Application Tips
- Use the flat glass electrodes when a self-cleaning feature is desired; especially useful in applications with abrasive chemicals for in-line installations.
- Use bulb protected electrodes for low temperature applications or where fast response is required.
- ORP electrodes are generally used for chemical reaction monitoring, not control.
- Ensure that sensor materials are chemically compatible with the process liquid.
- Keep electrode tip wet, avoid air pockets and sediment.

Model 2724-2726 Ordering Notes
1) pH and ORP electrodes require connection to model 2751 pH/ORP Smart Sensor Electronics or 2760 Preamplifier.
2) The 2751 "EasyCal" feature recognizes common pH and ORP buffer values of 4, 7 and 10 pH and +87, +264 and +469 mV for ORP.

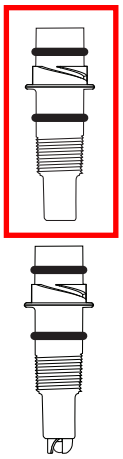
Buffer Solutions
3822-7004
3822-7007
3822-7010

Quinhydrone
3822-7115

The GF pH buffers are ideal for calibration.
The liquid solutions are conveniently packaged in one pint (473 ml) bottles. pH buffer kits in powder pillows are available for mixing fresh solutions with water at the time of use.

All pH buffers are color coded for easy identification; 4.01 pH is red, 7.00 pH is yellow, and 10.00 pH is blue.
All pH buffers are traceable to NIST standards.
The 4.01 and 7.00 pH buffer solutions can be used to calibrate ORP sensors when saturated with quinhydrone.

Ordering Information



Mfr. Part No.	Code	Tip Design	Process Connection Thread Options
pH Electrodes			
Temperature Element Pt1000; use with 2751 pH/ORP Smart Sensor Electronics* and Profibus Concentrator			
3-2724-00	**159 001 545**	Flat	¾ in. MNPT, Thread
3-2724-01	**159 001 546**	Flat	ISO 7/1-R 3/4 Thread
3-2726-00	**159 001 553**	Bulb	¾ in. MNPT, Thread
3-2726-01	**159 001 554**	Bulb	ISO 7/1-R 3/4 Thread
3-2726-HF-00	**159 001 549**	Bulb, HF Resistant[1]	¾ in. MNPT, Thread
3-2726-HF-01	**159 001 550**	Bulb, HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-LC-00	**159 001 557**	Bulb, Low Conductivity[2]	¾ in. MNPT, Thread
3-2726-LC-01	**159 001 558**	Bulb, Low Conductivity[2]	ISO 7/1-R 3/4 Thread
Temperature Element 3 KΩ Balco; Compatible with both the 2751 pH/ORP Smart Sensor Electronics* and the 2760 Preamplifier**			
3-2724-10	**159 001 547**	Flat	¾ in. MNPT, Thread
3-2724-11	**159 001 548**	Flat	ISO 7/1-R 3/4 Thread
3-2724-HF-10	**159 001 771**	Flat, HF Resistant[1]	3/4 in. NPT, Thread
3-2724-HF-11	**159 001 772**	Flat, HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-10	**159 001 555**	Bulb	¾ in. MNPT, Thread
3-2726-11	**159 001 556**	Bulb	ISO 7/1-R 3/4 Thread
3-2726-HF-10	**159 001 551**	Bulb HF Resistant[1]	¾ in. MNPT, Thread
3-2726-HF-11	**159 001 552**	Bulb HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-LC-10	**159 001 559**	Bulb, Low Conductivity[2]	¾ in. MNPT, Thread
3-2726-LC-11	**159 001 560**	Bulb, Low Conductivity[2]	ISO 7/1-R 3/4 Thread
ORP Electrodes; Compatible with both the 2751 pH/ORP Smart Sensor Electronics* and the 2760 Preamplifier**			
3-2725-60	**159 001 561**	Platinum, Flat, 10 KΩ ID, ¾ in. NPT	¾ in. MNPT, Thread
3-2725-61	**159 001 562**	Platinum, Flat, 10 KΩ ID, ISO 7/1 R¾	ISO 7/1-R 3/4 Thread

*The 2751 pH/ORP Smart Sensor Electronics has a digital (S^3L) output which is used with 8900, 9900 or 9950 instruments, and the Profibus Concentrator.
It also has a 4 to 20 mA output for connections to PLC's, data recorders, etc.

**The 2760 Preamplifier is used for connection directly to 8750 transmitter or other analog transmitters.

[1]HF resistant ≤2%HF

[2]Low conductivity applications, 20 - 100 µS/cm recommended

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
1220-0021	**198 801 000**	O-ring, FKM (2 required per sensor)
3-2700.395	**159 001 605**	Calibration Kit: includes 3 polypropylene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00
3822-7115	**159 001 606**	20 gm Bottle Quinhydrone for ORP Calibration (must use pH 4.01 and/or pH 7.00 buffer solutions)
3-2759	**159 000 762**	pH/ORP System Tester (adapter cable sold separately)
3-2759.391	**159 000 764**	2759 DryLoc Adapter Cable (for use with 2751 and 2760)
3-0700.390	**198 864 403**	pH Buffer Kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 ml of each)
3822-7004	**159 001 581**	pH 4.01 Buffer Solution, 1 pint (473 ml) bottle
3822-7007	**159 001 582**	pH 7.00 Buffer Solution, 1 pint (473 ml) bottle
3822-7010	**159 001 583**	pH 10.00 Buffer Solution, 1 pint (473 ml) bottle
3800-5000	**159 838 107**	3.0M KCl Storage Solution for pH and ORP, 1 pint (473 ml) bottle
3-2700.397	**159 001 870**	Protective Cap for pH/ORP Electrodes, 5 pieces
3-2700.398	**159 001 886**	O-ring Lubricant Kit (5 packs of Super Lube, 1cc each)

3-2724.099 Rev M (02/21)
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3401 Aero Jet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057 • www.gfsignet.com • e-mail: signet.ps@georgfischer.com
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Signet 2751 DryLoc® pH/ORP Smart Sensor Electronics

~~In-line~~
~~2751-1~~

In-line EasyCal
2751-2

~~Submersible~~
~~2751-3 or 2751-4~~

DryLoc® Electrodes sold separately

The Signet 2751 pH/ORP Smart Sensor Electronics featuring the DryLoc® connector, is the solution for field-free calibration, out of range glass impedance and broken glass detection, alerting the operator to probe failure or maintenance needs.

The 2751 features two different outputs: a two-wire 4 to 20 mA loop output with optional EasyCal function or a digital (S^3L) output which allows for longer cable lengths and is compatible with all Signet 8900, 9900 and 9950* instruments or in blind, 4 to 20 mA.

The Smart Sensor Electronics will allow for calibration of electrodes in a laboratory setting and installation of pre-calibrated probes in the field, reducing system downtime. Memory chip enabled electrodes will store operational data such as minimum and maximum pH/mV readings, runtime, minimum and maximum temperature (pH only), for troubleshooting and operational evaluation. To take full advantage of all features and benefits of the 2751, use with Signet 9900 (Generation IV or later), 9950 Transmitter or 0486 Profibus Concentrator.

The 2751 self-configures for pH or ORP operation via automatic recognition of the electrode type. The optional EasyCal feature allows simple push-button calibration and includes an LED indicator for visual feedback.

The 2751 submersible Smart Sensor Electronic can also be used in-line when used with the 3/4" or 1" threaded sensors including the 272X, 273X, 275X, 276X and 277X series of electrodes. The 2751 in-line sensor electronics can be used with Signet fittings up to DN100 (4 in.) and Wet-Tap assemblies.

Features

- **Probe health monitoring, glass impedance and broken glass detection**
- **Memory chip interface that allows for transferable calibration, runtime data, and manufacturing information**
- **In-line integral mount and submersible installation versions**
- **Automatic temperature compensation**
- **Auto configuration for pH or ORP operation**
- **Optional EasyCal calibration aid with automatic pH buffer recognition for 4, 7 and 10 pH and ORP solutions: quinhydrone saturated pH 4 or 7 buffers and Light's Solution +469 mV**
- **Junction boxes for convenient wiring**
- **Patented DryLoc® connector provides a quick and secure connection to the sensor****

Applications

- **Water and Wastewater Treatment**
- **Neutralization Systems**
- **Scrubber Control**
- **Effluent Monitoring**
- **Surface Finishing**
- **Flocculent Coagulation**
- **Heavy Metal Removal and Recovery**
- **Toxics Destruction**
- **Sanitization Systems**
- **Pool & Spa Control**
- **Aquatic Animal Life Support Systems**

*Users of 9950 Gen I and 9950 (Gen 2a) should update to 9950 (Gen 2b, available in Q4) to take full advantage of the 2751 features and benefits. Visit www.gfsignet.com for the latest software update.

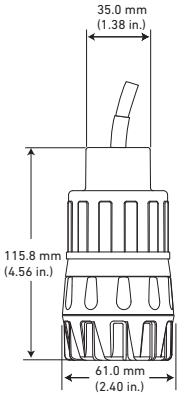
**U.S. Patent No.: 6,666,701

Specifications

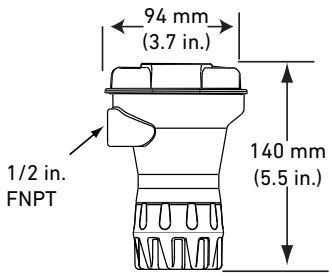
General				
Compatible Electrodes				
	Signet DryLoc® pH and ORP Electrodes, Models 2724-2726, 2734-2736, 2756-2757 Wet-Tap, 2764-2767, 2774-2777			
Operating Range	pH		-1 to 15 pH	
	ORP		±2000 mV	
Response Time	pH		< 6 sec. for 95% of change	
	ORP		Application dependent	
Materials	In-line		PBT (thermal plastic polyester) and polypropylene (retaining nut)	
	Submersible		CPVC	
Electrical				
Cable	4.6 m	15 ft	3-conductor shielded (3-2751-1 in-line and the 3-2751-3 or -4 submersible sensor electronics only)	
	22 AWG		For 9900, 9950 and 4 to 20 mA max. cable length is 300 m (1000 ft.). For 8900, please refer to the Cable Calculation Table of the Signet catalog for max. cable length.	
Power	12 to 24 VDC		±10%, regulated for 4 to 20 mA output	
	5 to 6.5 VDC		±5% regulated recommended, 3 mA max., for digital (S^3L) output	
Current Output	pH		Fixed 4 to 20 mA, isolated, = 0 to 14 pH (custom scaling available with 0252 tool)	
	ORP		Fixed 4 to 20 mA, isolated, = -1000 to +2000 mV (custom scaling available from ± 2000 mV with 0252 tool)	
Max Loop Resistance	100 Ω max. @ 12 V		325 Ω max. @ 18 V	600 Ω max. @ 24 V
Accuracy	±32 µA			
Resolution	±5 µA			
Update Rate	0.5 seconds			
Error Indication	3.6 mA, 22 mA, or none			
Digital (S^3L) Output	Serial ASCII, TTL level 9600 bps			
Accuracy	pH		± 0.02 pH @ 25 °C	± 0.02 pH @ 77 °F
	ORP		± 1.5 mV @ 25 ° C	± 1.5 mV @ 77 °F
	Temperature		≤ 0.4 °C	0.72 °F
Resolution	pH		≤ 0.01 pH	
	ORP		1.5 mV	
Update Rate	0.5 seconds			
Available Data	Raw mV, pH or ORP, Temperature (pH), Glass Impedance (pH), Minimum mV (pH), Maximum mV (pH), Minimum Temperature (pH), Maximum Temperature (pH), Model Number, Serial Number, Manufacturing Date, Runtime, Slope pH/mV, Measurement Offset, and Temperature			
Error Indication	Open input diagnostic, broken glass detection (pH), High Impedance			
Input Impedance, Z	$>10^{11}\Omega$			
Environmental				
Enclosure	3-2751-1 & -2		NEMA 4X/IP65 with electrode connected	
	3-2751-3 & -4		NEMA 6P/IP68 with electrode and watertight conduit and/or extension pipe connected	
Max. Temperature/Pressure Rating				
Operating Temperature				
Submersible	0 °C to 85 °C		32 °F to 185 °F	
In-line	0 °C to 85 °C		32 °F to 185 °F	
Storage Temperature	-20 °C to 85 °C		-4 °F to 185 °F	
Relative Humidity	0 to 95%, non-condensing (without electrode connected)			
Shipping Weight				
	2751-2		0.75 kg	1.65 lb
	2751-1, -3 & -4		0.64 kg	1.41 lb
Standards and Approvals				
	CE, FCC			
	RoHS compliant, China RoHS			
	Manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety			

Dimensions

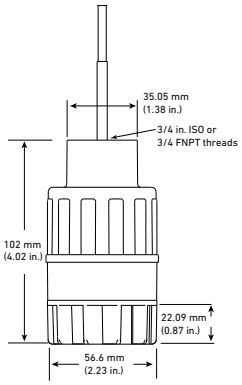
~~3-2751-1~~



3-2751-2

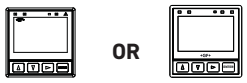
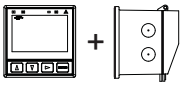
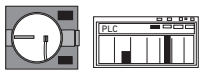
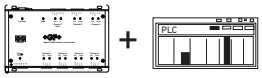
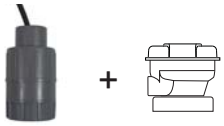
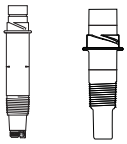


~~3-2751-3, -4~~

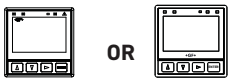
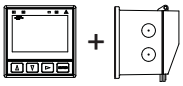
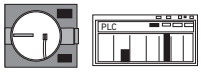
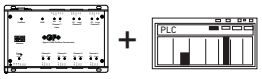
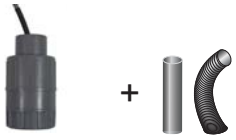
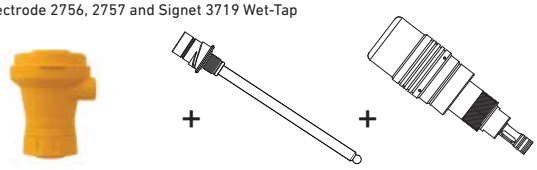
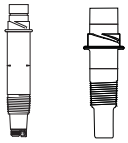
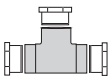


System Overview

In-Line Installation

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Input	Automation System
Signet Instruments 9900 9950 	Signet Instrument 9900 and Rear Enclosure 	3-2751 Smart Sensor Electronics and Customer Supplied Chart Recorder, Programmable Logic Controller, or Programmable Automation Controller 	3-0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or Programmable Automation Controller 
Signet 2751 Smart Sensor Electronics 	**Signet 2751 Smart Sensor Electronics** with Signet 3-8050-2 Universal Junction Box (EasyCal) 		**Signet 2751 Smart Sensor Electronics**
Signet Electrodes 2724-2726 ~~2734-2736~~ ~~2764-2767~~ ~~2774-2777~~ 			
2724-2726 and 2734-2736 DryLoc Electrodes: Use GF fittings* or customer supplied 3/4 in. NPT fittings 2764-2767 and 2774-2777 DryLoc Electrodes: Use customer supplied 3/4 in. or 1 in. NPT fittings			All sold separately

Submersible Installation

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Input	Automation System
Signet Instruments 9900 9950 	Signet Instrument 9900 and Rear Enclosure 	2751 Smart Sensor Electronics and Customer Supplied Chart Recorder, Programmable Logic Controller , or Programmable Automation Controller 	0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or Programmable Automation Controller 
Signet 2751 Smart Sensor Electronics with customer supplied pipe extension or conduit, 3/4 in. NPT or ISO 7/1-R 3/4 threads** 	**Signet 2751 Smart Sensor Electronics** with Signet Wet-Tap Electrode 2756, 2757 and Signet 3719 Wet-Tap 		
Signet Electrodes 2724-2726 2734-2736 2764-2767 2774-2777 	GF Tees and Fittings see model 3719 for more info 		All sold separately

* See fittings section for more information.
**Refer to the Signet Submersion Kit brochure (3-0000.707) located on our website for installation suggestions and options.

2751 Product Selection Guide

1. Choose the Electrode

2724-2726, 2734-2736

Can use Any 3-272X or 273X series Electrode

2764-2767 Differential

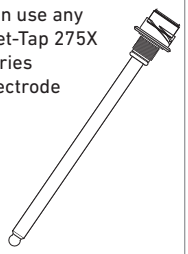
3-2764-1
3-2764-2
3-2766-1
3-2766-2

2774-2777
ORP electrodes must have 10K ID resistor use:
3-2775, 3-2777

pH Electrodes can be either the 1K or 3K use:
3-2774, 3-2774-1, 3-2776, 3-2776-1

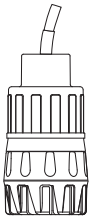
2756 and 2757 Wet-Tap

Can use any Wet-Tap 275X series electrode

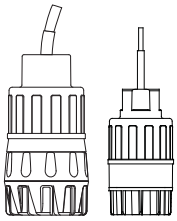


2. Determine the mounting style:

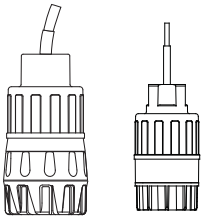
In-line



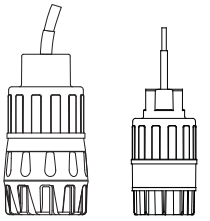
2751-1 or -2



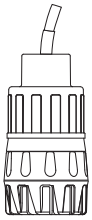
2751-1 or -2 | 2751-3 or -4



2751-1 or -2 | 2751-3 or -4



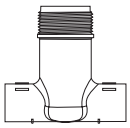
2751-1 or -2 | 2751-3 or -4



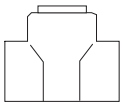
2751-1 or -2

And

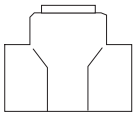
-In-line fitting



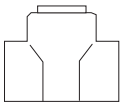
Signet fitting



¾" reducing tee



1" threaded tee



¾" reducing tee

Or

3719 Wet-Tap Assembly

(Submersible not applicable with Wet-Tap assembly)

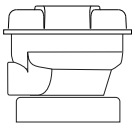
Submersible

2751-3 or -4
and cable conduit (customer supplied) connected to ¾" sensor electronics

+

3. Junction Boxes

3-8050-1: Use when extending the submersible cable over long distance.
3-8050-2: Use with the submersible 2751-3 or -4 and the in-line 2751-1 for best calibration results with the EasyCal function when using the blind 4 to 20 mA output.

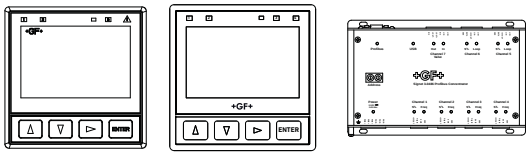


4. Choose the output instrument

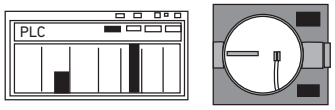
Digital (S³L)

Or

4 to 20 mA



OR



9900 or 9950 Instruments, Profibus Concentrator

PLCs or Chart Recorders

Model 2751 Ordering Information

1) Model 2751 requires 12 to 24 VDC to function as a blind 4 to 20 mA output transmitter.

2) Order a 3-2751-2 or any other 2751 with a junction box 3-8050-2 if the EasyCal feature is desired.

3) Conduit and mounting brackets for submersion installation must always be used (customer supplied).

4) The 3-2759 System Tester must be ordered with the adapter cable 3-2759.391 for exclusive use with the 2751.

5) All sensor electronics, preamplifiers and connectors require a DryLoc electrode for full system installation.

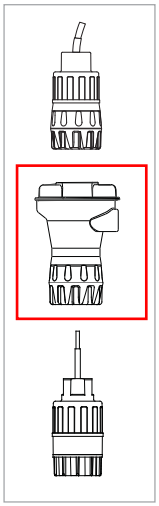
6) The 2751 Smart Sensor Electronics is compatible with all Signet 8900, 9900 and 9950 instruments. To take full advantage of the advanced features use the 9900 SmartPro Transmitters (Generation IV or greater), 9950 and 0486 Profibus Concentrator.

Application Tips

- The EasyCal feature automatically recognizes standard 4.0, 7.0, and 10.0 pH buffer or ORP quinhydrone solutions of +87 and +264 mV or Light's Solution, +469 mV, and simplifies calibration. For EasyCal ORP only single point calibration is used.

- Frequency of calibration of electrodes is dependent upon the application.

Ordering Information



Mfr. Part No.	Code	Description
In-line Smart Sensor Electronics (Yellow body)		
~~3-2751-1~~	~~**159 001 804**~~	~~with 4.6 m (15 ft) cable, recommended for 9900 or 9950 instruments~~
3-2751-2	**159 001 805**	with junction box and EasyCal, recommended for 4 to 20 mA use
Submersible Smart Sensor Electronics (Gray body)		
~~3-2751-3~~	~~**159 001 806**~~	~~with 4.6 m (15 ft) cable and ¾ in. NPT threads - when 4 to 20 mA is required use the 3-8050-2 junction box with EasyCal~~
~~3-2751-4~~	~~**159 001 807**~~	~~with 4.6 m (15 ft) cable and ISO 7/1-R 3/4 threads - when 4 to 20 mA is required use the 3-8050-2 junction box with EasyCal~~

Sensor Electronics with preamplified signal and Digital (S^3L) output (for use with the SmartPro Instruments) or 4 to 20 mA output - power supplied to unit dictates output type.

Note:
The 2751 Smart Sensor Electronics is compatible with 8900, 9900 and 9950 SmartPro Transmitters, and Signet 0486 Profibus Concentrator. To take full advantage of the 2751 features, use 9900 (Generation IV or later), 9950 or 0486 Profibus Concentrator.

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
Calibration		
3-2700.395	**159 001 605**	Calibration kit: includes 3 polyproplyene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00
3822-7115	**159 001 606**	20 gm bottle quinhydrone for ORP calibration (must use pH 4.01 and/or pH 7.00 buffer solutions)
3-2759	**159 000 762**	pH/ORP system tester (adapter cable sold separately)
3-2759.391	**159 000 764**	2759 adapter cable for use with 2751 DryLoc sensor electronics
3-0700.390	**198 864 403**	pH buffer kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 ml of each)
3822-7004	**159 001 581**	pH 4 buffer solution, 1 pint (473 ml) bottle
3822-7007	**159 001 582**	pH 7 buffer solution, 1 pint (473 ml) bottle
3822-7010	**159 001 583**	pH 10 buffer solution, 1 pint (473 ml) bottle
Mounting		
3-8050.390-3	**159 310 116**	Retaining nut replacement kit, Black Polypropylene
3-8050-1	**159 000 753**	Universal mount junction box
3-8050-2	**159 000 754**	Universal mount junction box w/EasyCal (for submersible applications, use with 3-2751-3 and -4 where 4 to 20 mA is required)
3-9000.392-1	**159 000 839**	Liquid tight connector kit, NPT (1 connector)
3-9000.392-2	**159 000 841**	Liquid tight connector kit, PG 13.5 (1 connector)
Other		
5523-0322	**159 000 761**	Sensor cable (per ft), 3-cond. plus shield, 22 AWG, black/red/white (for use with 2751)
P31515-0P200	**159 000 630**	Universal Pipe Adapter PVC
P31515-0C200	**159 000 631**	Universal Pipe Adapter CPVC
P31515-0V200	**159 000 459**	Universal Pipe Adapter PVDF
7310-1024	**159 873 004**	24 VDC power supply, 10W, 0.42 A
7310-2024	**159 873 005**	24 VDC power supply, 24W, 1.0 A
7310-4024	**159 873 006**	24 VDC power supply, 40W, 1.7 A
7310-6024	**159 873 007**	24 VDC power supply, 60W, 2.5 A
7310-7024	**159 873 008**	24 VDC power supply, 96W, 4.0 A

3-2751.099 Rev A (07/17)
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3401 Aero Jet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057 • www.gfsignet.com • e-mail: signet.ps@georgfischer.com
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APPENDIX C

Abrera, Bianca

From: Dale Konas, PE <dalek@envirotrac.com>
Sent: Monday, May 13, 2024 11:03 AM
To: Abrera, Bianca
Cc: Nichols, Howard
Subject: [EXTERNAL] FW: Message from UDig NY - West Nyack

This is an **External** email. Do not click links or open attachments unless you validate the sender and know the content is safe.

ALWAYS hover over the link to preview the actual URL/site and confirm its legitimacy.

Dale Konas
Principal Engineer
Office: Yaphank, New York

phone: 631.924.3001
mobile: 516.807.7978

From: Stephen Sussman <stephens@envirotrac.com>
Sent: Friday, May 10, 2024 4:08 PM
To: Dale Konas, PE <dalek@envirotrac.com>
Subject: FW: Message from UDig NY - West Nyack

I might have a few to send you

Stephen Sussman
Field Services Manager
Office: Yaphank, New York

phone: 631.924.3001
mobile: 631.484.9348

From: UDig NY Exactix <tickets@exactix.udigny.org>
Sent: Monday, February 5, 2024 2:33 PM
To: Stephen Sussman <stephens@envirotrac.com>
Subject: Message from UDig NY

```
Ticket: 02054-001-338-00 Type: Regular       Previous Ticket:
```

State: NY County: ROCKLAND Place: WEST NYACK
Addr: From: 8 To: Name: PINEVIEW RD
Cross: From: To: Name:
Offset:

Locate: FRONT OF PROPERTY, REAR OF PROPERTY, RIGHT SIDE OF PROPERTY AS FACING,
      : LEFT SIDE OF PROPERTY AS FACING, WORK IN DRIVEWAY AREA, INCLUDE STREET
      : TO CENTERLINE
NearSt: PINEVIEW RD
Means of Excavation: MINI EXCAVATOR Blasting: N
Site marked with white: N
Boring/Directional Drilling: N
Within 25ft of Edge of Road: Y

Work Type: PIPELINE MAINTENANCE / REPAIR
Estimated Work Complete Date: 02/14/2024
Depth of excavation: 4 FEET
Site dimensions: Length 10 FEET Width 5 FEET
Start Date and Time: 02/09/2024 08:00
Must Start By: 02/26/2024

Contact Name: STEPHEN SUSSMAN
Company: ENVIROTRAC, YAPHANK
Addr1: 5 OLD DOCK RD Addr2:
City: YAPHANK State: NY Zip: 11980
Phone: 631-484-9348 Fax:
Email: stephens@envirotrac.com
Field Contact: STEPHEN SUSSMAN
Alt Phone: 631-484-9348 Email: stephens@envirotrac.com
Working for: NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Comments: WORK LOCATION DIRT AREA ON NORTHWEST BUILDING SIDE NEAR GAS METER.
        : LARGE WHITE BUILDING JUST OVER THE RXR TRACKS.
        : Lookup Type: ADDRESS

Members:

CABLEVISION OF WEST NYACK	609-758-4700
ORANGE & ROCKLAND UTILITIES INC. | ROCK ORANGE	845-577-2374
ROCKLAND COUNTY SEWER DISTRICT 1	845-365-6056
SUEZ WATER NEW YORK	800-262-8600
TOWN OF CLARKSTOWN SEWER	845-517-7039
TOWN OF ORANGETOWN	845-359-6502 x4209
VERIZON | VALHALLA HUDSON VALLEY	844-661-0660
VILLAGE OF NYACK WATER DEPARTMENT	845-358-3734
ZAYO	800-961-6500

Abrera, Bianca

From: Dale Konas, PE <dalek@envirotrac.com>
Sent: Monday, May 13, 2024 11:03 AM
To: Abrera, Bianca
Cc: Nichols, Howard
Subject: [EXTERNAL] FW: Responses for UDig NY locate request 02054-001-338 - West Nyack

This is an External email. Do not click links or open attachments unless you validate the sender and know the content is safe.

ALWAYS hover over the link to preview the actual URL/site and confirm its legitimacy.

-----Original Message-----
From: Stephen Sussman <stephens@envirotrac.com>
Sent: Friday, May 10, 2024 4:10 PM
To: Dale Konas, PE <dalek@envirotrac.com>
Subject: FW: Responses for UDig NY locate request 02054-001-338 - West Nyack

-----Original Message-----
From: UDig NY Exactix <tickets@exactix.udigny.org>
Sent: Thursday, February 8, 2024 2:54 PM
To: Stephen Sussman <stephens@envirotrac.com>
Subject: Responses for UDig NY locate request 02054-001-338

This is a message from UDig NY's Automated Positive Response System (APR). Below is the response status from the facility operators associated with

Ticket # 02054-001-338

NY : ROCKLAND County, WEST NYACK
8 PINEVIEW RD

CABLEVISION OF WEST NYACK
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

ORANGE & ROCKLAND UTILITIES INC. | ROCK ORANGE
- UNMARKED, MARKING AND DIG DELAY REQUESTED. LOCATE TECHNICIAN HAS OR IS ATTEMPTING TO CONTACT THE EXCAVATOR. EXCAVATION SITE REMAINS UNMARKED OR INCOMPLETE. A NEW DEADLINE FOR MARKING IS TO BE OR HAS BEEN SCHEDULED.
  Comment - MARKED GM IN FRONT, COULD NOT MARK GS STUB DUE TO PROPERTY BEING FENCED IN. TRIED CALLING CONTACT, NO ANSWER AND NO VOICEMAIL SET UP.

ROCKLAND COUNTY SEWER DISTRICT 1
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

SUEZ WATER NEW YORK
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

TOWN OF CLARKSTOWN SEWER
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

TOWN OF ORANGETOWN
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

VERIZON | VALHALLA HUDSON VALLEY
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

VILLAGE OF NYACK WATER DEPARTMENT
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - NOT IN OUR SERVICE AREA

ZAYO
- CLEAR, NO FACILITIES WITHIN 15 FT OF THE EXCAVATOR DEFINED WORK AREA
  Comment - No Comment

For the most up-to-date response status please visit exactix.udigny.org or call 888-DIGGERS(344-4377).

For location requests which provide the legal 2 full working days' notice, facility operators have until the stated commencement date and time to provide a response status.

Abrera, Bianca

From: Dale Konas, PE <dalek@envirotrac.com>
Sent: Monday, May 13, 2024 11:03 AM
To: Abrera, Bianca
Cc: Nichols, Howard
Subject: [EXTERNAL] FW: Message from UDig NY - West Nyack

This is an **External** email. Do not click links or open attachments unless you validate the sender and know the content is safe.

ALWAYS hover over the link to preview the actual URL/site and confirm its legitimacy.

Dale Konas
Principal Engineer
Office: Yaphank, New York

phone: 631.924.3001
mobile: 516.807.7978

From: Stephen Sussman <stephens@envirotrac.com>
Sent: Friday, May 10, 2024 4:12 PM
To: Dale Konas, PE <dalek@envirotrac.com>
Subject: FW: Message from UDig NY - West Nyack

This was 2nd call ticket due snow after the 1st locate

Stephen Sussman
Field Services Manager
Office: Yaphank, New York

phone: 631.924.3001
mobile: 631.484.9348

From: UDig NY Exactix <tickets@exactix.udigny.org>
Sent: Wednesday, February 14, 2024 3:54 PM
To: Stephen Sussman <stephens@envirotrac.com>
Subject: Message from UDig NY

Ticket: 02144-001-244-00 Type: Regular Previous Ticket: 02054-001-338-00

State: NY County: ROCKLAND Place: WEST NYACK
Addr: From: 8 To: Name: PINEVIEW RD
Cross: From: To: Name:
Offset:

Locate: FRONT OF PROPERTY, REAR OF PROPERTY, RIGHT SIDE OF PROPERTY AS FACING,
      : LEFT SIDE OF PROPERTY AS FACING, WORK IN DRIVEWAY AREA, INCLUDE STREET
      : TO CENTERLINE
NearSt: PINEVIEW RD
Means of Excavation: MINI EXCAVATOR Blasting: N
Site marked with white: N
Boring/Directional Drilling: N
Within 25ft of Edge of Road: Y

Work Type: PIPELINE MAINTENANCE / REPAIR
Estimated Work Complete Date: 02/22/2024
Depth of excavation: 4 FEET
Site dimensions: Length 10 FEET Width 5 FEET
Start Date and Time: 02/20/2024 10:00
Must Start By: 03/05/2024

Contact Name: STEPHEN SUSSMAN
Company: ENVIROTRAC
Addr1: 5 OLD DOCK RD Addr2:
City: YAPHANK State: NY Zip: 11980
Phone: 631-484-9348 Fax:
Email: stephens@envirotrac.com
Field Contact: STEPHEN SUSSMAN
Alt Phone: 631-484-9348 Email: stephens@envirotrac.com
Working for: NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Comments: WORK LOCATION DIRT AREA ON NORTHWEST BUILDING SIDE NEAR GAS METER.
        : LARGE WHITE BUILDING JUST OVER THE RXR TRACKS.
        : Lookup Type: ADDRESS

Members:

CABLEVISION OF WEST NYACK	609-758-4700
ORANGE & ROCKLAND UTILITIES INC. | ROCK ORANGE	845-925-0333
ROCKLAND COUNTY SEWER DISTRICT 1	845-365-6056
SUEZ WATER NEW YORK	800-262-8600
TOWN OF CLARKSTOWN SEWER	845-517-7039
TOWN OF ORANGETOWN	845-359-6502 x4209
VERIZON | VALHALLA HUDSON VALLEY	844-661-0660
VILLAGE OF NYACK WATER DEPARTMENT	845-358-3734
ZAYO	800-961-6500

Ticket Status Notification

To: ENVIROTRAC
Email: STEPHENS@ENVIROTRAC.COM

Below lists utilities that were statused by USIC. Please note there may be other Utilities which include private facilities that may be present in the work area and are NOT the responsibility of USIC to locate or mark.

You are receiving this notification because your contact information is listed on the above ticket from the One Call System. If you have any questions regarding this notification, please contact USIC at 1-800-762-0592.

Ticket	Address
02054-001-338	8 PINEVIEW RD,WEST NYACK,NY

Utility	Locate Date /	Status	Detail
Suez Wtr	02/7/24 09:38 AM	Not Marked	Excavation Site Clear

Stay Up-to-Date with Real-Time Access to USIC's assigned Tickets through our DigCheck Pro App.
You will have the flexibility to see Open and Closed Tickets, Post Locate Photos, and Street Views!
There is no cost to access our DigCheck Pro App.

Sign up by emailing DigCheck@usicllc.com and provide your
First Name:
Last Name:
Company Name:
Email Address:
State or States:
Phone Number:

You can download DigCheck Pro from Apple App Store or Google Play Store Now!

It's Free!

Questions or Comments:

DigCheck@usicllc.com

APPENDIX D

PHOTOGRAPHIC LOG

Photo 1 **Date:** 06/13/2023 **Direction:** N **Photographer:** TS **Description:** View of former P&T system equipment.	

Photo 2 **Date:** 06/13/2023 **Direction:** N **Photographer:** TS **Description:** Removal of former P&T system equipment.	

PHOTOGRAPHIC LOG

Photo 3 **Date:** 06/14/2023 **Direction:** N **Photographer:** TS **Description:** Concrete removal for French drain installation within the treatment building.	

Photo 4 **Date:** 06/15/2023 **Direction:** N **Photographer:** TS **Description:** Installation of French drain and sump drain.	

PHOTOGRAPHIC LOG

Photo 5 **Date:** 08/14/2023 **Direction:** N **Photographer:** TS **Description:** Completed installation of French drain and sump drain along the roll-up door of the treatment building.	

Photo 6 **Date:** 08/14/2023 **Direction: E** **Photographer:** TS **Description:** RW-1 well vault.	

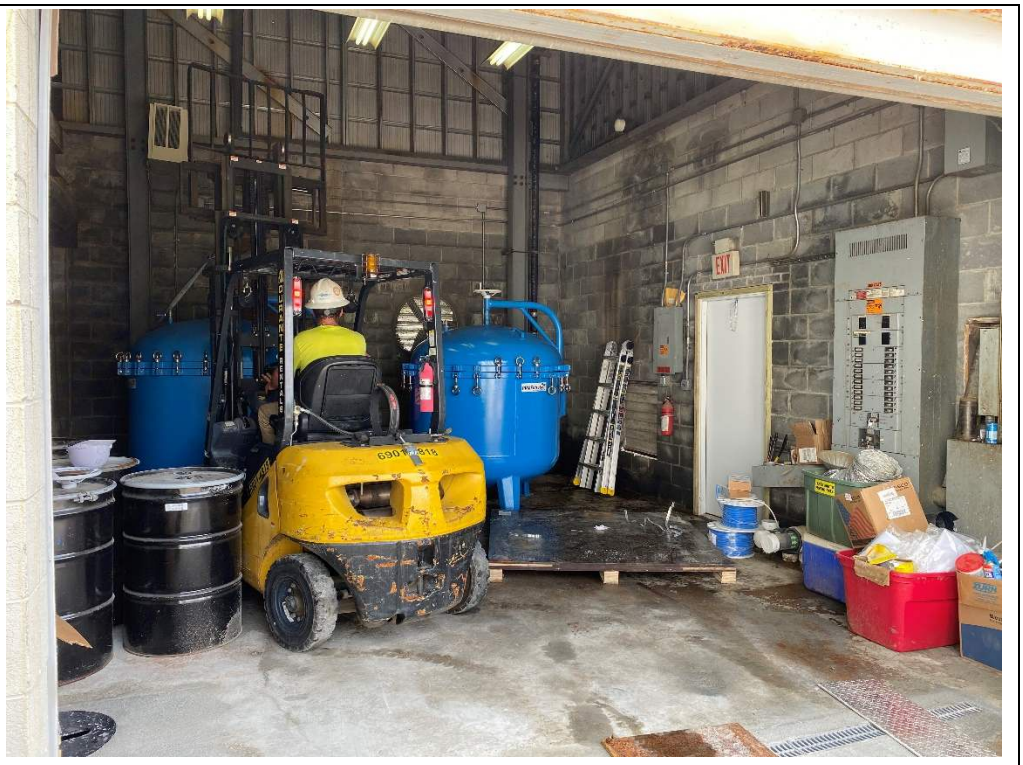
PHOTOGRAPHIC LOG

Photo 7 **Date:** 08/14/2023 **Direction:** SE **Photographer:** TS **Description:** Lifting RW-1 well pump for servicing prior to reinstallation.	

Photo 8 **Date:** 08/14/2023 **Direction:** N **Photographer:** TS **Description:** View of RW-1 pump after servicing and cleaning.	

PHOTOGRAPHIC LOG

Photo 9 **Date: 0**8/14/2023 **Direction:** SE **Photographer:** TS **Description:** RW-1 well pump reinstalled after servicing and cleaning.	

Photo 10 **Date: 0**8/16/2023 **Direction:** S **Photographer:** TS **Description:** Installation of LGAC vessels.	

PHOTOGRAPHIC LOG

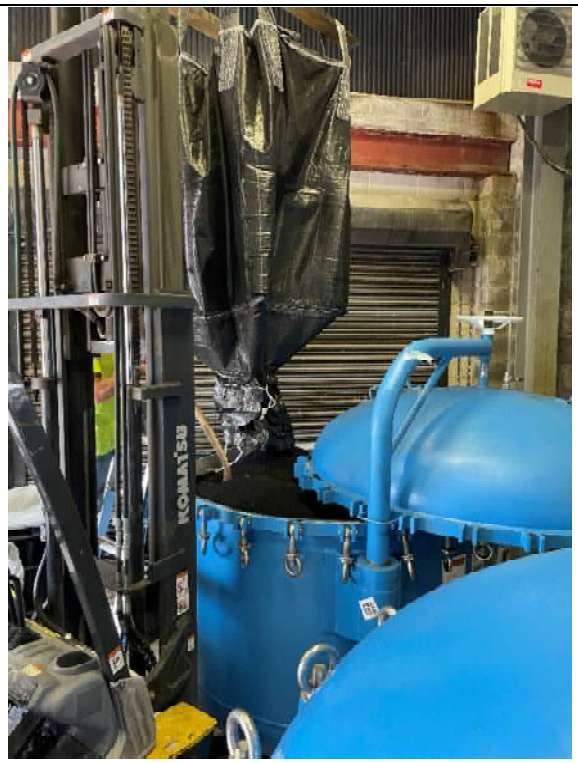
Photo 11 **Date: 0**8/17/2023 **Direction:** S **Photographer:** TS **Description:** Filling LGAC vessels with carbon.	

Photo 12 **Date:** 09/05/2023 **Direction:** S **Photographer:** TS **Description:** Installation of bag filter housings, and manifold and system piping.	

PHOTOGRAPHIC LOG

Photo 13 **Date:** 09/05/2023 **Direction:** S **Photographer:** TS **Description:** Installation of Equalization Tank.	

Photo 14 **Date:** 09/13/2023 **Direction:** S **Photographer:** TS **Description:** Installation of transfer pump and additional system piping.	

PHOTOGRAPHIC LOG

Photo 15 **Date:** 12/20/2023 **Direction:** NA **Photographer:** TS **Description:** Installation of transducer at RW-1.	

Photo 16 **Date:** 01/24/2024 **Direction:** W **Photographer:** BA **Description:** Installing VFDs and conduits for system operations.	

PHOTOGRAPHIC LOG

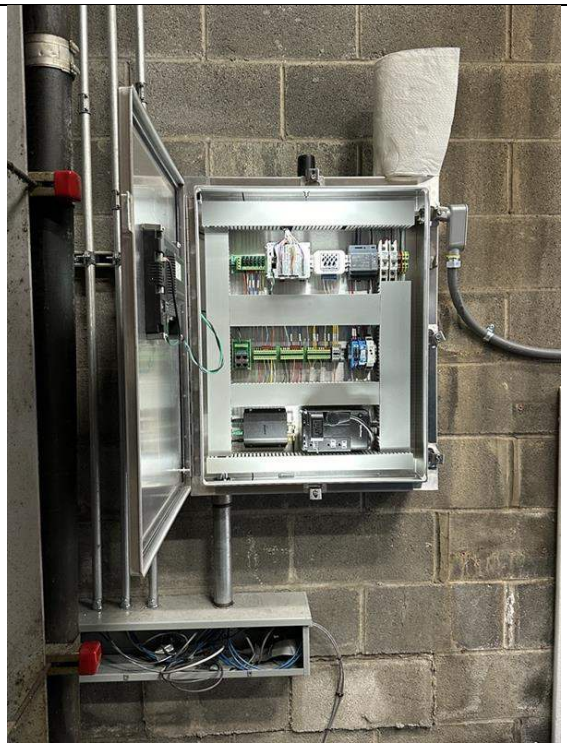
Photo 17 **Date:** 01/25/2024 **Direction:** W **Photographer:** CB **Description:** Installation of main control panel and PLC screen.	

Photo 18 **Date:** 01/26/2024 **Direction:** NA **Photographer:** BA **Description:** Leak observed within RW-1 vault.	

PHOTOGRAPHIC LOG

Photo 19 **Date:** 02/22/2024 **Direction:** SW **Photographer:** BA **Description:** ET removing broken PVC coupling at RW-1.	

Photo 20 **Date:** 02/22/2024 **Direction:** NA **Photographer:** BA **Description:** Broken PVC coupling observed by ET.	

PHOTOGRAPHIC LOG

Photo 21 **Date:** 02/22/2024 **Direction:** W **Photographer:** BA **Description:** PVC couplings replaced by ET at RW-1.	

Photo 22 **Date:** 02/22/2024 **Direction:** SW **Photographer:** BA **Description:** Backfilling of excavation at RW-1.	

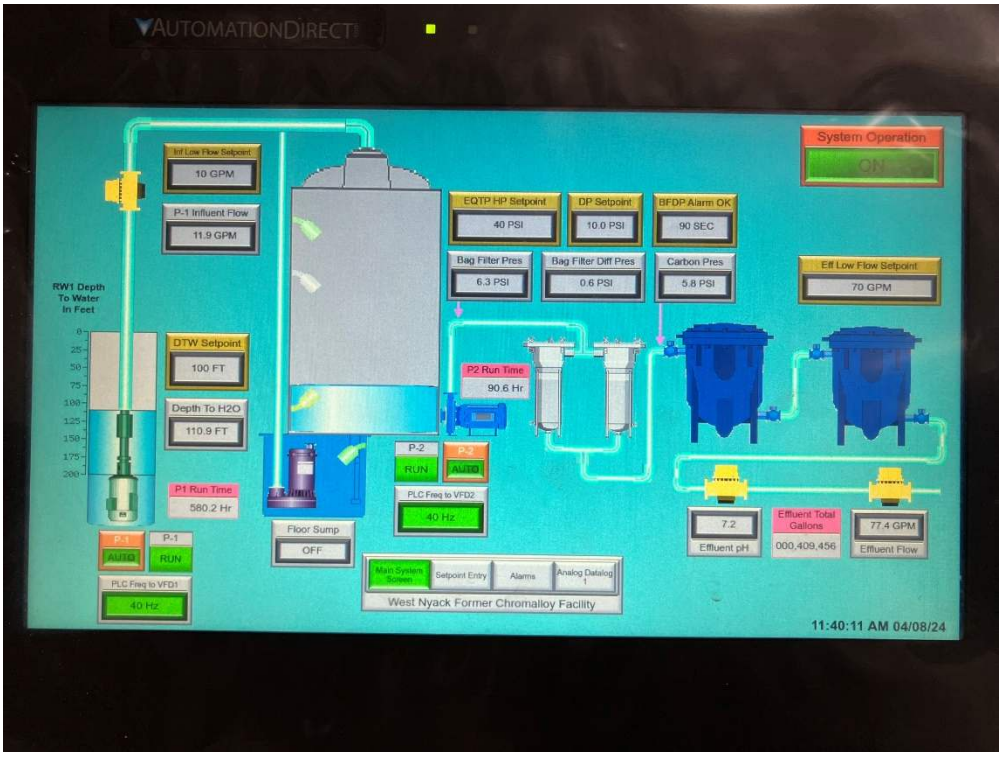
PHOTOGRAPHIC LOG

Photo 23 **Date:** 02/22/2024 **Direction:** E **Photographer:** BA **Description:** RW-1 backfilled with sand and topsoil, protected with orange fencing.	

Photo 24 **Date:** 04/12/2024 **Direction:** S **Photographer:** BA **Description:** View of manifold and LGAC vessels.	

PHOTOGRAPHIC LOG

Photo 25 **Date:** 04/12/2024 **Direction:** E **Photographer:** BA **Description:** View of equalization tank, transfer pump, and bag filter housings.	

Photo 26 **Date:** 04/12/2024 **Direction:** NA **Photographer:** BA **Description:** View of HMI Screen	

APPENDIX E

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/21/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
	Serial No.	Serial No.		Serial No.	Serial No.	
Date/Time	0B352750	0B345893	Δ	0B352750	0B345893	Δ
2/21/2024 13:48	0.0200	0.0133	-0.0067	0	0	0
2/21/2024 13:49	0.0205	0.0134	-0.0071	0	0	0
2/21/2024 13:50	0.0210	0.0135	-0.0075	0	0	0
2/21/2024 13:51	0.0215	0.0136	-0.0079	0	0	0
2/21/2024 13:52	0.0216	0.0137	-0.0079	0	0	0
2/21/2024 13:53	0.0218	0.0141	-0.0077	0	0	0
2/21/2024 13:54	0.0219	0.0145	-0.0074	0	0	0
2/21/2024 13:55	0.0220	0.0148	-0.0072	0	0	0
2/21/2024 13:56	0.0221	0.0152	-0.0069	0	0	0
2/21/2024 13:57	0.0222	0.0157	-0.0065	0	0	0
2/21/2024 13:58	0.0223	0.0159	-0.0064	0	0	0
2/21/2024 13:59	0.0223	0.0163	-0.0060	0	0	0
2/21/2024 14:00	0.0224	0.0175	-0.0049	0	0	0
2/21/2024 14:01	0.0226	0.0177	-0.0049	0	0	0
2/21/2024 14:02	0.0227	0.0171	-0.0056	0	0	0
2/21/2024 14:03	0.0230	0.0173	-0.0057	0	0	0
2/21/2024 14:04	0.0233	0.0175	-0.0058	0	0	0
2/21/2024 14:05	0.0234	0.0177	-0.0057	0	0	0
2/21/2024 14:06		0.0179	-		0	-
2/21/2024 14:07		0.0182	-		0	-
2/21/2024 14:08		0.0183	-		0	-
2/21/2024 14:09		0.0185	-		0	-
2/21/2024 14:10		0.0185	-		0	-
2/22/2024 14:11		0.0185	-		0	-
2/21/2024 14:12	0.0240	0.0183	-0.0057		0	-
2/21/2024 14:13	0.0242	0.0183	-0.0059		0	-
2/21/2024 14:14	0.0243	0.0182	-0.0061		0	-
2/21/2024 14:15	0.0246	0.0174	-0.0072		0	-
2/21/2024 14:16	0.0250	0.0175	-0.0075		0	-
2/21/2024 14:17	0.0253	0.0175	-0.0078		0	-
2/21/2024 14:18	0.0252	0.0177	-0.0075		0	-
2/21/2024 14:19	0.0300	0.0187	-0.0113		0	-
2/21/2024 14:20	0.0314	0.0199	-0.0115		0	-
2/21/2024 14:21	0.0313	0.0210	-0.0103		0	-
2/21/2024 14:22	0.0310	0.0211	-0.0099		0	-
2/21/2024 14:23	0.0303	0.0264	-0.0039		0	-
2/21/2024 14:24	0.0297	0.0270	-0.0027		0	-
2/21/2024 14:25	0.0293	0.0271	-0.0022		0	-
2/21/2024 14:26	0.0289	0.0275	-0.0014		0	-
2/21/2024 14:27	0.0291	0.0277	-0.0014		0	-
2/21/2024 14:28	0.0289	0.0281	-0.0008		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/21/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
	Serial No.	Serial No.		Serial No.	Serial No.	
Date/Time	0B352750	0B345893	Δ	0B352750	0B345893	Δ
2/21/2024 14:29	0.0287	0.0281	-0.0006		0	-
2/21/2024 14:30	0.0285	0.0281	-0.0004		0	-
2/21/2024 14:31	0.0280	0.0282	0.0002		0	-
2/21/2024 14:32	0.0277	0.0282	0.0005		0	-
2/21/2024 14:33	0.0276	0.0281	0.0005		0	-
2/21/2024 14:34	0.0250	0.0275	0.0025		0	-
2/21/2024 14:35	0.0241	0.0265	0.0024		0	-
2/21/2024 14:36	0.0237	0.0255	0.0018		0	-
2/21/2024 14:37	0.0233	0.0255	0.0022		0	-
2/21/2024 14:38	0.0233	0.0204	-0.0029		0	-
2/21/2024 14:39	0.0255	0.0201	-0.0054		0	-
2/21/2024 14:40	0.0256	0.0205	-0.0051		0	-
2/21/2024 14:41	0.0255	0.0205	-0.0050		0	-
2/21/2024 14:42	0.0252	0.0205	-0.0047		0	-
2/21/2024 14:43	0.0253	0.0204	-0.0049		0	-
2/21/2024 14:44	0.0254	0.0205	-0.0049		0	-
2/21/2024 14:45	0.0257	0.0207	-0.0050		0	-
2/21/2024 14:46	0.0256	0.0207	-0.0049		0	-
2/21/2024 14:47	0.0255	0.0207	-0.0048		0	-
2/21/2024 14:48	0.0254	0.0209	-0.0045		0	-
2/21/2024 14:49	0.0250	0.0207	-0.0043		0	-
2/21/2024 14:50	0.0250	0.0205	-0.0045		0	-
2/21/2024 14:51	0.0253	0.0209	-0.0044		0	-
2/21/2024 14:52		0.0208	-		0	-
2/21/2024 14:53		0.0207	-		0	-
2/21/2024 14:54		0.0205	-		0	-
2/21/2024 14:55	0.0230	0.0201	-0.0029		0	-
2/21/2024 14:56	0.0238	0.0200	-0.0038		0	-
2/21/2024 14:57	0.0239	0.0199	-0.0040		0	-
2/21/2024 14:58	0.0240	0.0203	-0.0037		0	-
2/21/2024 14:59	0.0241	0.0203	-0.0038		0	-
2/21/2024 15:00	0.0237	0.0202	-0.0035		0	-
2/21/2024 15:01	0.0242	0.0210	-0.0032		0	-
2/21/2024 15:02	0.0278	0.0219	-0.0059		0	-
2/21/2024 15:03	0.0286	0.0219	-0.0067		0	-
2/21/2024 15:04	0.0285	0.0221	-0.0064		0	-
2/21/2024 15:05	0.0312	0.0223	-0.0089		0	-
2/21/2024 15:06	0.0307	0.0225	-0.0082		0	-
2/21/2024 15:07	0.0299	0.0226	-0.0073		0	-
2/21/2024 15:08		0.0227	-		0	-
2/21/2024 15:09		0.0227	-		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/21/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
	Serial No.	Serial No.		Serial No.	Serial No.	
Date/Time	0B352750	0B345893	Δ	0B352750	0B345893	Δ
2/21/2024 15:10	0.0348	0.0226	-0.0122	0	0	0
2/21/2024 15:11	0.0342	0.0233	-0.0109	0	0	0
2/21/2024 15:12	0.0340	0.0238	-0.0102	0	0	0
2/21/2024 15:13	0.0335	0.0236	-0.0099	0	0	0
2/21/2024 15:14	0.0331	0.0237	-0.0094	0	0	0
2/21/2024 15:15	0.0329	0.0237	-0.0092	0	0	0
2/21/2024 15:16	0.0324	0.0229	-0.0095	0	0	0
2/21/2024 15:17	0.0291	0.0219	-0.0072	0	0	0
2/21/2024 15:18	0.0283	0.0219	-0.0064	0	0	0
2/21/2024 15:19	0.0288	0.0221	-0.0067	0	0	0
2/21/2024 15:20	0.0264	0.0221	-0.0043	0	0	0
2/21/2024 15:21	0.0265	0.0217	-0.0048	0	0	0
2/21/2024 15:22	0.0265	0.0215	-0.0050	0	0	0
2/21/2024 15:23	0.0262	0.0215	-0.0047	0	0	0
2/21/2024 15:24	0.0258	0.0214	-0.0044	0	0	0
2/21/2024 15:25	0.0219	0.0213	-0.0006	0	0	0
2/21/2024 15:26	0.0219	0.0205	-0.0014	0	0	0
2/21/2024 15:27	0.0216	0.0199	-0.0017	0	0	0
2/21/2024 15:28	0.0216	0.0196	-0.0020	0	0	0
2/21/2024 15:29	0.0219	0.0196	-0.0023	0	0	0
2/21/2024 15:30	0.0217	0.0193	-0.0024	0	0	0
2/21/2024 15:31	0.0213	0.0190	-0.0023	0	0	0
2/21/2024 15:32	0.0209	0.0190	-0.0019	0	0	0
2/21/2024 15:33	0.0205	0.0184	-0.0021	0	0	0
2/21/2024 15:34	0.0194	0.0175	-0.0019	0	0	0
2/21/2024 15:35	0.0187	0.0171	-0.0016	0	0	0
2/21/2024 15:36	0.0181	0.0163	-0.0018	0	0	0
2/21/2024 15:37	0.0175	0.0157	-0.0018	0	0	0
2/21/2024 15:38	0.0168	0.0151	-0.0017	0	0	0
2/21/2024 15:39	0.0163	0.0145	-0.0018	0	0	0
2/21/2024 15:40	0.0153	0.0141	-0.0012	0	0	0
2/21/2024 15:41	0.0147	0.0137	-0.0010	0	0	0
2/21/2024 15:42	0.0145	0.0133	-0.0012	0	0	0
2/21/2024 15:43	0.0141	0.0130	-0.0011	0	0	0
2/21/2024 15:44	0.0145	0.0127	-0.0018	0	0	0
2/21/2024 15:45	0.0152	0.0127	-0.0025	0	0	0
2/21/2024 15:46	0.0153	0.0126	-0.0027	0	0	0
2/21/2024 15:47	0.0151	0.0121	-0.0030	0	0	0
2/21/2024 15:48	0.0149	0.0119	-0.0030	0	0	0
2/21/2024 15:49	0.0147	0.0119	-0.0028	0	0	0
2/21/2024 15:50	0.0147	0.0117	-0.0030	0	0	0

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/21/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/21/2024 15:51	0.0146	0.0117	-0.0029	0	0	0
2/21/2024 15:52	0.0146	0.0117	-0.0029	0	0	0
2/21/2024 15:53	0.0145	0.0116	-0.0029	0	0	0
2/21/2024 15:54	0.0145	0.0115	-0.0030	0	0	0
2/21/2024 15:55	0.0143	0.0115	-0.0028	0	0	0
2/21/2024 15:56	0.0141	0.0114	-0.0027	0	0	0
2/21/2024 15:57	0.0140	0.0113	-0.0027	0	0	0
2/21/2024 15:58	0.0142	0.0112	-0.0030	0	0	0
2/21/2024 15:59	0.0137	0.0107	-0.0030	0	0	0
2/21/2024 16:00	0.0127	0.0107	-0.0020	0	0	0
2/21/2024 16:01	0.0125	0.0108	-0.0017	0	0	0
2/21/2024 16:02	0.0126	0.0110	-0.0016	0	0	0
2/21/2024 16:03	0.0129	0.0115	-0.0014	0	0	0
2/21/2024 16:04	0.0133	0.0116	-0.0017	0	0	0
2/21/2024 16:05		0.0122	-		0	-
2/21/2024 16:06		0.0124	-		0	-
2/21/2024 16:07		0.0124	-		0	-
2/21/2024 16:08		0.0123	-		0	-
2/21/2024 16:09		0.0123	-		0	-

Notes

Telemetry clock was not synchronized. Site work performed 09:00 - 11:33.

Upwind telemetry modem experienced connectivity issues on this day.

Particulate concentrations are in micrograms per cubic meter and shown as 15-minute time-weighted averages.

Volatile Organic Compounds (VOCs) concentrations are in parts per million and shown as 15-minute time-weighted averages.

Δ - Difference between upwind and downwind measurements.

Blank cells indicate readings were not uploaded via telemetry

- indicates Delta (Δ) could not be calculated

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 13:07	0.0140	0.0207	0.0067		0	-
2/22/2024 13:08	0.0155	0.0210	0.0055		0	-
2/22/2024 13:09	0.0163	0.0214	0.0051		0	-
2/22/2024 13:10	0.0168	0.0217	0.0049		0	-
2/22/2024 13:11	0.0170	0.0217	0.0047		0	-
2/22/2024 13:12	0.0168	0.0216	0.0048		0	-
2/22/2024 13:13	0.0167	0.0217	0.0050		0	-
2/22/2024 13:14	0.0175	0.0216	0.0041		0	-
2/22/2024 13:15	0.0176	0.0216	0.0040		0	-
2/22/2024 13:16	0.0174	0.0217	0.0043		0	-
2/22/2024 13:17	0.0172	0.0216	0.0044		0	-
2/22/2024 13:18	0.0170	0.0216	0.0046		0	-
2/22/2024 13:19	0.0168	0.0215	0.0047		0	-
2/22/2024 13:20	0.0167	0.0217	0.0050		0	-
2/22/2024 13:21	0.0167	0.0215	0.0048		0	-
2/22/2024 13:22	0.0168	0.0213	0.0045		0	-
2/22/2024 13:23	0.0168	0.0211	0.0043		0	-
2/22/2024 13:24	0.0168	0.0210	0.0042		0	-
2/22/2024 13:25	0.0169	0.0209	0.0040		0	-
2/22/2024 13:26	0.0170	0.0209	0.0039		0	-
2/22/2024 13:27	0.0175	0.0210	0.0035		0	-
2/22/2024 13:28	0.0179	0.0211	0.0032		0	-
2/22/2024 13:29	0.0178	0.0213	0.0035		0	-
2/22/2024 13:30	0.0180	0.0215	0.0035		0	-
2/22/2024 13:31	0.0183	0.0216	0.0033		0	-
2/22/2024 13:32	0.0188	0.0218	0.0030		0	-
2/22/2024 13:33	0.0193	0.0220	0.0027		0	-
2/22/2024 13:34	0.0197	0.0223	0.0026		0	-
2/22/2024 13:35	0.0202	0.0227	0.0025		0	-
2/22/2024 13:36	0.0206	0.0231	0.0025		0	-
2/22/2024 13:37	0.0210	0.0235	0.0025		0	-
2/22/2024 13:38	0.0213	0.0239	0.0026		0	-
2/22/2024 13:39	0.0216	0.0242	0.0026		0	-
2/22/2024 13:40	0.0219	0.0245	0.0026		0	-
2/22/2024 13:41	0.0221	0.0248	0.0027		0	-
2/22/2024 13:42	0.0223	0.0251	0.0028		0	-
2/22/2024 13:43	0.0224	0.0252	0.0028		0	-
2/22/2024 13:44	0.0225	0.0253	0.0028		0	-
2/22/2024 13:45	0.0226	0.0255	0.0029		0	-
2/22/2024 13:46	0.0227	0.0255	0.0028		0	-
2/22/2024 13:47	0.0228	0.0255	0.0027		0	-
2/22/2024 13:48	0.0227	0.0255	0.0028		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 13:49	0.0227	0.0254	0.0027		0	-
2/22/2024 13:50	0.0228	0.0253	0.0025		0	-
2/22/2024 13:51	0.0227	0.0252	0.0025		0	-
2/22/2024 13:52	0.0227	0.0251	0.0024		0	-
2/22/2024 13:53	0.0226	0.0249	0.0023		0	-
2/22/2024 13:54	0.0225	0.0247	0.0022		0	-
2/22/2024 13:55	0.0224	0.0246	0.0022		0	-
2/22/2024 13:56	0.0223	0.0245	0.0022		0	-
2/22/2024 13:57	0.0221	0.0243	0.0022		0	-
2/22/2024 13:58	0.0219	0.0242	0.0023		0	-
2/22/2024 13:59	0.0217	0.0240	0.0023		0	-
2/22/2024 14:00	0.0216	0.0238	0.0022		0	-
2/22/2024 14:01		0.0237	0.0237		0	-
2/22/2024 14:02	0.0214	0.0237	0.0023		0	-
2/22/2024 14:03	0.0214	0.0237	0.0023		0	-
2/22/2024 14:04	0.0216	0.0237	0.0021		0	-
2/22/2024 14:05	0.0218	0.0239	0.0021		0	-
2/22/2024 14:06	0.0219	0.0239	0.0020		0	-
2/22/2024 14:07	0.0221	0.0239	0.0018		0	-
2/22/2024 14:08	0.0221	0.0240	0.0019		0	-
2/22/2024 14:09	0.0223	0.0241	0.0018		0	-
2/22/2024 14:10	0.0226	0.0243	0.0017		0	-
2/22/2024 14:11	0.0231	0.0245	0.0014		0	-
2/22/2024 14:12	0.0233	0.0245	0.0012		0	-
2/22/2024 14:13	0.0237	0.0245	0.0008		0	-
2/22/2024 14:14	0.0241	0.0248	0.0007		0	-
2/22/2024 14:15	0.0246	0.0251	0.0005		0	-
2/22/2024 14:16	0.0246	0.0253	0.0007		0	-
2/22/2024 14:17	0.0249	0.0254	0.0005		0	-
2/22/2024 14:18	0.0254	0.0255	0.0001		0	-
2/22/2024 14:19	0.0255	0.0258	0.0003		0	-
2/22/2024 14:20	0.0253	0.0256	0.0003		0	-
2/22/2024 14:21	0.0257	0.0257	0.0000		0	-
2/22/2024 14:22	0.0259	0.0259	0.0000		0	-
2/22/2024 14:23	0.0261	0.0259	-0.0002		0	-
2/22/2024 14:24	0.0261	0.0260	-0.0001		0	-
2/22/2024 14:25	0.0262	0.0259	-0.0003		0	-
2/22/2024 14:26	0.0287	0.0268	-0.0019		0	-
2/22/2024 14:27	0.0289	0.0270	-0.0019		0	-
2/22/2024 14:28	0.0291	0.0270	-0.0021		0	-
2/22/2024 14:29	0.0290	0.0269	-0.0021		0	-
2/22/2024 14:30	0.0289	0.0267	-0.0022		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 14:31	0.0291	0.0267	-0.0024		0	-
2/22/2024 14:32	0.0295	0.0266	-0.0029		0	-
2/22/2024 14:33	0.0291	0.0265	-0.0026		0	-
2/22/2024 14:34	0.0293	0.0263	-0.0030		0	-
2/22/2024 14:35	0.0293	0.0262	-0.0031		0	-
2/22/2024 14:36	0.0297	0.0261	-0.0036		0	-
2/22/2024 14:37	0.0295	0.0260	-0.0035		0	-
2/22/2024 14:38	0.0295	0.0259	-0.0036		0	-
2/22/2024 14:39	0.0296	0.0258	-0.0038		0	-
2/22/2024 14:40	0.0301	0.0258	-0.0043		0	-
2/22/2024 14:41	0.0273	0.0246	-0.0027		0	-
2/22/2024 14:42	0.0290	0.0244	-0.0046		0	-
2/22/2024 14:43	0.0289	0.0245	-0.0044		0	-
2/22/2024 14:44	0.0289	0.0245	-0.0044		0	-
2/22/2024 14:45	0.0287	0.0244	-0.0043		0	-
2/22/2024 14:46	0.0284	0.0242	-0.0042		0	-
2/22/2024 14:47	0.0277	0.0242	-0.0035		0	-
2/22/2024 14:48	0.0275	0.0241	-0.0034		0	-
2/22/2024 14:49	0.0275	0.0241	-0.0034		0	-
2/22/2024 14:50	0.0276	0.0241	-0.0035		0	-
2/22/2024 14:51	0.0269	0.0240	-0.0029		0	-
2/22/2024 14:52	0.0270	0.0241	-0.0029		0	-
2/22/2024 14:53	0.0270	0.0242	-0.0028		0	-
2/22/2024 14:54	0.0279	0.0244	-0.0035		0	-
2/22/2024 14:55	0.0273	0.0242	-0.0031		0	-
2/22/2024 14:56	0.0273	0.0251	-0.0022		0	-
2/22/2024 14:57	0.0253	0.0251	-0.0002		0	-
2/22/2024 14:58	0.0249	0.0249	0.0000		0	-
2/22/2024 14:59	0.0245	0.0247	0.0002		0	-
2/22/2024 15:00	0.0248	0.0245	-0.0003		0	-
2/22/2024 15:01	0.0251	0.0245	-0.0006		0	-
2/22/2024 15:02	0.0251	0.0246	-0.0005		0	-
2/22/2024 15:03	0.0252	0.0246	-0.0006		0	-
2/22/2024 15:04	0.0255	0.0247	-0.0008		0	-
2/22/2024 15:05	0.0253	0.0247	-0.0006		0	-
2/22/2024 15:06	0.0253	0.0247	-0.0006		0	-
2/22/2024 15:07	0.0251	0.0245	-0.0006		0	-
2/22/2024 15:08	0.0255	0.0243	-0.0012		0	-
2/22/2024 15:09	0.0247	0.0239	-0.0008		0	-
2/22/2024 15:10	0.0247	0.0242	-0.0005		0	-
2/22/2024 15:11	0.0246	0.0231	-0.0015		0	-
2/22/2024 15:12	0.0246	0.0229	-0.0017		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 15:13	0.0247	0.0229	-0.0018		0	-
2/22/2024 15:14	0.0249	0.0229	-0.0020		0	-
2/22/2024 15:15	0.0246	0.0230	-0.0016		0	-
2/22/2024 15:16	0.0246	0.0227	-0.0019		0	-
2/22/2024 15:17	0.0243	0.0221	-0.0022		0	-
2/22/2024 15:18	0.0244	0.0217	-0.0027		0	-
2/22/2024 15:19	0.0242	0.0211	-0.0031		0	-
2/22/2024 15:20	0.0239	0.0209	-0.0030		0	-
2/22/2024 15:21	0.0235	0.0207	-0.0028		0	-
2/22/2024 15:22	0.0233	0.0205	-0.0028		0	-
2/22/2024 15:23	0.0228	0.0203	-0.0025		0	-
2/22/2024 15:24	0.0224	0.0200	-0.0024		0	-
2/22/2024 15:25	0.0219	0.0205	-0.0014		0	-
2/22/2024 15:26	0.0218	0.0203	-0.0015		0	-
2/22/2024 15:27	0.0219	0.0205	-0.0014		0	-
2/22/2024 15:28	0.0219	0.0203	-0.0016		0	-
2/22/2024 15:29	0.0217	0.0201	-0.0016		0	-
2/22/2024 15:30	0.0217	0.0201	-0.0016		0	-
2/22/2024 15:31	0.0213	0.0201	-0.0012		0	-
2/22/2024 15:32	0.0215	0.0203	-0.0012		0	-
2/22/2024 15:33	0.0216	0.0205	-0.0011		0	-
2/22/2024 15:34	0.0215	0.0207	-0.0008		0	-
2/22/2024 15:35	0.0217	0.0209	-0.0008		0	-
2/22/2024 15:36	0.0225	0.0213	-0.0012		0	-
2/22/2024 15:37	0.0233	0.0218	-0.0015		0.07	-
2/22/2024 15:38	0.0239	0.0222	-0.0017		0.07	-
2/22/2024 15:39	0.0240	0.0225	-0.0015		0.07	-
2/22/2024 15:40	0.0242	0.0216	-0.0026		0.07	-
2/22/2024 15:41	0.0239	0.0215	-0.0024		0.07	-
2/22/2024 15:42	0.0241	0.0211	-0.0030		0.07	-
2/22/2024 15:43	0.0252	0.0213	-0.0039		0.07	-
2/22/2024 15:44	0.0257	0.0215	-0.0042		0.07	-
2/22/2024 15:45	0.0259	0.0213	-0.0046		0.07	-
2/22/2024 15:46	0.0259	0.0212	-0.0047		0.07	-
2/22/2024 15:47	0.0259	0.0211	-0.0048		0.07	-
2/22/2024 15:48	0.0258	0.0214	-0.0044		0.07	-
2/22/2024 15:49	0.0255	0.0215	-0.0040		0.07	-
2/22/2024 15:50	0.0254	0.0214	-0.0040		0.07	-
2/22/2024 15:51	0.0250	0.0211	-0.0039		0.07	-
2/22/2024 15:52	0.0245	0.0207	-0.0038		0.01	-
2/22/2024 15:53	0.0240	0.0205	-0.0035		0	-
2/22/2024 15:54	0.0240	0.0206	-0.0034		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 15:55	0.0241	0.0207	-0.0034		0	-
2/22/2024 15:56	0.0244	0.0210	-0.0034		0.01	-
2/22/2024 15:57	0.0243	0.0213	-0.0030		0.01	-
2/22/2024 15:58	0.0229	0.0217	-0.0012		0.01	-
2/22/2024 15:59	0.0225	0.0215	-0.0010		0.01	-
2/22/2024 16:00	0.0225	0.0217	-0.0008		0.01	-
2/22/2024 16:01	0.0226	0.0219	-0.0007		0.01	-
2/22/2024 16:02	0.0224	0.0219	-0.0005		0.01	-
2/22/2024 16:03	0.0225	0.0219	-0.0006		0.01	-
2/22/2024 16:04	0.0224	0.0217	-0.0007		0.01	-
2/22/2024 16:05	0.0226	0.0216	-0.0010		0.01	-
2/22/2024 16:06	0.0229	0.0215	-0.0014		0.01	-
2/22/2024 16:07	0.0232	0.0214	-0.0018		0.01	-
2/22/2024 16:08	0.0230	0.0212	-0.0018		0.01	-
2/22/2024 16:09	0.0227	0.0210	-0.0017		0.01	-
2/22/2024 16:10	0.0230	0.0207	-0.0023		0.01	-
2/22/2024 16:11	0.0228	0.0206	-0.0022		0	-
2/22/2024 16:12	0.0227	0.0210	-0.0017		0	-
2/22/2024 16:13	0.0229	0.0209	-0.0020		0	-
2/22/2024 16:14	0.0247	0.0211	-0.0036		0	-
2/22/2024 16:15	0.0246	0.0207	-0.0039		0	-
2/22/2024 16:16	0.0243	0.0205	-0.0038		0	-
2/22/2024 16:17	0.0245	0.0205	-0.0040		0	-
2/22/2024 16:18	0.0243	0.0203	-0.0040		0	-
2/22/2024 16:19	0.0243	0.0204	-0.0039		0	-
2/22/2024 16:20	0.0241	0.0203	-0.0038		0	-
2/22/2024 16:21	0.0239	0.0208	-0.0031		0	-
2/22/2024 16:22	0.0233	0.0210	-0.0023		0	-
2/22/2024 16:23	0.0233	0.0214	-0.0019		0	-
2/22/2024 16:24	0.0233	0.0213	-0.0020		0	-
2/22/2024 16:25	0.0236	0.0214	-0.0022		0	-
2/22/2024 16:26	0.0238	0.0214	-0.0024		0	-
2/22/2024 16:27	0.0239	0.0208	-0.0031		0	-
2/22/2024 16:28	0.0245	0.0204	-0.0041		0	-
2/22/2024 16:29	0.0228	0.0203	-0.0025		0	-
2/22/2024 16:30	0.0233	0.0205	-0.0028		0	-
2/22/2024 16:31	0.0248	0.0207	-0.0041		0	-
2/22/2024 16:32	0.0248	0.0207	-0.0041		0	-
2/22/2024 16:33	0.0249	0.0207	-0.0042		0	-
2/22/2024 16:34	0.0257	0.0206	-0.0051		0	-
2/22/2024 16:35	0.0257	0.0207	-0.0050		0	-
2/22/2024 16:36	0.0255	0.0202	-0.0053		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 16:37	0.0258	0.0199	-0.0059		0	-
2/22/2024 16:38	0.0261	0.0195	-0.0066		0	-
2/22/2024 16:39	0.0265	0.0196	-0.0069		0	-
2/22/2024 16:40	0.0261	0.0195	-0.0066		0	-
2/22/2024 16:41	0.0259	0.0199	-0.0060		0	-
2/22/2024 16:42	0.0259	0.0199	-0.0060		0	-
2/22/2024 16:43	0.0253	0.0199	-0.0054		0	-
2/22/2024 16:44	0.0254	0.0199	-0.0055		0	-
2/22/2024 16:45	0.0250	0.0201	-0.0049		0	-
2/22/2024 16:46	0.0237	0.0199	-0.0038		0	-
2/22/2024 16:47	0.0239	0.0201	-0.0038		0	-
2/22/2024 16:48	0.0241	0.0205	-0.0036		0	-
2/22/2024 16:49	0.0237	0.0207	-0.0030		0	-
2/22/2024 16:50	0.0237	0.0208	-0.0029		0	-
2/22/2024 16:51	0.0239	0.0208	-0.0031		0	-
2/22/2024 16:52	0.0237	0.0208	-0.0029		0	-
2/22/2024 16:53	0.0235	0.0209	-0.0026		0	-
2/22/2024 16:54	0.0232	0.0207	-0.0025		0	-
2/22/2024 16:55	0.0231	0.0207	-0.0024		0	-
2/22/2024 16:56	0.0231	0.0203	-0.0028		0	-
2/22/2024 16:57	0.0230	0.0201	-0.0029		0	-
2/22/2024 16:58	0.0228	0.0199	-0.0029		0	-
2/22/2024 16:59	0.0225	0.0197	-0.0028		0	-
2/22/2024 17:00	0.0223	0.0195	-0.0028		0	-
2/22/2024 17:01	0.0227	0.0197	-0.0030		0	-
2/22/2024 17:02	0.0224	0.0195	-0.0029		0	-
2/22/2024 17:03	0.0223	0.0199	-0.0024		0	-
2/22/2024 17:04	0.0222	0.0196	-0.0026		0	-
2/22/2024 17:05	0.0222	0.0195	-0.0027		0	-
2/22/2024 17:06	0.0223	0.0197	-0.0026		0	-
2/22/2024 17:07	0.0230	0.0202	-0.0028		0	-
2/22/2024 17:08	0.0241	0.0204	-0.0037		0	-
2/22/2024 17:09	0.0244	0.0207	-0.0037		0	-
2/22/2024 17:10	0.0243	0.0210	-0.0033		0	-
2/22/2024 17:11	0.0245	0.0217	-0.0028		0	-
2/22/2024 17:12	0.0246	0.0220	-0.0026		0	-
2/22/2024 17:13	0.0247	0.0220	-0.0027		0	-
2/22/2024 17:14	0.0248	0.0222	-0.0026		0	-
2/22/2024 17:15	0.0247	0.0221	-0.0026		0	-
2/22/2024 17:16	0.0245	0.0225	-0.0020		0	-
2/22/2024 17:17	0.0255	0.0231	-0.0024		0	-
2/22/2024 17:18	0.0258	0.0229	-0.0029		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 17:19	0.0261	0.0230	-0.0031		0	-
2/22/2024 17:20	0.0261	0.0231	-0.0030		0	-
2/22/2024 17:21	0.0260	0.0230	-0.0030		0	-
2/22/2024 17:22	0.0254	0.0228	-0.0026		0	-
2/22/2024 17:23	0.0250	0.0226	-0.0024		0	-
2/22/2024 17:24	0.0253	0.0223	-0.0030		0	-
2/22/2024 17:25	0.0253	0.0218	-0.0035		0	-
2/22/2024 17:26	0.0250	0.0209	-0.0041		0	-
2/22/2024 17:27	0.0251	0.0207	-0.0044		0	-
2/22/2024 17:28	0.0251	0.0209	-0.0042		0	-
2/22/2024 17:29	0.0250	0.0207	-0.0043		0	-
2/22/2024 17:30	0.0250	0.0207	-0.0043		0	-
2/22/2024 17:31	0.0250	0.0202	-0.0048		0	-
2/22/2024 17:32	0.0247	0.0197	-0.0050		0	-
2/22/2024 17:33	0.0244	0.0196	-0.0048		0	-
2/22/2024 17:34	0.0242	0.0196	-0.0046		0	-
2/22/2024 17:35	0.0241	0.0195	-0.0046		0	-
2/22/2024 17:36	0.0239	0.0194	-0.0045		0	-
2/22/2024 17:37	0.0238	0.0190	-0.0048		0	-
2/22/2024 17:38	0.0238	0.0189	-0.0049		0	-
2/22/2024 17:39	0.0236	0.0198	-0.0038		0	-
2/22/2024 17:40	0.0237	0.0200	-0.0037		0	-
2/22/2024 17:41	0.0238	0.0200	-0.0038		0	-
2/22/2024 17:42	0.0239	0.0202	-0.0037		0	-
2/22/2024 17:43	0.0256	0.0201	-0.0055		0	-
2/22/2024 17:44	0.0277	0.0208	-0.0069		0	-
2/22/2024 17:45	0.0279	0.0206	-0.0073		0	-
2/22/2024 17:46	0.0282	0.0205	-0.0077		0	-
2/22/2024 17:47	0.0274	0.0201	-0.0073		0	-
2/22/2024 17:48	0.0273	0.0195	-0.0078		0	-
2/22/2024 17:49	0.0275	0.0195	-0.0080		0	-
2/22/2024 17:50	0.0277	0.0194	-0.0083		0	-
2/22/2024 17:51	0.0280	0.0193	-0.0087		0	-
2/22/2024 17:52	0.0285	0.0195	-0.0090		0	-
2/22/2024 17:53	0.0278	0.0194	-0.0084		0	-
2/22/2024 17:54	0.0276	0.0187	-0.0089		0	-
2/22/2024 17:55	0.0279	0.0187	-0.0092		0	-
2/22/2024 17:56	0.0281	0.0188	-0.0093		0	-
2/22/2024 17:57	0.0279	0.0199	-0.0080		0	-
2/22/2024 17:58	0.0262	0.0197	-0.0065		0	-
2/22/2024 17:59	0.0243	0.0190	-0.0053		0	-
2/22/2024 18:00	0.0243	0.0193	-0.0050		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 18:01	0.0239	0.0192	-0.0047		0	-
2/22/2024 18:02	0.0239	0.0192	-0.0047		0	-
2/22/2024 18:03	0.0242	0.0193	-0.0049		0	-
2/22/2024 18:04	0.0240	0.0193	-0.0047		0	-
2/22/2024 18:05	0.0239	0.0195	-0.0044		0	-
2/22/2024 18:06	0.0234	0.0193	-0.0041		0	-
2/22/2024 18:07	0.0231	0.0191	-0.0040		0	-
2/22/2024 18:08	0.0231	0.0190	-0.0041		0	-
2/22/2024 18:09	0.0230	0.0187	-0.0043		0	-
2/22/2024 18:10	0.0227	0.0185	-0.0042		0	-
2/22/2024 18:11	0.0225	0.0184	-0.0041		0	-
2/22/2024 18:12	0.0224	0.0171	-0.0053		0	-
2/22/2024 18:13	0.0223	0.0172	-0.0051		0	-
2/22/2024 18:14	0.0223	0.0171	-0.0052		0	-
2/22/2024 18:15	0.0226	0.0170	-0.0056		0	-
2/22/2024 18:16	0.0226	0.0170	-0.0056		0	-
2/22/2024 18:17	0.0225	0.0170	-0.0055		0	-
2/22/2024 18:18	0.0223	0.0171	-0.0052		0	-
2/22/2024 18:19	0.0221	0.0169	-0.0052		0	-
2/22/2024 18:20	0.0220	0.0171	-0.0049		0	-
2/22/2024 18:21	0.0223	0.0174	-0.0049		0	-
2/22/2024 18:22	0.0221	0.0175	-0.0046		0	-
2/22/2024 18:23	0.0223	0.0176	-0.0047		0	-
2/22/2024 18:24	0.0225	0.0177	-0.0048		0	-
2/22/2024 18:25	0.0227	0.0198	-0.0029		0	-
2/22/2024 18:26	0.0229	0.0199	-0.0030		0	-
2/22/2024 18:27	0.0232	0.0199	-0.0033		0	-
2/22/2024 18:28	0.0233	0.0197	-0.0036		0	-
2/22/2024 18:29	0.0233	0.0198	-0.0035		0	-
2/22/2024 18:30	0.0229	0.0196	-0.0033		0	-
2/22/2024 18:31	0.0229	0.0196	-0.0033		0	-
2/22/2024 18:32	0.0234	0.0197	-0.0037		0	-
2/22/2024 18:33	0.0236	0.0197	-0.0039		0	-
2/22/2024 18:34	0.0236	0.0202	-0.0034		0	-
2/22/2024 18:35	0.0236	0.0200	-0.0036		0	-
2/22/2024 18:36	0.0233	0.0197	-0.0036		0	-
2/22/2024 18:37	0.0233	0.0196	-0.0037		0	-
2/22/2024 18:38	0.0235	0.0198	-0.0037		0	-
2/22/2024 18:39	0.0233	0.0199	-0.0034		0	-
2/22/2024 18:40	0.0233	0.0182	-0.0051		0	-
2/22/2024 18:41	0.0233	0.0184	-0.0049		0	-
2/22/2024 18:42	0.0231	0.0186	-0.0045		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 18:43	0.0231	0.0189	-0.0042		0	-
2/22/2024 18:44	0.0232	0.0192	-0.0040		0	-
2/22/2024 18:45	0.0233	0.0196	-0.0037		0	-
2/22/2024 18:46	0.0235	0.0199	-0.0036		0	-
2/22/2024 18:47	0.0233	0.0203	-0.0030		0	-
2/22/2024 18:48	0.0231	0.0207	-0.0024		0	-
2/22/2024 18:49	0.0231	0.0201	-0.0030		0	-
2/22/2024 18:50	0.0231	0.0200	-0.0031		0	-
2/22/2024 18:51	0.0235	0.0202	-0.0033		0	-
2/22/2024 18:52	0.0239	0.0206	-0.0033		0	-
2/22/2024 18:53	0.0237	0.0205	-0.0032		0	-
2/22/2024 18:54	0.0235	0.0208	-0.0027		0	-
2/22/2024 18:55	0.0235	0.0209	-0.0026		0	-
2/22/2024 18:56	0.0235	0.0207	-0.0028		0	-
2/22/2024 18:57	0.0233	0.0208	-0.0025		0	-
2/22/2024 18:58	0.0232	0.0207	-0.0025		0	-
2/22/2024 18:59	0.0229	0.0203	-0.0026		0	-
2/22/2024 19:00	0.0230	0.0201	-0.0029		0	-
2/22/2024 19:01	0.0227	0.0197	-0.0030		0	-
2/22/2024 19:02	0.0224	0.0193	-0.0031		0	-
2/22/2024 19:03	0.0226	0.0188	-0.0038		0	-
2/22/2024 19:04	0.0228	0.0188	-0.0040		0	-
2/22/2024 19:05	0.0228	0.0189	-0.0039		0	-
2/22/2024 19:06	0.0225	0.0189	-0.0036		0	-
2/22/2024 19:07	0.0222	0.0189	-0.0033		0	-
2/22/2024 19:08	0.0225	0.0190	-0.0035		0	-
2/22/2024 19:09	0.0230	0.0190	-0.0040		0	-
2/22/2024 19:10	0.0233	0.0190	-0.0043		0	-
2/22/2024 19:11	0.0232	0.0190	-0.0042		0	-
2/22/2024 19:12	0.0233	0.0191	-0.0042		0	-
2/22/2024 19:13	0.0233	0.0191	-0.0042		0	-
2/22/2024 19:14	0.0233	0.0191	-0.0042		0	-
2/22/2024 19:15	0.0231	0.0189	-0.0042		0	-
2/22/2024 19:16	0.0232	0.0192	-0.0040		0	-
2/22/2024 19:17	0.0233	0.0191	-0.0042		0	-
2/22/2024 19:18	0.0241	0.0207	-0.0034		0	-
2/22/2024 19:19	0.0244	0.0211	-0.0033		0	-
2/22/2024 19:20	0.0247	0.0212	-0.0035		0	-
2/22/2024 19:21	0.0247	0.0211	-0.0036		0	-
2/22/2024 19:22	0.0247	0.0209	-0.0038		0	-
2/22/2024 19:23	0.0245	0.0210	-0.0035		0	-
2/22/2024 19:24	0.0242	0.0205	-0.0037		0	-

Community Air Monitoring Program Summary

Former Chromalloy Facility (NYSDEC Site No. 344039)

West Nyack, New York

2/22/2024						
	Upwind Particulate Matter Concentration	Downwind Particulate Matter Concentration		Upwind VOC Concentration	Downwind VOC Concentration	
Date/Time	Serial No. 0B352750	Serial No. 0B345893	Δ	Serial No. 0B352750	Serial No. 0B345893	Δ
2/22/2024 19:25	0.0245	0.0207	-0.0038		0	-
2/22/2024 19:26	0.0248	0.0208	-0.0040		0	-
2/22/2024 19:27	0.0246	0.0205	-0.0041		0	-
2/22/2024 19:28	0.0250	0.0205	-0.0045		0	-
2/22/2024 19:29	0.0255	0.0207	-0.0048		0	-
2/22/2024 19:30	0.0255	0.0207	-0.0048		0	-
2/22/2024 19:31	0.0259	0.0205	-0.0054		0	-
2/22/2024 19:32	0.0265	0.0209	-0.0056		0	-
2/22/2024 19:33	0.0257	0.0193	-0.0064		0	-
2/22/2024 19:34	0.0251	0.0189	-0.0062		0	-
2/22/2024 19:35	0.0249	0.0185	-0.0064		0	-
2/22/2024 19:36	0.0250	0.0185	-0.0065		0	-
2/22/2024 19:37	0.0248	0.0183	-0.0065		0	-
2/22/2024 19:38	0.0245	0.0179	-0.0066		0	-
2/22/2024 19:39	0.0244	0.0177	-0.0067		0.03	-
2/22/2024 19:40	0.0237	0.0170	-0.0067		0.04	-
2/22/2024 19:41	0.0231	0.0165	-0.0066		0.04	-
2/22/2024 19:42	0.0231	0.0162	-0.0069		0.04	-
2/22/2024 19:43	0.0227	0.0159	-0.0068		0.05	-
2/22/2024 19:44	0.0221	0.0155	-0.0066		0.05	-
2/22/2024 19:45	0.0219	0.0154	-0.0065		0.07	-
2/22/2024 19:46	0.0213	0.0153	-0.0060		0.09	-
2/22/2024 19:47	0.0209	0.0148	-0.0061		0.17	-
2/22/2024 19:48	0.0205	0.0146	-0.0059		0.25	-
2/22/2024 19:49	0.0205	0.0146	-0.0059		0.25	-
2/22/2024 19:50	0.0203		-			-
2/22/2024 19:51	0.0200		-			-
2/22/2024 19:52	0.0199		-			-
2/22/2024 19:53	0.0197		-			-

Notes

Telemetry clock was not synchronized. Site work performed 09:00 - 11:33.

Upwind telemetry modem experienced connectivity issues on this day.

Particulate concentrations are in micrograms per cubic meter and shown as 15-minute time-weighted averages.

Volatile Organic Compounds (VOCs) concentrations are in parts per million and shown as 15-minute time-weighted averages.

Δ - Difference between upwind and downwind measurements.

Blank cells indicate readings were not uploaded via telemetry

- indicates Delta (Δ) could not be calculated

APPENDIX F

ANALYTICAL REPORT

Lab Number:	L2409772
Client:	TRC Solutions 3 Corporate Drive Suite 202 Clifton Park, NY 12065
ATTN:	Justin King
Phone:	(518) 688-3109
Project Name:	FORMER CHROMALLOY
Project Number:	190273.2021
Report Date:	03/01/24

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0826), IL (200077), IN (C-MA-03), KY (KY98045), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), OH (CL108), OR (MA-1316), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #525-23-122-91930).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2409772-01	FILL_20240222	SOIL	WEST NYACK, NY	02/22/24 13:45	02/22/24

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
Project Number:	190273.2021	**Report Date:**	03/01/24

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
Project Number:	190273.2021	**Report Date:**	03/01/24

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

Total Metals

L2409772-01: The sample has elevated detection limits for all elements, with the exception of mercury, due to the dilution required by the sample matrix.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Cristin Walker

Title: Technical Director/Representative Date: 03/01/24

ORGANICS

VOLATILES

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY
Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 1,8260D
Analytical Date: 02/26/24 14:58
Analyst: AJK
Percent Solids: 97%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by EPA 5035 Low - Westborough Lab						
Methylene chloride	ND		ug/kg	5.4	2.5	1
1,1-Dichloroethane	ND		ug/kg	1.1	0.16	1
Chloroform	ND		ug/kg	1.6	0.15	1
Carbon tetrachloride	ND		ug/kg	1.1	0.25	1
1,2-Dichloropropane	ND		ug/kg	1.1	0.14	1
Dibromochloromethane	ND		ug/kg	1.1	0.15	1
1,1,2-Trichloroethane	ND		ug/kg	1.1	0.29	1
Tetrachloroethene	ND		ug/kg	0.54	0.21	1
Chlorobenzene	ND		ug/kg	0.54	0.14	1
Trichlorofluoromethane	ND		ug/kg	4.3	0.75	1
1,2-Dichloroethane	ND		ug/kg	1.1	0.28	1
1,1,1-Trichloroethane	ND		ug/kg	0.54	0.18	1
Bromodichloromethane	ND		ug/kg	0.54	0.12	1
trans-1,3-Dichloropropene	ND		ug/kg	1.1	0.30	1
cis-1,3-Dichloropropene	ND		ug/kg	0.54	0.17	1
Bromoform	ND		ug/kg	4.3	0.27	1
1,1,2,2-Tetrachloroethane	ND		ug/kg	0.54	0.18	1
Benzene	ND		ug/kg	0.54	0.18	1
Toluene	ND		ug/kg	1.1	0.59	1
Ethylbenzene	ND		ug/kg	1.1	0.15	1
Chloromethane	ND		ug/kg	4.3	1.0	1
Bromomethane	ND		ug/kg	2.2	0.63	1
Vinyl chloride	ND		ug/kg	1.1	0.36	1
Chloroethane	ND		ug/kg	2.2	0.49	1
1,1-Dichloroethene	ND		ug/kg	1.1	0.26	1
trans-1,2-Dichloroethene	ND		ug/kg	1.6	0.15	1
Trichloroethene	ND		ug/kg	0.54	0.15	1
1,2-Dichlorobenzene	ND		ug/kg	2.2	0.16	1

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY
Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by EPA 5035 Low - Westborough Lab						
1,3-Dichlorobenzene	ND		ug/kg	2.2	0.16	1
1,4-Dichlorobenzene	ND		ug/kg	2.2	0.18	1
Methyl tert butyl ether	ND		ug/kg	2.2	0.22	1
p/m-Xylene	ND		ug/kg	2.2	0.61	1
o-Xylene	ND		ug/kg	1.1	0.32	1
cis-1,2-Dichloroethene	ND		ug/kg	1.1	0.19	1
Styrene	ND		ug/kg	1.1	0.21	1
Dichlorodifluoromethane	ND		ug/kg	11	0.99	1
Acetone	ND		ug/kg	11	5.2	1
Carbon disulfide	ND		ug/kg	11	4.9	1
2-Butanone	ND		ug/kg	11	2.4	1
4-Methyl-2-pentanone	ND		ug/kg	11	1.4	1
2-Hexanone	ND		ug/kg	11	1.3	1
Bromochloromethane	ND		ug/kg	2.2	0.22	1
1,2-Dibromoethane	ND		ug/kg	1.1	0.30	1
1,2-Dibromo-3-chloropropane	ND		ug/kg	3.2	1.1	1
Isopropylbenzene	ND		ug/kg	1.1	0.12	1
1,2,3-Trichlorobenzene	ND		ug/kg	2.2	0.35	1
1,2,4-Trichlorobenzene	ND		ug/kg	2.2	0.29	1
Methyl Acetate	ND		ug/kg	4.3	1.0	1
Cyclohexane	ND		ug/kg	11	0.59	1
1,4-Dioxane	ND		ug/kg	87	38.	1
Freon-113	ND		ug/kg	4.3	0.75	1
Methyl cyclohexane	ND		ug/kg	4.3	0.65	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	97		70-130
Toluene-d8	99		70-130
4-Bromofluorobenzene	100		70-130
Dibromofluoromethane	104		70-130

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 02/26/24 08:27
Analyst: MKS

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by EPA 5035 Low - Westborough Lab for sample(s): 01 Batch: WG1889794-5					
Methylene chloride	ND		ug/kg	5.0	2.3
1,1-Dichloroethane	ND		ug/kg	1.0	0.14
Chloroform	ND		ug/kg	1.5	0.14
Carbon tetrachloride	ND		ug/kg	1.0	0.23
1,2-Dichloropropane	ND		ug/kg	1.0	0.12
Dibromochloromethane	ND		ug/kg	1.0	0.14
1,1,2-Trichloroethane	ND		ug/kg	1.0	0.27
Tetrachloroethene	ND		ug/kg	0.50	0.20
Chlorobenzene	ND		ug/kg	0.50	0.13
Trichlorofluoromethane	ND		ug/kg	4.0	0.70
1,2-Dichloroethane	ND		ug/kg	1.0	0.26
1,1,1-Trichloroethane	ND		ug/kg	0.50	0.17
Bromodichloromethane	ND		ug/kg	0.50	0.11
trans-1,3-Dichloropropene	ND		ug/kg	1.0	0.27
cis-1,3-Dichloropropene	ND		ug/kg	0.50	0.16
Bromoform	ND		ug/kg	4.0	0.25
1,1,2,2-Tetrachloroethane	ND		ug/kg	0.50	0.17
Benzene	ND		ug/kg	0.50	0.17
Toluene	ND		ug/kg	1.0	0.54
Ethylbenzene	ND		ug/kg	1.0	0.14
Chloromethane	ND		ug/kg	4.0	0.93
Bromomethane	ND		ug/kg	2.0	0.58
Vinyl chloride	ND		ug/kg	1.0	0.34
Chloroethane	ND		ug/kg	2.0	0.45
1,1-Dichloroethene	ND		ug/kg	1.0	0.24
trans-1,2-Dichloroethene	ND		ug/kg	1.5	0.14
Trichloroethene	ND		ug/kg	0.50	0.14
1,2-Dichlorobenzene	ND		ug/kg	2.0	0.14
1,3-Dichlorobenzene	ND		ug/kg	2.0	0.15

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 02/26/24 08:27
Analyst: MKS

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by EPA 5035 Low - Westborough Lab for sample(s): 01 Batch: WG1889794-5					
1,4-Dichlorobenzene	ND		ug/kg	2.0	0.17
Methyl tert butyl ether	ND		ug/kg	2.0	0.20
p/m-Xylene	ND		ug/kg	2.0	0.56
o-Xylene	ND		ug/kg	1.0	0.29
cis-1,2-Dichloroethene	ND		ug/kg	1.0	0.18
Styrene	ND		ug/kg	1.0	0.20
Dichlorodifluoromethane	ND		ug/kg	10	0.92
Acetone	ND		ug/kg	10	4.8
Carbon disulfide	ND		ug/kg	10	4.6
2-Butanone	ND		ug/kg	10	2.2
4-Methyl-2-pentanone	ND		ug/kg	10	1.3
2-Hexanone	ND		ug/kg	10	1.2
Bromochloromethane	ND		ug/kg	2.0	0.20
1,2-Dibromoethane	ND		ug/kg	1.0	0.28
1,2-Dibromo-3-chloropropane	ND		ug/kg	3.0	1.0
Isopropylbenzene	ND		ug/kg	1.0	0.11
1,2,3-Trichlorobenzene	ND		ug/kg	2.0	0.32
1,2,4-Trichlorobenzene	ND		ug/kg	2.0	0.27
Methyl Acetate	ND		ug/kg	4.0	0.95
Cyclohexane	ND		ug/kg	10	0.54
1,4-Dioxane	ND		ug/kg	80	35.
Freon-113	ND		ug/kg	4.0	0.69
Methyl cyclohexane	ND		ug/kg	4.0	0.60

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 02/26/24 08:27
Analyst: MKS

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by EPA 5035 Low - Westborough Lab for sample(s): 01 Batch: WG1889794-5					

Surrogate	%Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	111		70-130
Toluene-d8	97		70-130
4-Bromofluorobenzene	96		70-130
Dibromofluoromethane	116		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by EPA 5035 Low - Westborough Lab Associated sample(s): 01 Batch: WG1889794-3 WG1889794-4								
Methylene chloride	98		96		70-130	2		30
1,1-Dichloroethane	105		96		70-130	9		30
Chloroform	101		99		70-130	2		30
Carbon tetrachloride	93		94		70-130	1		30
1,2-Dichloropropane	90		91		70-130	1		30
Dibromochloromethane	98		101		70-130	3		30
1,1,2-Trichloroethane	91		93		70-130	2		30
Tetrachloroethene	104		99		70-130	5		30
Chlorobenzene	94		91		70-130	3		30
Trichlorofluoromethane	118		120		70-139	2		30
1,2-Dichloroethane	92		96		70-130	4		30
1,1,1-Trichloroethane	98		98		70-130	0		30
Bromodichloromethane	92		95		70-130	3		30
trans-1,3-Dichloropropene	93		93		70-130	0		30
cis-1,3-Dichloropropene	93		96		70-130	3		30
Bromoform	94		95		70-130	1		30
1,1,2,2-Tetrachloroethane	89		89		70-130	0		30
Benzene	94		93		70-130	1		30
Toluene	94		90		70-130	4		30
Ethylbenzene	93		91		70-130	2		30
Chloromethane	100		95		52-130	5		30
Bromomethane	105		103		57-147	2		30
Vinyl chloride	114		105		67-130	8		30

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by EPA 5035 Low - Westborough Lab Associated sample(s): 01 Batch: WG1889794-3 WG1889794-4								
Chloroethane	114		117		50-151	3		30
1,1-Dichloroethene	96		119		65-135	21		30
trans-1,2-Dichloroethene	115		108		70-130	6		30
Trichloroethene	95		96		70-130	1		30
1,2-Dichlorobenzene	92		91		70-130	1		30
1,3-Dichlorobenzene	93		91		70-130	2		30
1,4-Dichlorobenzene	93		90		70-130	3		30
Methyl tert butyl ether	96		92		66-130	4		30
p/m-Xylene	94		92		70-130	2		30
o-Xylene	92		90		70-130	2		30
cis-1,2-Dichloroethene	109		102		70-130	7		30
Styrene	93		94		70-130	1		30
Dichlorodifluoromethane	105		95		30-146	10		30
Acetone	77		84		54-140	9		30
Carbon disulfide	86		110		59-130	24		30
2-Butanone	**67**	Q	75		70-130	11		30
4-Methyl-2-pentanone	76		81		70-130	6		30
2-Hexanone	71		77		70-130	8		30
Bromochloromethane	107		103		70-130	4		30
1,2-Dibromoethane	96		98		70-130	2		30
1,2-Dibromo-3-chloropropane	77		82		68-130	6		30
Isopropylbenzene	95		91		70-130	4		30
1,2,3-Trichlorobenzene	95		95		70-130	0		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by EPA 5035 Low - Westborough Lab Associated sample(s): 01 Batch: WG1889794-3 WG1889794-4								
1,2,4-Trichlorobenzene	99		97		70-130	2		30
Methyl Acetate	80		83		51-146	4		30
Cyclohexane	83		78		59-142	6		30
1,4-Dioxane	86		92		65-136	7		30
Freon-113	88		110		50-139	22		30
Methyl cyclohexane	87		84		70-130	4		30

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
1,2-Dichloroethane-d4	94		102		70-130
Toluene-d8	101		97		70-130
4-Bromofluorobenzene	99		97		70-130
Dibromofluoromethane	105		108		70-130

SEMIVOLATILES

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY

Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 1,8270E
Analytical Date: 02/26/24 03:40
Analyst: HNY
Percent Solids: 97%

Extraction Method: EPA 3546
Extraction Date: 02/25/24 04:50

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Semivolatile Organics by GC/MS - Westborough Lab						
Acenaphthene	ND		ug/kg	140	18.	1
Hexachlorobenzene	ND		ug/kg	100	19.	1
Bis(2-chloroethyl)ether	ND		ug/kg	150	23.	1
2-Chloronaphthalene	ND		ug/kg	170	17.	1
3,3'-Dichlorobenzidine	ND		ug/kg	170	45.	1
2,4-Dinitrotoluene	ND		ug/kg	170	34.	1
2,6-Dinitrotoluene	ND		ug/kg	170	29.	1
Fluoranthene	ND		ug/kg	100	19.	1
4-Chlorophenyl phenyl ether	ND		ug/kg	170	18.	1
4-Bromophenyl phenyl ether	ND		ug/kg	170	26.	1
Bis(2-chloroisopropyl)ether	ND		ug/kg	200	29.	1
Bis(2-chloroethoxy)methane	ND		ug/kg	180	17.	1
Hexachlorobutadiene	ND		ug/kg	170	25.	1
Hexachlorocyclopentadiene	ND		ug/kg	480	150	1
Hexachloroethane	ND		ug/kg	140	27.	1
Isophorone	ND		ug/kg	150	22.	1
Naphthalene	ND		ug/kg	170	21.	1
Nitrobenzene	ND		ug/kg	150	25.	1
NDPA/DPA	ND		ug/kg	140	19.	1
n-Nitrosodi-n-propylamine	ND		ug/kg	170	26.	1
Bis(2-ethylhexyl)phthalate	ND		ug/kg	170	58.	1
Butyl benzyl phthalate	ND		ug/kg	170	43.	1
Di-n-butylphthalate	ND		ug/kg	170	32.	1
Di-n-octylphthalate	ND		ug/kg	170	58.	1
Diethyl phthalate	ND		ug/kg	170	16.	1
Dimethyl phthalate	ND		ug/kg	170	36.	1
Benzo(a)anthracene	ND		ug/kg	100	19.	1
Benzo(a)pyrene	ND		ug/kg	140	41.	1

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01 Date Collected: 02/22/24 13:45

Client ID: FILL_20240222 Date Received: 02/22/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Semivolatile Organics by GC/MS - Westborough Lab						
Benzo(b)fluoranthene	ND		ug/kg	100	28.	1
Benzo(k)fluoranthene	ND		ug/kg	100	27.	1
Chrysene	ND		ug/kg	100	18.	1
Acenaphthylene	ND		ug/kg	140	26.	1
Anthracene	ND		ug/kg	100	33.	1
Benzo(ghi)perylene	ND		ug/kg	140	20.	1
Fluorene	ND		ug/kg	170	16.	1
Phenanthrene	ND		ug/kg	100	20.	1
Dibenzo(a,h)anthracene	ND		ug/kg	100	20.	1
Indeno(1,2,3-cd)pyrene	ND		ug/kg	140	24.	1
Pyrene	ND		ug/kg	100	17.	1
Biphenyl	ND		ug/kg	380	22.	1
4-Chloroaniline	ND		ug/kg	170	31.	1
2-Nitroaniline	ND		ug/kg	170	33.	1
3-Nitroaniline	ND		ug/kg	170	32.	1
4-Nitroaniline	ND		ug/kg	170	70.	1
Dibenzofuran	ND		ug/kg	170	16.	1
2-Methylnaphthalene	ND		ug/kg	200	20.	1
1,2,4,5-Tetrachlorobenzene	ND		ug/kg	170	18.	1
Acetophenone	ND		ug/kg	170	21.	1
2,4,6-Trichlorophenol	ND		ug/kg	100	32.	1
p-Chloro-m-cresol	ND		ug/kg	170	25.	1
2-Chlorophenol	ND		ug/kg	170	20.	1
2,4-Dichlorophenol	ND		ug/kg	150	27.	1
2,4-Dimethylphenol	ND		ug/kg	170	56.	1
2-Nitrophenol	ND		ug/kg	360	64.	1
4-Nitrophenol	ND		ug/kg	240	69.	1
2,4-Dinitrophenol	ND		ug/kg	810	79.	1
4,6-Dinitro-o-cresol	ND		ug/kg	440	81.	1
Pentachlorophenol	ND		ug/kg	140	37.	1
Phenol	ND		ug/kg	170	26.	1
2-Methylphenol	ND		ug/kg	170	26.	1
3-Methylphenol/4-Methylphenol	ND		ug/kg	240	26.	1
2,4,5-Trichlorophenol	ND		ug/kg	170	32.	1
Carbazole	ND		ug/kg	170	16.	1
Atrazine	ND		ug/kg	140	59.	1
Benzaldehyde	ND		ug/kg	220	46.	1

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01 Date Collected: 02/22/24 13:45

Client ID: FILL_20240222 Date Received: 02/22/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Semivolatile Organics by GC/MS - Westborough Lab						
Caprolactam	ND		ug/kg	170	51.	1
2,3,4,6-Tetrachlorophenol	ND		ug/kg	170	34.	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
2-Fluorophenol	65		25-120
Phenol-d6	68		10-120
Nitrobenzene-d5	63		23-120
2-Fluorobiphenyl	58		30-120
2,4,6-Tribromophenol	78		10-136
4-Terphenyl-d14	65		18-120

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270E
Analytical Date: 02/25/24 20:47
Analyst: IM

Extraction Method: EPA 3546
Extraction Date: 02/25/24 04:50

Parameter	Result	Qualifier	Units	RL	MDL
Semivolatile Organics by GC/MS - Westborough Lab for sample(s): 01 Batch: WG1888943-1					
Acenaphthene	ND		ug/kg	130	17.
Hexachlorobenzene	ND		ug/kg	97	18.
Bis(2-chloroethyl)ether	ND		ug/kg	140	22.
2-Chloronaphthalene	ND		ug/kg	160	16.
3,3'-Dichlorobenzidine	ND		ug/kg	160	43.
2,4-Dinitrotoluene	ND		ug/kg	160	32.
2,6-Dinitrotoluene	ND		ug/kg	160	28.
Fluoranthene	ND		ug/kg	97	18.
4-Chlorophenyl phenyl ether	ND		ug/kg	160	17.
4-Bromophenyl phenyl ether	ND		ug/kg	160	25.
Bis(2-chloroisopropyl)ether	ND		ug/kg	190	28.
Bis(2-chloroethoxy)methane	ND		ug/kg	170	16.
Hexachlorobutadiene	ND		ug/kg	160	24.
Hexachlorocyclopentadiene	ND		ug/kg	460	150
Hexachloroethane	ND		ug/kg	130	26.
Isophorone	ND		ug/kg	140	21.
Naphthalene	ND		ug/kg	160	20.
Nitrobenzene	ND		ug/kg	140	24.
NDPA/DPA	ND		ug/kg	130	18.
n-Nitrosodi-n-propylamine	ND		ug/kg	160	25.
Bis(2-ethylhexyl)phthalate	ND		ug/kg	160	56.
Butyl benzyl phthalate	ND		ug/kg	160	41.
Di-n-butylphthalate	ND		ug/kg	160	31.
Di-n-octylphthalate	ND		ug/kg	160	55.
Diethyl phthalate	ND		ug/kg	160	15.
Dimethyl phthalate	ND		ug/kg	160	34.
Benzo(a)anthracene	ND		ug/kg	97	18.
Benzo(a)pyrene	ND		ug/kg	130	40.
Benzo(b)fluoranthene	ND		ug/kg	97	27.

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270E
Analytical Date: 02/25/24 20:47
Analyst: IM

Extraction Method: EPA 3546
Extraction Date: 02/25/24 04:50

Parameter	Result	Qualifier	Units	RL	MDL
Semivolatile Organics by GC/MS - Westborough Lab for sample(s): 01 Batch: WG1888943-1					
Benzo(k)fluoranthene	ND		ug/kg	97	26.
Chrysene	ND		ug/kg	97	17.
Acenaphthylene	ND		ug/kg	130	25.
Anthracene	ND		ug/kg	97	32.
Benzo(ghi)perylene	ND		ug/kg	130	19.
Fluorene	ND		ug/kg	160	16.
Phenanthrene	ND		ug/kg	97	20.
Dibenzo(a,h)anthracene	ND		ug/kg	97	19.
Indeno(1,2,3-cd)pyrene	ND		ug/kg	130	22.
Pyrene	ND		ug/kg	97	16.
Biphenyl	ND		ug/kg	370	21.
4-Chloroaniline	ND		ug/kg	160	29.
2-Nitroaniline	ND		ug/kg	160	31.
3-Nitroaniline	ND		ug/kg	160	30.
4-Nitroaniline	ND		ug/kg	160	67.
Dibenzofuran	ND		ug/kg	160	15.
2-Methylnaphthalene	ND		ug/kg	190	20.
1,2,4,5-Tetrachlorobenzene	ND		ug/kg	160	17.
Acetophenone	ND		ug/kg	160	20.
2,4,6-Trichlorophenol	ND		ug/kg	97	31.
p-Chloro-m-cresol	ND		ug/kg	160	24.
2-Chlorophenol	ND		ug/kg	160	19.
2,4-Dichlorophenol	ND		ug/kg	140	26.
2,4-Dimethylphenol	ND		ug/kg	160	53.
2-Nitrophenol	ND		ug/kg	350	61.
4-Nitrophenol	ND		ug/kg	230	66.
2,4-Dinitrophenol	ND		ug/kg	780	75.
4,6-Dinitro-o-cresol	ND		ug/kg	420	78.
Pentachlorophenol	ND		ug/kg	130	36.

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8270E
Analytical Date: 02/25/24 20:47
Analyst: IM

Extraction Method: EPA 3546
Extraction Date: 02/25/24 04:50

Parameter	Result	Qualifier	Units	RL	MDL
Semivolatile Organics by GC/MS - Westborough Lab for sample(s): 01 Batch: WG1888943-1					
Phenol	ND		ug/kg	160	24.
2-Methylphenol	ND		ug/kg	160	25.
3-Methylphenol/4-Methylphenol	ND		ug/kg	230	25.
2,4,5-Trichlorophenol	ND		ug/kg	160	31.
Carbazole	ND		ug/kg	160	16.
Atrazine	ND		ug/kg	130	57.
Benzaldehyde	ND		ug/kg	210	44.
Caprolactam	ND		ug/kg	160	49.
2,3,4,6-Tetrachlorophenol	ND		ug/kg	160	33.

Surrogate	%Recovery	Qualifier	Acceptance Criteria
2-Fluorophenol	82		25-120
Phenol-d6	87		10-120
Nitrobenzene-d5	80		23-120
2-Fluorobiphenyl	74		30-120
2,4,6-Tribromophenol	92		10-136
4-Terphenyl-d14	80		18-120

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Semivolatile Organics by GC/MS - Westborough Lab Associated sample(s): 01 Batch: WG1888943-2 WG1888943-3								
Acenaphthene	61		59		31-137	3		50
Hexachlorobenzene	64		60		40-140	6		50
Bis(2-chloroethyl)ether	60		58		40-140	3		50
2-Chloronaphthalene	62		58		40-140	7		50
3,3'-Dichlorobenzidine	46		46		40-140	0		50
2,4-Dinitrotoluene	67		63		40-132	6		50
2,6-Dinitrotoluene	67		62		40-140	8		50
Fluoranthene	62		59		40-140	5		50
4-Chlorophenyl phenyl ether	61		57		40-140	7		50
4-Bromophenyl phenyl ether	64		59		40-140	8		50
Bis(2-chloroisopropyl)ether	41		40		40-140	2		50
Bis(2-chloroethoxy)methane	70		66		40-117	6		50
Hexachlorobutadiene	58		59		40-140	2		50
Hexachlorocyclopentadiene	80		77		40-140	4		50
Hexachloroethane	59		57		40-140	3		50
Isophorone	68		64		40-140	6		50
Naphthalene	59		56		40-140	5		50
Nitrobenzene	68		65		40-140	5		50
NDPA/DPA	63		62		36-157	2		50
n-Nitrosodi-n-propylamine	67		63		32-121	6		50
Bis(2-ethylhexyl)phthalate	71		71		40-140	0		50
Butyl benzyl phthalate	71		68		40-140	4		50
Di-n-butylphthalate	68		66		40-140	3		50

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Semivolatile Organics by GC/MS - Westborough Lab Associated sample(s): 01 Batch: WG1888943-2 WG1888943-3								
Di-n-octylphthalate	73		72		40-140	1		50
Diethyl phthalate	67		62		40-140	8		50
Dimethyl phthalate	66		58		40-140	13		50
Benzo(a)anthracene	59		57		40-140	3		50
Benzo(a)pyrene	59		59		40-140	0		50
Benzo(b)fluoranthene	57		56		40-140	2		50
Benzo(k)fluoranthene	60		59		40-140	2		50
Chrysene	56		57		40-140	2		50
Acenaphthylene	62		59		40-140	5		50
Anthracene	62		61		40-140	2		50
Benzo(ghi)perylene	57		57		40-140	0		50
Fluorene	62		59		40-140	5		50
Phenanthrene	60		58		40-140	3		50
Dibenzo(a,h)anthracene	56		55		40-140	2		50
Indeno(1,2,3-cd)pyrene	58		58		40-140	0		50
Pyrene	62		59		35-142	5		50
Biphenyl	64		61		37-127	5		50
4-Chloroaniline	57		55		40-140	4		50
2-Nitroaniline	72		66		47-134	9		50
3-Nitroaniline	53		49		26-129	8		50
4-Nitroaniline	64		61		41-125	5		50
Dibenzofuran	60		57		40-140	5		50
2-Methylnaphthalene	62		59		40-140	5		50

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Semivolatile Organics by GC/MS - Westborough Lab Associated sample(s): 01 Batch: WG1888943-2 WG1888943-3								
1,2,4,5-Tetrachlorobenzene	63		60		40-117	5		50
Acetophenone	69		66		14-144	4		50
2,4,6-Trichlorophenol	66		61		30-130	8		50
p-Chloro-m-cresol	72		66		26-103	9		50
2-Chlorophenol	65		62		25-102	5		50
2,4-Dichlorophenol	68		64		30-130	6		50
2,4-Dimethylphenol	81		75		30-130	8		50
2-Nitrophenol	70		65		30-130	7		50
4-Nitrophenol	72		68		11-114	6		50
2,4-Dinitrophenol	59		58		4-130	2		50
4,6-Dinitro-o-cresol	63		58		10-130	8		50
Pentachlorophenol	66		62		17-109	6		50
Phenol	70		66		26-90	6		50
2-Methylphenol	74		67		30-130.	10		50
3-Methylphenol/4-Methylphenol	74		69		30-130	7		50
2,4,5-Trichlorophenol	67		61		30-130	9		50
Carbazole	61		59		54-128	3		50
Atrazine	67		64		40-140	5		50
Benzaldehyde	68		64		40-140	6		50
Caprolactam	60		55		15-130	9		50
2,3,4,6-Tetrachlorophenol	66		63		40-140	5		50

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Semivolatile Organics by GC/MS - Westborough Lab Associated sample(s): 01 Batch: WG1888943-2 WG1888943-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
2-Fluorophenol	66		65		25-120
Phenol-d6	71		66		10-120
Nitrobenzene-d5	65		62		23-120
2-Fluorobiphenyl	60		55		30-120
2,4,6-Tribromophenol	71		68		10-136
4-Terphenyl-d14	60		58		18-120

PCBS

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY

Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 1,8082A
Analytical Date: 02/25/24 17:52
Analyst: MEO
Percent Solids: 97%

Extraction Method: EPA 3546
Extraction Date: 02/25/24 03:23
Cleanup Method: EPA 3665A
Cleanup Date: 02/25/24
Cleanup Method: EPA 3660B
Cleanup Date: 02/25/24

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
Polychlorinated Biphenyls by GC - Westborough Lab							
Aroclor 1016	ND		ug/kg	48.7	4.33	1	A
Aroclor 1221	ND		ug/kg	48.7	4.88	1	A
Aroclor 1232	ND		ug/kg	48.7	10.3	1	A
Aroclor 1242	ND		ug/kg	48.7	6.57	1	A
Aroclor 1248	8.08	J	ug/kg	48.7	7.31	1	B
Aroclor 1254	ND		ug/kg	48.7	5.33	1	A
Aroclor 1260	ND		ug/kg	48.7	9.01	1	A
Aroclor 1262	ND		ug/kg	48.7	6.19	1	A
Aroclor 1268	ND		ug/kg	48.7	5.05	1	A
PCBs, Total	8.08	J	ug/kg	48.7	4.33	1	B

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	56		30-150	A
Decachlorobiphenyl	58		30-150	A
2,4,5,6-Tetrachloro-m-xylene	60		30-150	B
Decachlorobiphenyl	58		30-150	B

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8082A
Analytical Date: 02/25/24 16:40
Analyst: MHG

Extraction Method: EPA 3546
Extraction Date: 02/25/24 03:23
Cleanup Method: EPA 3665A
Cleanup Date: 02/25/24
Cleanup Method: EPA 3660B
Cleanup Date: 02/25/24

Parameter	Result	Qualifier	Units	RL	MDL	Column
Polychlorinated Biphenyls by GC - Westborough Lab for sample(s): 01 Batch: WG1888938-1						
Aroclor 1016	ND		ug/kg	47.5	4.22	A
Aroclor 1221	ND		ug/kg	47.5	4.76	A
Aroclor 1232	ND		ug/kg	47.5	10.1	A
Aroclor 1242	ND		ug/kg	47.5	6.40	A
Aroclor 1248	11.0	J	ug/kg	47.5	7.12	A
Aroclor 1254	ND		ug/kg	47.5	5.19	A
Aroclor 1260	ND		ug/kg	47.5	8.77	A
Aroclor 1262	ND		ug/kg	47.5	6.03	A
Aroclor 1268	ND		ug/kg	47.5	4.92	A
PCBs, Total	11.0	J	ug/kg	47.5	4.22	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	66		30-150	A
Decachlorobiphenyl	71		30-150	A
2,4,5,6-Tetrachloro-m-xylene	72		30-150	B
Decachlorobiphenyl	73		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
Polychlorinated Biphenyls by GC - Westborough Lab Associated sample(s): 01 Batch: WG1888938-2 WG1888938-3									
Aroclor 1016	62		52		40-140	18		50	A
Aroclor 1260	57		51		40-140	11		50	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	59		53		30-150	A
Decachlorobiphenyl	60		52		30-150	A
2,4,5,6-Tetrachloro-m-xylene	62		55		30-150	B
Decachlorobiphenyl	60		53		30-150	B

PESTICIDES

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY

Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 1,8081B
Analytical Date: 02/26/24 11:24
Analyst: PEG
Percent Solids: 97%

Extraction Method: EPA 3546
Extraction Date: 02/25/24 01:38
Cleanup Method: EPA 3620B
Cleanup Date: 02/25/24
Cleanup Method: EPA 3660B
Cleanup Date: 02/25/24

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
Organochlorine Pesticides by GC - Westborough Lab							
Delta-BHC	ND		ug/kg	1.56	0.306	1	A
Lindane	ND		ug/kg	0.651	0.291	1	A
Alpha-BHC	ND		ug/kg	0.651	0.185	1	A
Beta-BHC	ND		ug/kg	1.56	0.592	1	A
Heptachlor	ND		ug/kg	0.781	0.350	1	A
Aldrin	ND		ug/kg	1.56	0.550	1	A
Heptachlor epoxide	ND		ug/kg	2.93	0.878	1	A
Endrin	ND		ug/kg	0.651	0.267	1	A
Endrin aldehyde	ND		ug/kg	1.95	0.683	1	A
Endrin ketone	ND		ug/kg	1.56	0.402	1	A
Dieldrin	ND		ug/kg	0.976	0.488	1	A
4,4'-DDE	ND		ug/kg	1.56	0.361	1	A
4,4'-DDD	ND		ug/kg	1.56	0.557	1	A
4,4'-DDT	ND		ug/kg	1.56	1.26	1	A
Endosulfan I	ND		ug/kg	1.56	0.369	1	A
Endosulfan II	ND		ug/kg	1.56	0.522	1	A
Endosulfan sulfate	ND		ug/kg	0.651	0.310	1	A
Methoxychlor	ND		ug/kg	2.93	0.911	1	A
Toxaphene	ND		ug/kg	29.3	8.20	1	A
cis-Chlordane	ND		ug/kg	1.95	0.544	1	A
trans-Chlordane	ND		ug/kg	1.95	0.515	1	A
Chlordane	ND		ug/kg	13.0	5.17	1	A

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01 Date Collected: 02/22/24 13:45

Client ID: FILL_20240222 Date Received: 02/22/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
Organochlorine Pesticides by GC - Westborough Lab							

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	64		30-150	A
Decachlorobiphenyl	84		30-150	A
2,4,5,6-Tetrachloro-m-xylene	61		30-150	B
Decachlorobiphenyl	77		30-150	B

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY

Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 1,8151A
Analytical Date: 02/27/24 22:31
Analyst: MMG
Percent Solids: 97%
Methylation Date: 02/27/24 12:11

Extraction Method: EPA 8151A
Extraction Date: 02/26/24 17:04

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Column
Chlorinated Herbicides by GC - Westborough Lab							
2,4-D	ND		ug/kg	169	10.6	1	A
2,4,5-T	ND		ug/kg	169	5.24	1	A
2,4,5-TP (Silvex)	ND		ug/kg	169	4.50	1	A

Surrogate	% Recovery	Qualifier	Acceptance Criteria	Column
DCAA	75		30-150	A
DCAA	74		30-150	B

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8081B
Analytical Date: 02/26/24 08:05
Analyst: PEG

Extraction Method: EPA 3546
Extraction Date: 02/25/24 01:38
Cleanup Method: EPA 3620B
Cleanup Date: 02/25/24
Cleanup Method: EPA 3660B
Cleanup Date: 02/25/24

Parameter	Result	Qualifier	Units	RL	MDL	Column
Organochlorine Pesticides by GC - Westborough Lab for sample(s): 01 Batch: WG1888932-1						
Delta-BHC	ND		ug/kg	1.57	0.307	A
Lindane	ND		ug/kg	0.654	0.292	A
Alpha-BHC	ND		ug/kg	0.654	0.186	A
Beta-BHC	ND		ug/kg	1.57	0.595	A
Heptachlor	ND		ug/kg	0.784	0.352	A
Aldrin	ND		ug/kg	1.57	0.552	A
Heptachlor epoxide	ND		ug/kg	2.94	0.882	A
Endrin	ND		ug/kg	0.654	0.268	A
Endrin aldehyde	ND		ug/kg	1.96	0.686	A
Endrin ketone	ND		ug/kg	1.57	0.404	A
Dieldrin	ND		ug/kg	0.980	0.490	A
4,4'-DDE	ND		ug/kg	1.57	0.363	A
4,4'-DDD	ND		ug/kg	1.57	0.559	A
4,4'-DDT	ND		ug/kg	1.57	1.26	A
Endosulfan I	ND		ug/kg	1.57	0.370	A
Endosulfan II	ND		ug/kg	1.57	0.524	A
Endosulfan sulfate	ND		ug/kg	0.654	0.311	A
Methoxychlor	ND		ug/kg	2.94	0.915	A
Toxaphene	ND		ug/kg	29.4	8.24	A
cis-Chlordane	ND		ug/kg	1.96	0.546	A
trans-Chlordane	ND		ug/kg	1.96	0.518	A
Chlordane	ND		ug/kg	13.1	5.20	A

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8081B
Analytical Date: 02/26/24 08:05
Analyst: PEG

Extraction Method: EPA 3546
Extraction Date: 02/25/24 01:38
Cleanup Method: EPA 3620B
Cleanup Date: 02/25/24
Cleanup Method: EPA 3660B
Cleanup Date: 02/25/24

Parameter	Result	Qualifier	Units	RL	MDL	Column
Organochlorine Pesticides by GC - Westborough Lab for sample(s): 01 Batch: WG1888932-1						

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	77		30-150	A
Decachlorobiphenyl	102		30-150	A
2,4,5,6-Tetrachloro-m-xylene	73		30-150	B
Decachlorobiphenyl	100		30-150	B

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8151A
Analytical Date: 02/27/24 17:37
Analyst: MMG

Extraction Method: EPA 8151A
Extraction Date: 02/26/24 16:59

Methylation Date: 02/27/24 12:11

Parameter	Result	Qualifier	Units	RL	MDL	Column
Chlorinated Herbicides by GC - Westborough Lab for sample(s): 01 Batch: WG1889428-1						
2,4-D	ND		ug/kg	165	10.4	A
2,4,5-T	ND		ug/kg	165	5.11	A
2,4,5-TP (Silvex)	ND		ug/kg	165	4.38	A

Surrogate	%Recovery	Qualifier	Acceptance Criteria	Column
DCAA	62		30-150	A
DCAA	64		30-150	B

Lab Control Sample Analysis
Batch Quality Control

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
Organochlorine Pesticides by GC - Westborough Lab Associated sample(s): 01 Batch: WG1888932-2 WG1888932-3									
Delta-BHC	86		87		30-150	1		30	A
Lindane	81		81		30-150	0		30	A
Alpha-BHC	82		82		30-150	0		30	A
Beta-BHC	93		99		30-150	6		30	A
Heptachlor	103		104		30-150	1		30	A
Aldrin	82		82		30-150	0		30	A
Heptachlor epoxide	92		93		30-150	1		30	A
Endrin	93		93		30-150	0		30	A
Endrin aldehyde	90		95		30-150	5		30	A
Endrin ketone	103		103		30-150	0		30	A
Dieldrin	96		96		30-150	0		30	A
4,4'-DDE	84		86		30-150	2		30	A
4,4'-DDD	98		98		30-150	0		30	A
4,4'-DDT	102		103		30-150	1		30	A
Endosulfan I	95		96		30-150	1		30	A
Endosulfan II	94		95		30-150	1		30	A
Endosulfan sulfate	90		90		30-150	0		30	A
Methoxychlor	128		133		30-150	4		30	A
cis-Chlordane	91		91		30-150	0		30	A

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Organochlorine Pesticides by GC - Westborough Lab Associated sample(s): 01 Batch: WG1888932-2 WG1888932-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	75		76		30-150	A
Decachlorobiphenyl	94		97		30-150	A
2,4,5,6-Tetrachloro-m-xylene	72		73		30-150	B
Decachlorobiphenyl	96		97		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
Organochlorine Pesticides by GC - Westborough Lab Associated sample(s): 01 Batch: WG1888932-2 WG1888932-3									
trans-Chlordane	88		87		30-150	1		30	B

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
2,4,5,6-Tetrachloro-m-xylene	75		76		30-150	A
Decachlorobiphenyl	94		97		30-150	A
2,4,5,6-Tetrachloro-m-xylene	72		73		30-150	B
Decachlorobiphenyl	96		97		30-150	B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits	Column
Chlorinated Herbicides by GC - Westborough Lab Associated sample(s): 01 Batch: WG1889428-2 WG1889428-3									
2,4-D	80		61		30-150	27		30	A
2,4,5-T	85		62		30-150	**31**	Q	30	A
2,4,5-TP (Silvex)	80		62		30-150	25		30	A

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria	Column
DCAA	74		52		30-150	A
DCAA	84		59		30-150	B

METALS

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01 Date Collected: 02/22/24 13:45

Client ID: FILL_20240222 Date Received: 02/22/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 97%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Aluminum, Total	322		mg/kg	20.1	5.43	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Antimony, Total	ND		mg/kg	10.0	0.764	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Arsenic, Total	ND		mg/kg	2.01	0.418	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Barium, Total	2.23		mg/kg	2.01	0.350	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Beryllium, Total	ND		mg/kg	1.00	0.066	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Cadmium, Total	ND		mg/kg	2.01	0.197	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Calcium, Total	120		mg/kg	20.1	7.04	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Chromium, Total	1.10	J	mg/kg	2.01	0.193	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Cobalt, Total	ND		mg/kg	4.02	0.334	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Copper, Total	1.24	J	mg/kg	2.01	0.519	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Iron, Total	1340		mg/kg	10.0	1.82	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Lead, Total	0.722	J	mg/kg	10.0	0.539	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Magnesium, Total	118		mg/kg	20.1	3.10	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Manganese, Total	21.1		mg/kg	2.01	0.320	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Mercury, Total	ND		mg/kg	0.070	0.045	1	02/28/24 15:30	02/29/24 14:09	EPA 7471B	1,7471B	GMG
Nickel, Total	0.517	J	mg/kg	5.03	0.487	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Potassium, Total	43.1	J	mg/kg	503	29.0	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Selenium, Total	ND		mg/kg	4.02	0.519	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Silver, Total	ND		mg/kg	1.00	0.569	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Sodium, Total	20.6	J	mg/kg	402	6.33	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Thallium, Total	ND		mg/kg	4.02	0.633	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Vanadium, Total	2.36		mg/kg	2.01	0.408	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC
Zinc, Total	1.74	J	mg/kg	10.0	0.589	5	02/28/24 13:17	03/01/24 14:35	EPA 3050B	1,6010D	DMC

Project Name: FORMER CHROMALLOY **Lab Number:** L2409772

Project Number: 190273.2021 **Report Date:** 03/01/24

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Mansfield Lab for sample(s): 01 Batch: WG1890222-1										
Aluminum, Total	ND		mg/kg	4.00	1.08	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Antimony, Total	ND		mg/kg	2.00	0.152	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Arsenic, Total	ND		mg/kg	0.400	0.083	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Barium, Total	ND		mg/kg	0.400	0.070	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Beryllium, Total	ND		mg/kg	0.200	0.013	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Cadmium, Total	ND		mg/kg	0.400	0.039	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Calcium, Total	ND		mg/kg	4.00	1.40	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Chromium, Total	ND		mg/kg	0.400	0.038	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Cobalt, Total	ND		mg/kg	0.800	0.066	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Copper, Total	ND		mg/kg	0.400	0.103	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Iron, Total	1.05	J	mg/kg	2.00	0.361	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Lead, Total	ND		mg/kg	2.00	0.107	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Magnesium, Total	ND		mg/kg	4.00	0.616	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Manganese, Total	ND		mg/kg	0.400	0.064	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Nickel, Total	ND		mg/kg	1.00	0.097	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Potassium, Total	8.23	J	mg/kg	100	5.76	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Selenium, Total	ND		mg/kg	0.800	0.103	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Silver, Total	ND		mg/kg	0.200	0.113	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Sodium, Total	12.4	J	mg/kg	80.0	1.26	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Thallium, Total	ND		mg/kg	0.800	0.126	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Vanadium, Total	ND		mg/kg	0.400	0.081	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC
Zinc, Total	ND		mg/kg	2.00	0.117	1	02/28/24 13:17	03/01/24 11:12	1,6010D	DMC

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Mansfield Lab for sample(s): 01 Batch: WG1890225-1										
Mercury, Total	ND		mg/kg	0.083	0.054	1	02/28/24 15:30	02/29/24 13:16	1,7471B	GMG

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021
Lab Number: L2409772
Report Date: 03/01/24

Method Blank Analysis
Batch Quality Control

Prep Information

Digestion Method: EPA 7471B

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01 Batch: WG1890222-2 SRM Lot Number: D123-540								
Aluminum, Total	64		-		53-147	-		
Antimony, Total	177		-		2-201	-		
Arsenic, Total	100		-		82-118	-		
Barium, Total	101		-		82-118	-		
Beryllium, Total	95		-		83-117	-		
Cadmium, Total	97		-		83-118	-		
Calcium, Total	99		-		82-118	-		
Chromium, Total	99		-		81-118	-		
Cobalt, Total	105		-		83-117	-		
Copper, Total	102		-		83-117	-		
Iron, Total	89		-		58-142	-		
Lead, Total	104		-		82-119	-		
Magnesium, Total	81		-		75-124	-		
Manganese, Total	98		-		81-119	-		
Nickel, Total	102		-		82-118	-		
Potassium, Total	83		-		72-128	-		
Selenium, Total	102		-		81-119	-		
Silver, Total	100		-		79-120	-		
Sodium, Total	108		-		74-126	-		
Thallium, Total	101		-		81-120	-		
Vanadium, Total	96		-		78-122	-		

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	LCS %Recovery	LCSD %Recovery	%Recovery Limits	RPD	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01 Batch: WG1890222-2 SRM Lot Number: D123-540					
Zinc, Total	98	-	80-120	-	
Total Metals - Mansfield Lab Associated sample(s): 01 Batch: WG1890225-2 SRM Lot Number: D123-540					
Mercury, Total	101	-	67-132	-	

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01 QC Batch ID: WG1890222-3 WG1890222-4 QC Sample: L2409961-16 Client ID: MS Sample												
Aluminum, Total	8760	190	8270	**0**	Q	8840	**44**	Q	75-125	7		20
Antimony, Total	13.1	47.6	69.3	118		57.7	97		75-125	18		20
Arsenic, Total	7.71	11.4	20.1	108		21.4	124		75-125	6		20
Barium, Total	143	190	316	91		317	95		75-125	0		20
Beryllium, Total	0.531J	4.76	5.08	107		4.89	106		75-125	4		20
Cadmium, Total	2.20J	5.04	6.30	125		6.53	**134**	Q	75-125	4		20
Calcium, Total	14300	951	51400	**3900**	Q	12400	**0**	Q	75-125	**122**	Q	20
Chromium, Total	37.7	19	56.4	98		52.1	78		75-125	8		20
Cobalt, Total	10.4	47.6	55.7	95		56.6	101		75-125	2		20
Copper, Total	879	23.8	715	**0**	Q	810	**0**	Q	75-125	12		20
Iron, Total	35000	95.1	31800	**0**	Q	31200	**0**	Q	75-125	2		20
Lead, Total	549	50.4	597	95		563	**29**	Q	75-125	6		20
Magnesium, Total	4650	951	10900	**657**	Q	4860	**23**	Q	75-125	**77**	Q	20
Manganese, Total	602	47.6	1220	**1300**	Q	646	96		75-125	**62**	Q	20
Nickel, Total	40.7	47.6	129	**186**	Q	87.0	101		75-125	**39**	Q	20
Potassium, Total	691	951	1740	110		1530	91		75-125	13		20
Selenium, Total	ND	11.4	11.5	101		11.4	103		75-125	1		20
Silver, Total	ND	4.76	5.18	109		4.86	106		75-125	6		20
Sodium, Total	154J	951	1190	125		1130	123		75-125	5		20
Thallium, Total	ND	11.4	8.50	**74**	Q	9.34	85		75-125	9		20
Vanadium, Total	24.6	47.6	71.8	99		68.5	96		75-125	5		20

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Parameter	Native Sample	MS Added	MS Found	MS %Recovery		MSD Found	MSD %Recovery		Recovery Limits	RPD		RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01 QC Batch ID: WG1890222-3 WG1890222-4 QC Sample: L2409961-16 Client ID: MS Sample												
Zinc, Total	520	47.6	378	**0**	Q	627	**233**	Q	75-125	**50**	Q	20
Total Metals - Mansfield Lab Associated sample(s): 01 QC Batch ID: WG1890225-3 WG1890225-4 QC Sample: L2409778-08 Client ID: MS Sample												
Mercury, Total	0.887	1.59	2.27	87		3.01	**166**	Q	80-120	**28**	Q	20

INORGANICS
&
MISCELLANEOUS

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

SAMPLE RESULTS

Lab ID: L2409772-01
Client ID: FILL_20240222
Sample Location: WEST NYACK, NY

Date Collected: 02/22/24 13:45
Date Received: 02/22/24
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	96.6		%	0.100	NA	1	-	02/23/24 15:49	121,2540G	SJB

Lab Duplicate Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021

Lab Number: L2409772

Report Date: 03/01/24

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1888634-1 QC Sample: L2409705-06 Client ID: DUP Sample						
Solids, Total	84.3	85.1	%	1		20

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021

Lab Number: L2409772
Report Date: 03/01/24

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2409772-01A	Vial MeOH preserved	A	NA		3.6	Y	Absent		NYTCL-8260HLW-R2(14)
L2409772-01B	Vial water preserved	A	NA		3.6	Y	Absent	23-FEB-24 12:11	NYTCL-8260HLW-R2(14)
L2409772-01C	Vial water preserved	A	NA		3.6	Y	Absent	23-FEB-24 12:11	NYTCL-8260HLW-R2(14)
L2409772-01D	Plastic 2oz unpreserved for TS	A	NA		3.6	Y	Absent		TS(7)
L2409772-01E	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.6	Y	Absent		BE-TI(180),BA-TI(180),AS-TI(180),AG-TI(180),AL-TI(180),CR-TI(180),TL-TI(180),NI-TI(180),SB-TI(180),CU-TI(180),PB-TI(180),ZN-TI(180),SE-TI(180),CO-TI(180),V-TI(180),HG-T(28),FE-TI(180),MG-TI(180),MN-TI(180),K-TI(180),NA-TI(180),CA-TI(180),CD-TI(180)
L2409772-01F	Glass 500ml/16oz unpreserved	A	NA		3.6	Y	Absent		NYTCL-8270(14),HERB-APA(14),NYTCL-8081(14),NYTCL-8082(365)

*Values in parentheses indicate holding time in days

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
Project Number:	190273.2021	**Report Date:**	03/01/24

GLOSSARY

Acronyms

DL	- Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LOD	- Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
LOQ	- Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.) Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
NR	- No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
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Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Chlordane: The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Gasoline Range Organics (GRO): Gasoline Range Organics (GRO) results include all chromatographic peaks eluting from Methyl tert butyl ether through Naphthalene, with the exception of GRO analysis in support of State of Ohio programs, which includes all chromatographic peaks eluting from Hexane through Dodecane.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
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Data Qualifiers

Identified Compounds (TICs). For calculated parameters, this represents that one or more values used in the calculation were estimated.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

V - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Z - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2409772
Project Number:	190273.2021	**Report Date:**	03/01/24

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - VI, 2018.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625.1: alpha-Terpineol
EPA 8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 524.2: THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables).
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

NEW YORK CHAIN OF CUSTODY

ALPHA ANALYTICAL

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Service Centers
Mahwah, NJ 07430: 35 Whitney Rd, Suite 5
Albany, NY 12205: 14 Walker Way
Tonawanda, NY 14150: 275 Cooper Ave, Suite 105

Page 1 of 1

Date Rec'd in Lab: 2/23/24

ALPHA Job #: L2409772

Client Information
Client: TRC
Address: 3 Corporate Dr. Suite 202
Clifton Park, NY 12065
Phone: 518-348-1192
Fax: 518-348-1194
Email: JKing@trccompanies.com

Project Information
Project Name: Former Chromalloy
Project Location: West Nyack, NY
Project #: 190273.2021
(Use Project name as Project #) ☐
Project Manager: Justin King
ALPHAQuote #:

Turn-Around Time
Standard ☑ Due Date:
Rush (only if pre approved) ☐ # of Days:

Deliverables
☑ ASP-A ☐ ASP-B
☑ EQuIS (1 File) ☐ EQuIS (4 File)
☐ Other

Regulatory Requirement
☐ NY TOGS ☐ NY Part 375
☐ AWQ Standards ☐ NY CP-51
☐ NY Restricted Use ☐ Other
☐ NY Unrestricted Use
☐ NYC Sewer Discharge

Billing Information
☑ Same as Client Info
PO #

Disposal Site Information
Please identify below location of applicable disposal facilities.
Disposal Facility:
☐ NJ ☐ NY
☐ Other:

These samples have been previously analyzed by Alpha ☐

Other project specific requirements/comments:

Please specify Metals or TAL.

ANALYSIS

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	Full TCLP+RCRA Characteristics	TCL VOCs	TCL SVOCs	PCBs	TAL Metals	Pesticides	Herbicides	Total Bottle
09772-01	FILL_20240222	02/22/24	1335	S	BA		/	/	/	/	/	/	
	~~WC-20240222~~ BA	02/22/24	1340	S	BA	/	/	/	/				

Sample Filtration
☐ Done
☐ Lab to do
Preservation
☐ Lab to do
(Please Specify below)

Sample Specific Comments

Container Type	G	V	G	G	G	G	G	
Preservative	A	A	A	A	A	A	A	

Preservative Code:
A = None
B = HCl
C = HNO_3
D = H_2SO_4
E = NaOH
F = MeOH
G = $NaHSO_4$
H = $Na_2S_2O_3$
K/E = Zn Ac/NaOH
O = Other

Container Code
P = Plastic
A = Amber Glass
V = Vial
G = Glass
B = Bacteria Cup
C = Cube
O = Other
E = Encore
D = BOD Bottle

Westboro: Certification No: MA935
Mansfield: Certification No: MA015

Relinquished By:	Date/Time	Received By:	Date/Time
	02/22/24 18:14	Scott Wolk	2/22/24 18:14
Scott Wolk	2/22/24 18:14		2/22/24 18:30
	2/22/24		2/22 22:00
	2/23 1:00		2/23/24 0900

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. BY EXECUTING THIS COC, THE CLIENT HAS READ AND AGREES TO BE BOUND BY ALPHA'S TERMS & CONDITIONS. (See reverse side.)

Form No: 01-25 HC (rev. 30-Sept-2013)

APPENDIX G

Please print or type.
(Form designed for use on elite (12-pitch) typewriter.)

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	1	631-586-5900	NHWM221955

GENERATOR

5. Generator's Name and Mailing Address
SEQUA CORPORATION
4100 RCA BOULEVARD
PALM BEACH GARDENS, FL, 33410
Generator's Phone:

Generator's Site Address (if different than mailing address)
FORMER CHROMALLOY FACILITY
169 WESTERN HYGHWAY
WEST NYACK, NY 10994

6. Transporter 1 Company Name
AARCO ENVIRONMENTAL SERVICES
U.S. EPA ID Number
NYR000107326

7. Transporter 2 Company Name
U.S. EPA ID Number

8. Designated Facility Name and Site Address
DALE TRANSFER CORPORATION
129 DALE STREET, WEST BABYLON NY 11704
631-393-2882
Facility's Phone:
U.S. EPA ID Number
N/A

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	NON-REGULATED SOLIDS (SOIL)	3	DW	1500	P	
2.	NON-REGULATED SOLIDS (RCRA EMPTY DRUMS)	4	DW	~~50~~		
3.						
4.						

13. Special Handling Instructions and Additional Information
1. APPROVAL # 2023-989 (... 3 ... x 55 gal
2. APPROVAL # 2024-421 (... 4 ... x 55 gal empty
AARCO WO# 221955 TRUCK# B 507

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name	Signature	Month	Day	Year
Andrew Fishman as agent of Chromalloy	Andrew Fishman as agent of Chromalloy	5	17	24

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name	Signature	Month	Day	Year
Kurt F Carlson	Kurt F Carlson	5	17	24
Transporter 2 Printed/Typed Name	Signature	Month	Day	Year

DESIGNATED FACILITY

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator) U.S. EPA ID Number
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)	Month	Day	Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name	Signature	Month	Day	Year
O Brien		5	17	24

Printed in USA by GC Labels
1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

APPENDIX H

41 Spring St., Suite 102
New Providence, NJ 07974
T 908.988.1700
TRCcompanies.com

Field Work Plan
Former Chromalloy
Pump and Treat System Check
169 Western Highway (aka 10 Pineview Road)
West Nyack, New York

TRC Project Numbers:
90273.2021.0000 – Former Chromalloy-West Nyack, Phase 000002 – P&T System, Task 000001 – Routine O&M

Main Site Address: 10 Pineview Road, West Nyack, New York

Contacts:

TRC Project Manager:	Jeffrey LaRock Justin King	(518) 275-9307 (cell) (518) 860-7656 (cell)
TRC Task Manager:	Howard Nichols Bianca Abrera	(973) 610-8529 (cell) (908) 313-8209 (cell)
TRC Field Crew:	Charlene Balmaceda Andrew Fishman Rich DePolo	(732) 210-8480 (cell) (518) 478-5210 (cell) (838) 218-5279 (cell)
Analytical Labs: PO#	Alpha Analytical Melissa Deyo Mdeyo@alphalab.com	(716) 427-5229
Equipment Rental: PO#	Eco-Rental Solutions Chris Prakad	(914) 400-0324 (office) (845) 542-6444 (cell)

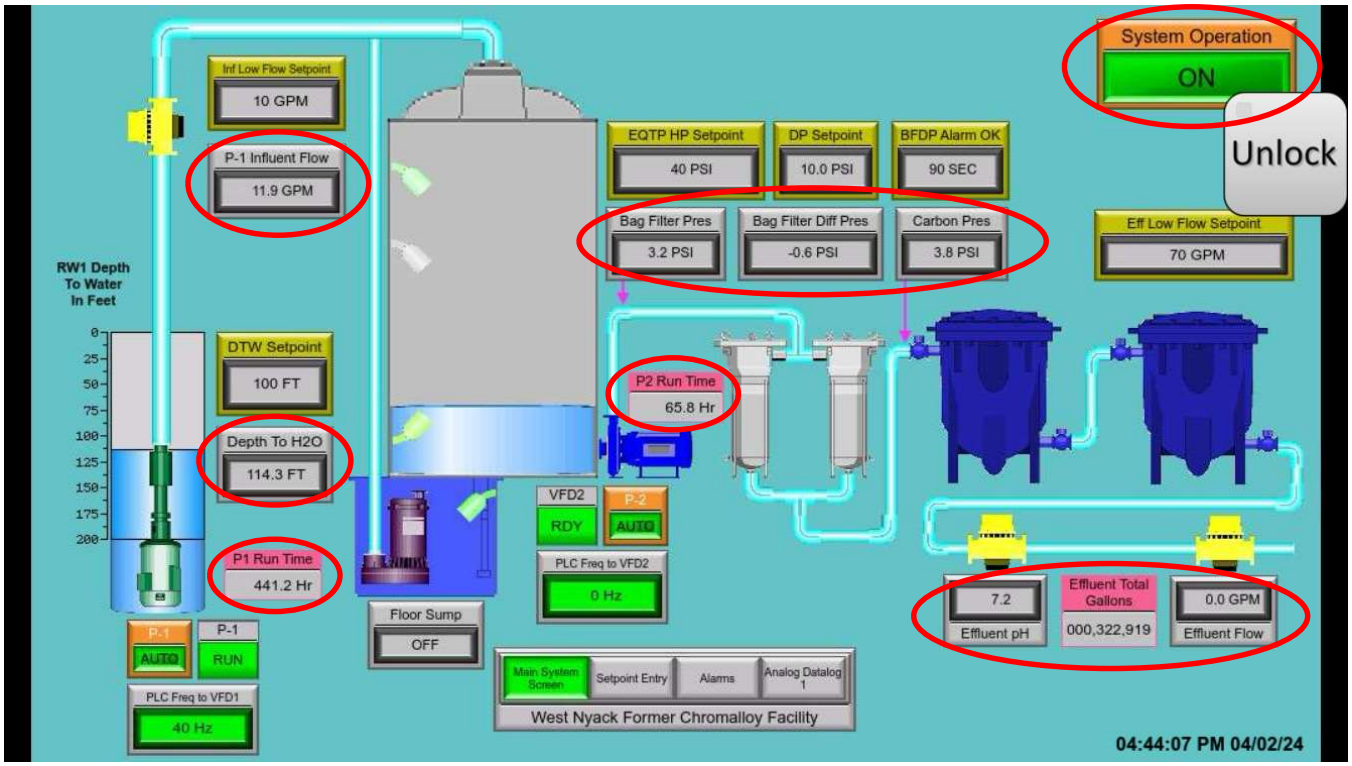
PROJECT OBJECTIVES:

1. Access work area. Code for the treatment building is 1-2-3-4- 🔒 .
2. Conduct brief tailgate safety meeting. Ensure all field staff have reviewed and signed the site-specific HASP (this includes all personnel on-site). Document the meeting in the field notebook.
3. Begin system readings using PLC screen and gauges.
4. Identify if bag filters need to be changed or if GAC backwash is necessary.
5. Change bag filters or begin GAC backwash if necessary.
6. Take another round of system readings using PLC screen and gauges.
7. Lock the treatment shed door prior to leaving by holding the 🔒 (lock button).

Health & Safety:

1. Exercise caution when opening the bag filter housing and replacing bag filters. The equipment can be heavy so be mindful of:
    a. Proper lifting – Do not lift with your back, make sure you have solid footing.
    b. Pinch points - Make sure not to get hands pinched during replacement of bag filters. Wear proper PPE and do not place hands where you cannot see them.

c. Slips, trips, and falls – Be aware of your surroundings including the system pipes and sump pump cover.



A. System Readings at the Site:

1. Begin by filling out the System Log Sheet on paper and on the Fulcrum App.
2. Write down the name of the personnel/s on-site, the date, and the weather.
3. Identify it the system is operational. Tap on the PLC screen to wake up the screen. Click on "Main System Screen" along the bottom of the screen. Take a picture of the PLC screen.
    a. If the system is operating, The System Operation on the top right of the screen should be green and say "ON". And P-1 and P-2 should be on "Auto"
    b. If the system is not operating, The System Operation on the top right of the screen should be red and say "OFF".
        i. Check the breakers for the VFD to make sure they are turned on (vertical).
        ii. Go back to the "Main System Screen" and turn on the System by pressing the red "OFF" button on the top right of the screen.
        iii. If the system is operating, The System Operation on the top right of the screen should be green and say "ON".
        iv. Click on P-2 and turn it to "Auto".

v. Click on P-1 and turn it to “Auto”. P-1 will take about 2-3 minutes before it starts stabilizing at around 12 gpm.

c. Begin noting down the readings on the PLC screen.

4. Click on the “Alarms” button along the bottom of the screen.
    a. Identify if any alarms went off since the last visit and write them in the notes portion of the System Log Sheet. Take a picture of the PLC screen.
    b. Click on “Confirm All” if there are any active (red) alarms on the screen.
    c. Double click on “Reset Non-Active Alarms” to turn any confirmed (pink) alarms on the screen.
5. If P-2 is operating and there is effluent flow, record the differential pressures. Record the pressure gauge readings for the Pre-Bag Filter Housing, Post-Bag Filter Housing, Pre-GAC, Mid-GAC, and Post GAC. If there is no effluent flow, wait for the equalization tank to fill up and for P-2 to be operating prior to recording pressures.
6. Identify the level of water inside the Equalization Tank.
7. Note down and take a picture of the Totalizer readings.
8. If sampling is scheduled for the day and there is effluent flow, proceed to Section B.
9. If the differential pressure for the bag filter housing is almost at 10 psi, proceed to Section C to replace the bag filters.
10. If the differential pressure for the GAC is almost at XX psi, proceed to Section D to perform GAC backwash.
11. Identify if any leaks are present and note the location.
12. Observe the Outfall conditions if there is effluent flow and with permission from the homeowner.
13. Perform another round of PLC and gauge readings prior to leaving the site. Ensure that at least one of the system readings is when there is effluent flow.
14. Lock the door to the treatment shed.

B. Collecting Quarterly Samples:

1. Ensure that there is enough volume in the Equalization tank prior to sampling and that there is effluent flow.
2. Prepare the sample bottles by labeling them with the following:
    a. YYYY-MM-DD_Influent
    b. YYYY-MM-DD_Mid-fluent
    c. YYYY-MM-DD_Efffluent
3. Take the Influent sample at the Equalization Tank.
    a. Install the Barbed Hose Fitting with plumber’s tape into the sampling port.
    b. Install ¼” tubing into the sampling port.

   c. Place a 5-gallon bucket underneath the sampling tube to catch any water that may spill out during sampling.
   d. Begin taking the sample and label the sample with the date and time.

4. Take the Mid-fluent sample at the port located in the middle of the two GACs.
   a. Install the Barbed Hose Fitting with plumber's tape into the sampling port.
   b. Install ¼" tubing into the sampling port.
   c. Place a 5-gallon bucket underneath the sampling tube to catch any water that may spill out during sampling.
   d. Begin taking the sample and label the sample with the date and time.
5. Take the Effluent sample at the Effluent pipe located at the bottom of the manifold along the wall.
   a. Install the Barbed Hose Fitting with plumber's tape into the sampling port.
   b. Install ¼" tubing into the sampling port.
   c. Place a 5-gallon bucket underneath the sampling tube to catch any water that may spill out during sampling.
   d. Begin taking the sample and label the sample with the date and time.
6. Pack all bottles for a given sample into a large zip-lock bag and immediately place it in a cooler with ice. Record the sample information in the field book.
7. All samples are to be analyzed on a standard TAT; samples will be dropped off at the Alpha Analytical Lab located at 35 Whitney Rd Ste 5, Mahwah, NJ 07430.
8. All water spilled into the 5-gallon buckets for sampling is to be poured into the sump pump.
9. Clean up any water spilled using paper towels or rags and dispose of them into the 55-gallon steel drum.

C. Changing bag filters:

1. If the differential pressure for the bag filter housings is almost at 10 psi, turn off the system by clicking on the green "ON" System Operation button so that it is red and "OFF".
2. Close the valves to the inflow and outflow of both bag filter housings.
3. Prepare the four bag filters that will be used to replace the used bag filters by removing the tag inside and noting that in the System Log sheet.
4. Open the valve along the side of the bag filter housing and let the water drain into 5-gallon buckets. This will yield around 10-gallons of water.
5. Unscrew the bolts for one of the bag filter housings and begin removing one of the bag filters. Let it drain and squeeze out the excess water from the bag filter before placing it inside the dedicated 55-gallon steel drum. Do the same for the other bag filter.
6. Repeat step 5 for the other bag filter housing.
7. Close and screw both the bag filter housings.

8. Open the valves to the inflow and outflow of both bag filter housings.
9. Turn on the System by pressing the red “OFF” button on the top right of the screen.
    a. If the system is operating, The System Operation on the top right of the screen should be green and say “ON”.
    b. Click on P-2 and turn it to “Auto”.
    c. Click on P-1 and turn it to “Auto”.
10. Slowly open the bleed valve at the top of each of the bag filter housings to let air escape from the housings.
    a. Have the hosing for the bleed valve discharge water into a 5-gallon bucket.
    b. Once water start flowing with no air bubbles, close the bleed valve.
11. Pour the water from the 5-gallon buckets into the sump pump.
12. Clean up any water spilled using paper towels or rags and dispose of them into the 55-gallon steel drum.

E. GAC Backwash – to be finalized in the field

1. If the differential pressure of the GAC is almost at XX psi, prepare the system for a GAC backwash.
2. Turn off the system by clicking on the green “ON” System Operation button so that it is red and “OFF”.
3. Connect the shorter backwash hose from the transfer pump to the bottom of the manifold (Valve 12).
4. Connect the longer backwash hose from the equalization tank to the middle of the manifold (Valve 6).
5. Close the valves that lead from the transfer pump to the bag filter housings.
6. Begin by backwashing GAC 1.
    a. Turn the valves to the following configuration:
        - Valve 1 – Closed
        - Valve 2 – Closed
        - Valve 3 – Opened
        - Valve 4 – Closed
        - Valve 5 – Closed
        - Valve 6 – Opened
        - Valve 7 – Closed
        - Valve 8 – Closed
        - Valve 9 – Closed
        - Valve 10 – Opened
        - Valve 11 – Closed
        - Valve 12 – Opened
        - Valve 13 – Closed
        - Valve 14 – Closed
    b. Turn on Pump-2 (transfer pump) to hand and check the GAC pressure while backwashing GAC 1.

   c. After pressure drops down to XX psi, turn off Pump-2.
7. Begin backwashing GAC 2.
   a. Turn the valves to the following configuration:
      - Valve 1 – Closed
      - Valve 2 – Closed
      - Valve 3 – Closed
      - Valve 4 – Opened
      - Valve 5 – Closed
      - Valve 6 – Opened
      - Valve 7 – Closed
      - Valve 8 – Closed
      - Valve 9 – Closed
      - Valve 10 – Closed
      - Valve 11 – Opened
      - Valve 12 – Opened
      - Valve 13 – Closed
      - Valve 14 – Closed
   b. Turn on Pump-2 (transfer pump) to hand and check the GAC pressure while backwashing GAC 1.
   c. After pressure drops down to XX psi, turn off Pump-2.
8. Return the Valves to the initial configuration (shown in the picture below).
9. Disconnect both backwash hoses. Be careful not to spill too much water, try catching them with 5-gallon buckets.
10. Open the valves leading from the transfer pump to the bag filter housings.
11. Turn on the System by pressing the red “OFF” button on the top right of the screen.
    a. If the system is operating, The System Operation on the top right of the screen should be green and say “ON”.
    b. Click on P-2 and turn it to “Auto”.
    c. Click on P-1 and turn it to “Auto”.
12. Slowly open the bleed valve at the top of each of the GAC vessels to let air escape.
    a. Have the hosing for the bleed valve discharge water into a 5-gallon bucket.
    b. Once water start flowing with no air bubbles, close the bleed valve.
13. Pour the water from the 5-gallon buckets into the sump pump.
14. Clean up any water spilled using paper towels or rags and dispose of them into the 55-gallon steel drum.

2024 System O&M Plan
169 Western Highway
West Nyack, New York

REGULAR OPERATIONS (GAC 1 as LEAD)

Office Follow-up

At the end of the event:

1) Drop off samples at the laboratory and take a picture of the COC;
2) Scan any field documentation that TRC filled out and any documentation provided by subcontractors. Upload scans of any completed field documentation to the task field folder.
3) Make sure Fulcrum is up to date with system log sheets.
4) File all field documentation in a field folder labeled with the name and date of the event (YYYY_MM_DD), and give it to the Task Manager or Project Manager.
5) Prepare a written email summary to the task manager and project manager of the work completed, any issues encountered, and a list of any outstanding tasks.

EQUIPMENT:

General

- Field Book
- Decon equipment
- PPE
- Trash bags
- Buckets
- Tool set

Sampling

- Sample bottles
- Ice and cooler
- Ziploc bags

Pump and Treat System O&M Manual

Former Chromalloy Facility
West Nyack, NY

Prepared for:

TRC
3 Corporate Drive, Suite 202
Clifton Park, NY 12065

Prepared by:

EnviroTrac Ltd.
5 Old Dock Road
Yaphank, NY 11980

March 2024

Table of Contents

Section 1 – Pumps

- Grundfos **#85S75-6** Submersible Pump Specifications, Installation and Operating Instructions
- Franklin **#2366119020** Submersible Motor Specifications, Application/Installation/Maintenance Manual
- AMT #**3152-95** Transfer Pump Specifications, Operating Instructions & Maintenance Manual, Repair Parts Manual
- Everbilt #**HDPS33W** Sump Pump Specifications, Use & Care Guide

Section 2 – Tanks/Filters

- Ace Roto-Mold **#VT2000-64** Poly Tank Specifications
- Evernbilt **#1000027544** Sump Pump Basin Specifications
- PRM **#HP-2000-RDL** LGAC Vessel Specifications
- General Carbon **#GC8X30R** LGAC Media Specifications
- Rosedale Filter Bag Specifications

Section 3 – Instrumentation

- Dwyer **#MBLT-2SB-IVPF-200-220** Level Transducer Specifications – Installation & Operating Instructions
- Prosense **#SPT25-20-0060A** Pressure Transmitter Specifications, Installation & Maintenance Sheet
- GF Signet **#2537** Paddlewheel Flowmeter Specifications, Operating Instructions
- GF Signet **#3-2724-00** pH Electrode Specifications, Operating Instructions
- GF Signet **#3-2751-2** pH Sensor Electronics Specifications, Operating Instructions
- PRM **#WM300PVX** Water Flow Totalizer Specifications, Manual
- Sump Alarm **#2539** EQ Tank Float Switch Specifications, Instruction Sheet
- Sump Alarm **#LS-Float** Floor Sump Float Switch Data Sheet
- Sump Alarm **#LS-2600** Floor Leak Sensor Data Sheet
- PIC Gauges **#PRO-201L-254D** Pressure Gauge Specifications

Section 4 – Heating

- Dayton **#2YU73** Operating Instructions & Parts Manual
- Honeywell **#CT87K1004** Thermostat User's Manual

Section 5 – Controls

- Automation Direct **GS23X-4010 & GS23X-45PO** Variable Frequency Drive Specifications, User Manual
- Automation Direct Drive Output Filter **#VTF-46-LM** Specifications, Installation Guide

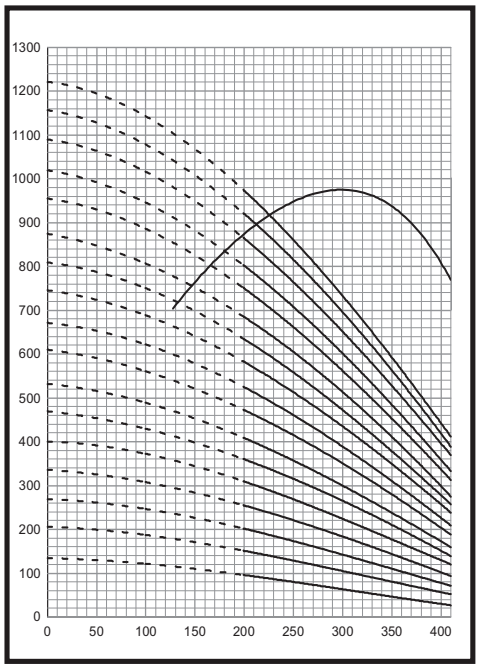
Section 6 – Figures

- FIG-1-P&T System Process & Instrumentation Diagram
- FIG-2-P&T System Layout
- FIG-3-P&T System HMI Screen Descriptions and Startup Procedures

1. PUMPS

Performance Curves and Technical Data

6-Inch, 8-Inch & 10-Inch Submersible Pumps



Performance Curves

Materials of Construction

DIMENSIONS AND WEIGHTS

MODEL NO.	FIG.	HP	MOTOR SIZE	DISCH. SIZE	DIMENSIONS IN INCHES A	B	C	D	E	APPROX. SHIP WT.
85S15-1	A	1 1/2	4"	3" NPT	25.9	13.6	12.3	3.75	5.2	37
85S30-2	A	3	4"	3" NPT	35.3	20.6	14.7	3.75	5.2	61
85S50-3	A	5	4"	3" NPT	40.7	23.6	17.1	3.75	5.2	75
85S50-4	A	5	4"	3" NPT	43.1	23.6	19.5	3.75	5.2	77
85S75-5	A	7 1/2	4"	3" NPT	51.5	29.6	21.9	3.75	5.2	95
85S75-6	A	7 1/2	4"	3" NPT	53.9	29.6	24.3	3.75	5.2	97
85S100-7	A	10	4"	3" NPT	70.5	43.9	26.6	3.75	5.2	151
85S100-8	A	10	4"	3" NPT	72.9	43.9	29.0	3.75	5.2	154
85S100-9	A	10	4"	3" NPT	75.3	43.9	31.4	3.75	5.2	156
85S75-5	A	7 1/2	6"	3" NPT	46.7	24.2	22.5	5.38	5.6	135
85S75-6	A	7 1/2	6"	3" NPT	49.1	24.2	24.9	5.38	5.6	137
85S100-7	A	10	6"	3" NPT	52.7	25.4	27.3	5.38	5.6	148
85S100-8	A	10	6"	3" NPT	55.0	25.4	29.6	5.38	5.6	151
85S100-9	A	10	6"	3" NPT	57.4	25.4	32.0	5.38	5.6	153
85S150-10	A	15	6"	3" NPT	62.4	28.0	34.4	5.38	5.6	170
85S150-11	A	15	6"	3" NPT	64.8	28.0	36.8	5.38	5.6	174
85S150-12	A	15	6"	3" NPT	67.2	28.0	39.2	5.38	5.6	176
85S150-13	A	15	6"	3" NPT	69.6	28.0	41.6	5.38	5.6	178
85S200-14	A	20	6"	3" NPT	74.5	30.6	43.9	5.38	5.6	193
85S200-15	A	20	6"	3" NPT	76.9	30.6	46.3	5.38	5.6	198
85S200-16	A	20	6"	3" NPT	79.3	30.6	48.7	5.38	5.6	200
85S200-17	A	20	6"	3" NPT	81.7	30.6	51.1	5.38	5.6	202
85S200-18	A	20	6"	3" NPT	84.1	30.6	53.5	5.38	5.6	204
85S250-19	A	25	6"	3" NPT	88.9	33.1	55.8	5.38	5.6	240
85S250-20	A	25	6"	3" NPT	91.9	33.1	58.8	5.38	5.6	244
85S250-21	A	25	6"	3" NPT	94.3	33.1	61.2	5.38	5.6	246
85S250-22	A	25	6"	3" NPT	96.7	33.1	63.6	5.38	5.6	249
85S300-23	A	30	6"	3" NPT	101.9	35.7	66.2	5.38	5.6	264
85S300-24	A	30	6"	3" NPT	104.1	35.7	68.4	5.38	5.6	266
85S300-25	A	30	6"	3" NPT	106.4	35.7	70.7	5.38	5.6	271
85S300-26	A	30	6"	3" NPT	108.8	35.7	73.1	5.38	5.6	273
85S300-27	A	30	6"	3" NPT	116.3	40.8	75.5	5.38	5.6	278
85S400-28	A	40	6"	3" NPT	118.7	40.8	77.9	5.38	5.6	281
85S400-29	A	40	6"	3" NPT	121.1	40.8	80.3	5.38	5.6	283
85S400-30	A	40	6"	3" NPT	123.4	40.8	82.6	5.38	5.6	287
85S400-33*	B	40	6"	3" NPT	139.7	40.8	98.9	5.38	6.9	343
85S400-36*	B	40	6"	3" NPT	146.9	40.8	106.1	5.38	6.9	354
85S500-39*	B	50	6"	3" NPT	171.0	57.8	113.2	5.38	6.9	448
85S400-33*	B	40	8"	3" NPT	134.7	35.8	98.9	7.5	6.9	377
85S400-36*	B	40	8"	3" NPT	141.9	35.8	106.1	7.5	6.9	390
85S500-39*	B	50	8"	3" NPT	152.0	38.8	113.2	7.5	6.9	498

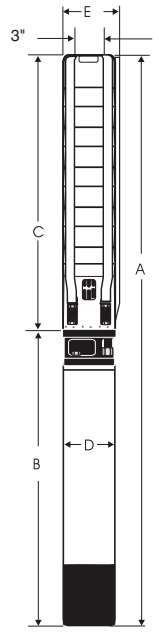


Fig. A

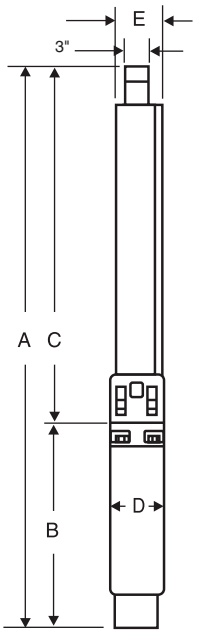
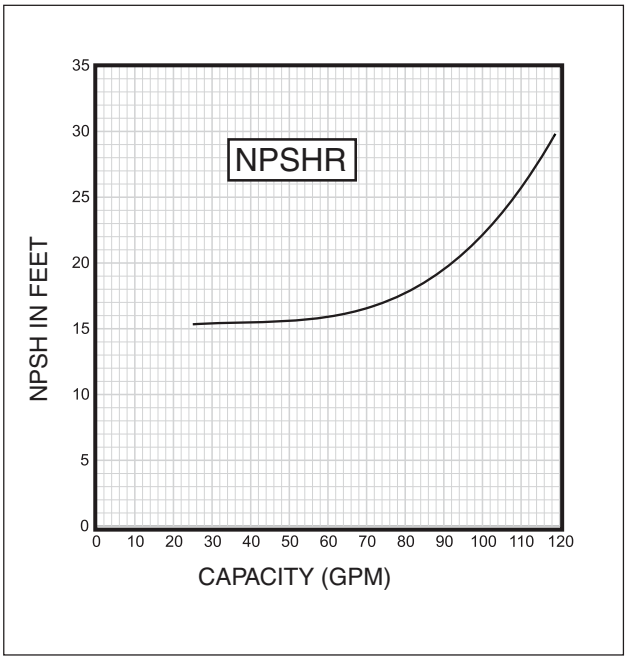


Fig. B

NOTES: All models suitable for use in 6" wells, unless otherwise noted.
Weights include pump end with motor in lbs.
* Built into sleeve 3" NPT discharge, 8" min. well dia.

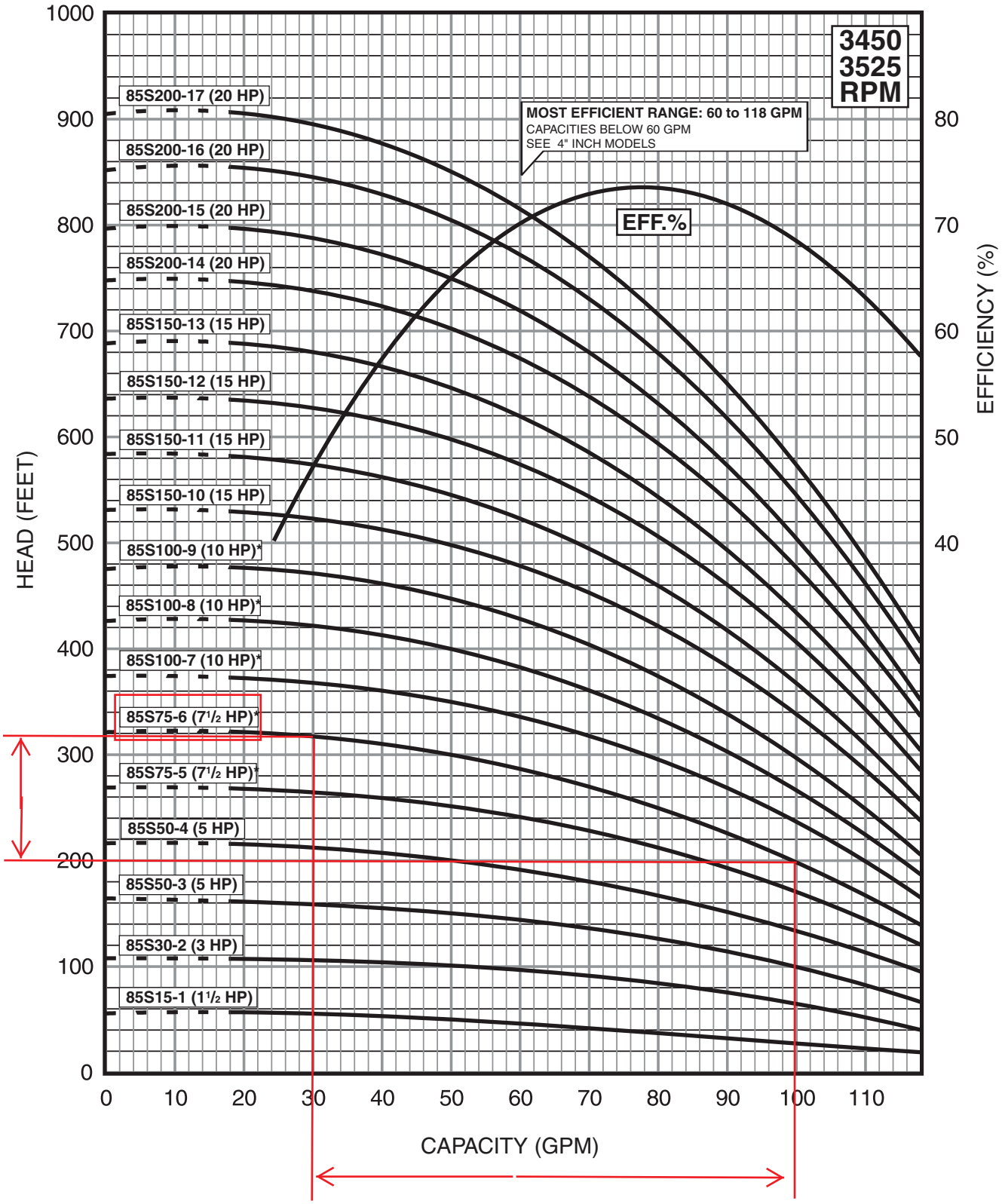
MATERIALS OF CONSTRUCTION

COMPONENT	CYLINDRICAL SHAFT (1- 39 Stgs.)
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Split Cone Nut	304 Stainless Steel
Split Cone	304 Stainless Steel
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Seal Ring Support	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Coupling	316/329 Stainless Steel**
Pump Shaft	431 Stainless Steel
Intermediate Bearings	NBR
Impeller Seal Ring	NBR/PPS
Check Valve Seat	NBR/316 Stainless Steel
Upthrust Disc	Carbon/Graphite
Upthrust Stop Washer	304 Stainless Steel
8" Motor Adaptor Plate	304 Stainless Steel
Sleeve *	316 Stainless Steel
Sleeve Flange *	316 Stainless Steel
NOTES: Specifications are subject to change without notice. * Required for 33-39 stages. ** 4" Coupling made of 316 Stainless Steel	



PERFORMANCE CURVES 85 GPM MODEL 85S

FLOW RANGE: 18 -118 GPM **OUTLET SIZE: 3" NPT** **NOMINAL DIA. 6"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, 1.5-5 HP/3450 RPM
6" MOTOR STANDARD, 7.5-50 HP/3450 RPM.
* Alternate motor sizes available.

Performance conforms to ISO 9906 Annex A
@ 5 ft. min. submergence.

SP/SPE

Stainless steel submersible pumps

Installation and operating instructions

GRUNDFOS

SP/SPE

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Original installation and operating instructions

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1. Limited warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, FOB Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

2. General information

Read this document before you install the product. Installation and operation must comply with local regulations and accepted codes of good practice.

The use of this product requires experience with and knowledge of the product.

Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety.

Children must not use or play with this product.

2.1 Hazard statements

The symbols and hazard statements below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious personal injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious personal injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate personal injury.

The hazard statements are structured in the following way:

SIGNAL WORD

Description of the hazard

Consequence of ignoring the warning

- Action to avoid the hazard.

2.2 Notes

The symbols and notes below may appear in Grundfos installation and operating instructions, safety instructions and service instructions.

Observe these instructions for explosion-proof products.

A blue or grey circle with a white graphical symbol indicates that an action must be taken.

A red or grey circle with a diagonal bar, possibly with a black graphical symbol, indicates that an action must not be taken or must be stopped.

If these instructions are not observed, it may result in malfunction or damage to the equipment.

Tips and advice that make the work easier.

3. Product description

3.1 Product introduction

This manual includes instructions for installation, operation, and maintenance of Grundfos SP submersible pumps with 0.5 to 250 Hp motors.

3.2 Applications

Grundfos SP submersible pumps are suitable for the following applications:

- groundwater supply to waterworks
- irrigation in horticulture and agriculture
- groundwater lowering (dewatering)
- pressure boosting
- industrial applications
- domestic water supply.

The pump must be installed so that the suction interconnector is completely submerged in the liquid. The pump can be installed horizontally or vertically. See section Positional requirements.

3.2.1 Pumped liquids

The pumps are designed for pumping clean, thin, non-explosive liquids without solid particles or fibers.

The maximum sand content of the water must not exceed 50/100/150 ppm. A larger sand content may reduce the life of the pump and increase the risk of blockage.

Pump type	Maximum content of sand [ppm]
SP 5S - SP 25S	50
SP 35S - SP 77S	150
SP 90S - SP 300S	100
SP 385S - SP 1100S	50

When pumping liquids with a density higher than water (62.3 - 62.4 lb/ftm^3), motors with correspondingly higher outputs must be used.

If liquids with a viscosity higher than water are to be pumped, contact Grundfos.

N AISI 416 and R AISI 904L grade stainless steel pump sets are designed for liquids more aggressive than drinking water.

For the maximum liquid temperature, see section Motor cooling requirements.

Related information

10.1.1 Maximum water temperature - minimum velocity/flow past the motor

3.3 Drinking water

If the product is used for drinking water, the following precautions must be taken to avoid contamination:

- Before use, make sure that the product does not come into contact with dust or with chemicals not suitable for contact with drinking water, for example lubricants, greases or oils.
- If the pump is used with potentially toxic liquids, it can no longer be used for drinking water.
- Always use original parts to maintain the initial hygienic characteristics of the product.

3.4 Features and benefits

- state-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- resistant to sand
- resistant to aggressive water
- monitoring, protection, and communication through protection unit MP 204, and GO remote control.

3.5 Type key

Example	**SPE**	**475**	**S**	**500**	**5**	**PD**
Pos.	1	2	3	4	5	6

Pos.	Description		
1	Pump type		
	- or SP	=	Standard design
	SPE	=	ECM-design (MS6000P)
2	Rated flow rate in gpm		
3	Material version Stainless steel parts of material		
	S	=	AISI 304 (EN 1.4301) SS
	N	=	AISI 316 (EN 1.4401) SS
	R	=	AISI 904L (EN 1.4539) SS
4	Hp of motor		
5	Number of impellers		
6	BP	=	Bare Pump
	-	=	Pump and motor (Standard or ECM motor)
	CUE	-	Standard motor and VFD
	PD	-	ECM motor and VFD (SPE only)

4. Delivery, handling and storage

4.1 Scope of delivery

Make sure that the pump and its components, motor, cable, or control box are not damaged during transportation.

4.2 Handling

WARNING

Crushing of feet

Death or serious personal injury

- Stack the pumps with the biggest at the bottom, and do not stack above 1 m.
- Use lifting equipment which is approved for the weight of the product.
- Wear personal protective equipment.

WARNING

Crushing of hands

Death or serious personal injury

- Stack the pumps with the biggest at the bottom, and do not stack above 1 m.
- Use lifting equipment which is approved for the weight of the product.

Store the pump in the package until it is ready for installation.

Handle the pump with care.

Fix the extra nameplate supplied with the pump at the installation site.

Do not expose the pump to mechanical impact, vibrations etc.

4.3 Storage

4.3.1 Storage temperature

Pump: -4 to +140 °F (-20 to +60 °C).

Motor: -4 to +158 °F (-20 to +70 °C).

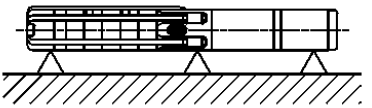
Store the motors in a closed, dry and well ventilated room.

If MMS motors are stored, the shaft must be turned by hand at least once a month. If a motor has been stored for more than a year before installation, the rotating parts of the motor must be dismantled and checked before use.

Do not expose the pump to direct sunlight.

If the pump is unpacked, store it horizontally, or vertically to prevent misalignment. Make sure that the pump cannot roll or fall over. Support it if necessary.

During storage, the pump can be supported as indicated in the figure below.



Pump position during storage

4.3.2 Frost protection

If the pump has to be stored after use, it must be stored on a frost-free location, or the motor liquid must be frost-proof.

5. Operating conditions

Flow rate, Q:		Up to 1400 gpm (318 m^3/h)
Head, H:		Up to 2657 ft (810 m)
Liquid temperature:		32-140 °F (0-60 °C)
Maximum submersible depth:	MS 402	492 ft (150 m) (213 psi)
	MS 4000	1969 ft (600 m) (852 psi)
	MS 6000	1969 ft (600 m) (852 psi)
	All MMS	1969 ft (600 m) (852 psi)

6. Installation

DANGER

Electric shock

Death or serious personal injury

- Switch off the power supply before you start any work on the product.
- Make sure that the power supply cannot be switched on accidentally.

WARNING

Crushing of feet

Death or serious personal injury

- When lifting the pump out of the box, use lifting equipment which is approved for the weight of the product.
- Wear personal protective equipment.

WARNING

Crushing of hands

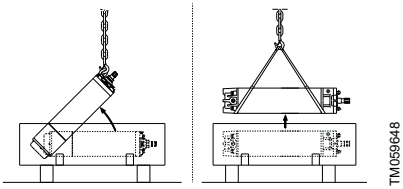
Death or serious personal injury

- When lifting the pump out of the box, use lifting equipment which is approved for the weight of the product.
- Wear personal protective equipment.

Install products in accordance with local regulations. Installation must be carried out by a qualified person.

Use a sine-wave filter when operating an SPE pump set.

Fit a 12 inch long pipe to the pump to during installation.



Handling of the motor

6.1 Pre-installation checklist

Check the following before installation:

- condition of the well
- condition of the water
- installation depth
- power supply
- cable type.

These checks are all critical for the proper installation of this pump.

6.1.1 Condition of the well

If the pump is to be installed in a new well, make sure that the well is fully developed and bailed or blown free of cuttings, drillings and sand. The stainless steel construction makes the pump resistant to abrasion. However; constant exposure to sandy water may cause damage to the pump.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine pump in an existing well, the well must be blown or bailed clear of oil.

Determine the maximum depth of the well, and the draw-down level at the maximum capacity of the pump. Use this data for pump selection and to determine installation depth.

Check the inside diameter of the well casing to ensure that it is larger than the size of the pump and motor.

6.2 Positional requirements

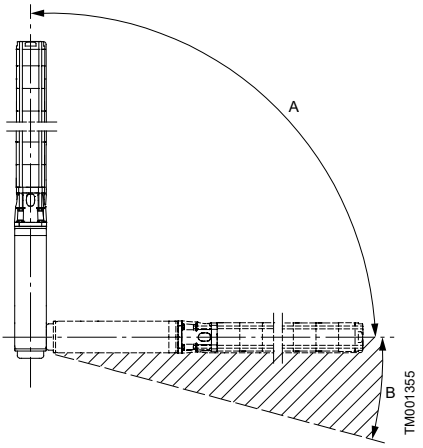
WARNING

Crushing of hands

Death or serious personal injury

- If the pump is to be installed in a position where it is accessible, make sure the coupling is isolated and cannot be touched. For instance, the pump can be be built into a flow sleeve.

Depending on the motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section Motors suitable for horizontal installation. If the pump is installed horizontally, the outlet port must never fall below the horizontal plane. See the figure below.



Positional requirements

Pos.	Description
A	Allowed
B	Not allowed

If the pump is installed horizontally, fit it in a flow sleeve.

Related information

3.2 Applications

6.2.1 Motors suitable for horizontal installation

6.2.1 Motors suitable for horizontal installation

Motor	Output power 60 Hz	Output power 50 Hz
	[Hp (kW)]	[Hp (kW)]
MS	0.5 - 40 (0.37 - 30)	All
MMS6	50-60 (37 - 44.7)	5-50 (3.7 - 37)
MMS8000	30-150 (22-112)	30-150 (22-112)
MMS10000	100-250 (75-190)	100-250 (75-190)

CAUTION

Hot surface

Minor or moderate personal injury

- If the pump is used to transfer hot (104-140 °F) liquid, make sure it cannot be touched, by adding extra covers or guard rails on the pump or around the installation spot.

During operation, the suction interconnector of the pump must always be completely submerged in the liquid. Make sure that the NPSH values are fulfilled.

6.2.2 Pumped liquids

This pump is tested for use with water only. Water temperature should not exceed rated motor temperature. SP pumps can withstand water temperatures up to 140 °F (60 °C). Water temperature exceeding the rated temperature shortens the lifespan of the motor. Using the pump with different liquids than water is a customer responsibility. For drinking water applications, the temperature must not exceed 86 °F (30 °C).

Submersible pumps are designed for pumping the following liquids:

- clear and cold water that is free of air and gasses
- clean, thin, non-explosive liquids without solid particles or fibers.

Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gasses.

See the flow velocity table in section Motor cooling requirements.

Flow rate, Q:	0.44 - 1475 gpm (0.1 - 335 m^3/h)
Head, H:	Maximum 2657 ft (810 m)

When the pump is used for pumping water above the rated temperatures of the motor, pay attention to the minimum water flow past the motor for cooling. Water temperature that exceeds the rated temperature shortens the lifespan of the motor.

The pump is highly resistant to the normal corrosive environment found in some water wells. If water well tests show that the water has an excessive or unusual corrosive quality, or exceeds the motor temperature rating, contact Grundfos.

6.3 Preparation

DANGER

Electric shock

Death or serious personal injury

- Switch off the power supply before you start any work on the product.
- Make sure that the power supply cannot be switched on accidentally.

6.3.1 Checking the motor liquid

The MS submersible motors are factory-filled with SML-3 liquid, which is frost-proof down to -4 °F (-20 °C).

Check the level of the motor liquid and refill if required. Use tap water.

If frost protection is required, special Grundfos liquid must be used to refill the motor. Otherwise tap water may be used for refilling.

Refill the liquid as described below.

6.3.2 Grundfos submersible motors MS4000 and MS402

The filling hole for the motor liquid is placed in the following positions:

MS4000: on the side of the motor near the top.

MS402: on the bottom of the motor.

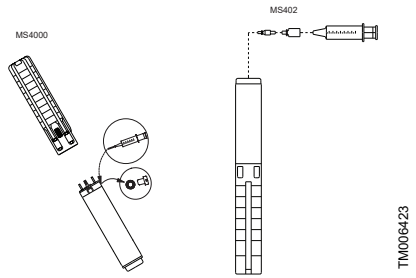
1. Position the pump as indicated in the figure below. Make sure that the filling screw is at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe as indicated in the figure below until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torques:

MS4000: 2.2 ft-lbs (3.0 Nm).

MS402: 1.5 ft-lbs (2.0 Nm).

The pump is now ready for installation.



Pump position during filling, MS4000 and MS402

6.3.3 Grundfos submersible motors, MS6000 and MS6000P

- If the motor is delivered from stock, the liquid level must be checked before the motor is fitted to the pump. See the figure below.
- On pumps delivered directly from Grundfos, the liquid level has already been checked.
- In case of service, the liquid level must be checked. See the figure below.

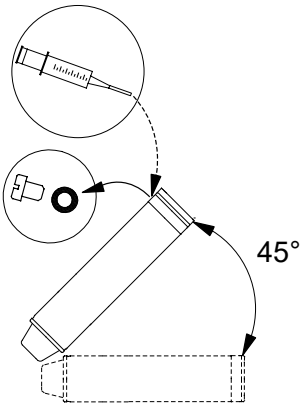
Filling procedure:

The filling hole for the motor liquid is placed on the top of the motor.

1. Position the pump as indicated the in figure below. Make sure that the filling screw is at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe (see the figure below) until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the motor.

Torque: 2.2 ft-lbs (3.0 Nm).

The pump is now ready for installation.



Motor position during filling, MS6000 and MS6000P

6.3.4 Grundfos submersible motors, MMS6, MMS8000 and MMS10000

Filling procedure:

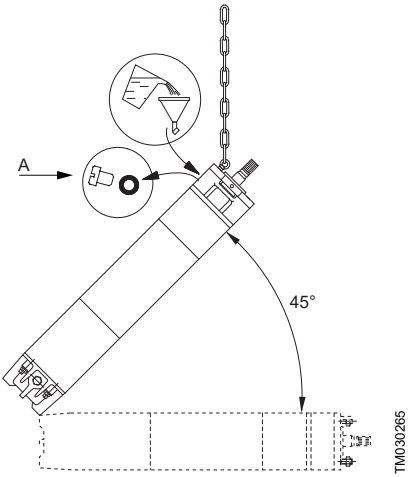
1. Place the motor at a 45 ° angle with the top of the motor upwards. See the figure below.
2. Unscrew the plug A and place a funnel in the hole.
3. Pour tap water into the motor until the motor liquid inside the motor starts running back out of the filling hole.

> **!** Do not use motor liquid that contains oil.

4. Remove the funnel and refit the plug A.

> **!** Before fitting the motor to a pump after a long period of storage, lubricate the shaft seal by adding a few drops of water and turning the shaft.

The pump is now ready for installation.



Motor position during filling, MMS

Pos.	Description
A	Plug

6.3.5 Installation depth

Make sure that the installation depth of the pump is always at least 3 ft (1 m) below the maximum draw-down level of the well. For flow rates exceeding 100 gpm (22.7 m^3/h), refer to the performance curves for recommended minimum submergence.

Never install the pump so that the bottom of the motor is lower than the top of the well screen or within 5 ft (1.5 m) of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, make sure that the water velocity passing over the motor is sufficient to ensure proper motor cooling. The minimum recommended water flow rates ensuring proper cooling are listed in section Maximum water temperature.

Related information

10.1.1 Maximum water temperature - minimum velocity/flow past the motor

6.3.6 Power supply

Check the motor voltage, phase number and frequency indicated on the motor nameplate against the actual power supply.

6.3.7 Power cable type

The power cable used between the pump and the control box or control panel must be approved for submersible pump applications. Conductors may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation must be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association (CSA) certified cable may also be used.

Related information

10.4 Submersible drop cable selection charts (60 Hz)

6.4 Removing and fitting the cable guard

If the cable guard is attached with screws, remove the screws to loosen it. To fit the cable guard on the pump, tighten the screws to fit it securely to the pump. See Appendix A for further details.

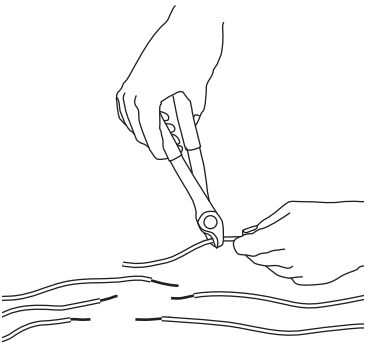
Make sure that the pump chambers are aligned when the cable guard has been fitted.

6.5 Splicing the motor cable

A good cable splice is critical to proper operation of the pump.

If the splice is carefully made, it works as well as any other portion of the cable, and is completely watertight. Use a heat shrink splice kit. Make the splice in accordance with the kit manufacturer's instructions. Typically a heat shrink splice can be made as follows:

1. Check the motor - and the submersible drop cables for damage.
2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. See the figure Cutting and stripping the motor leads below. On single-phase motors, make sure to match the colors.
3. Strip back and trim off 1/2 inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.
4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-Kon" type connector on each lead, making sure that lead colors are matched. Using "Sta-Kon" crimping pliers, indent the lugs. See the figure Crimping the connectors below. Make sure to squeeze hard on the pliers, particularly in the case of a large cable.
5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working towards the ends. See the figure Applying heat to the connector below.
6. Continue to apply the heat to the tubing. Make sure not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete. See the figure Completed splices below.



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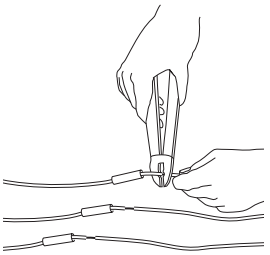
Cutting and stripping the motor leads



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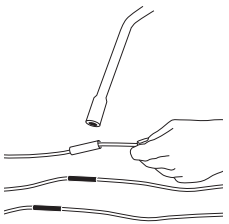
Crimping the connectors



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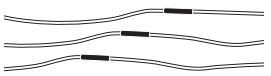
Applying heat to the connector



TM050035_0611

Completed splices

6.6 Riser pipe

WARNING

Sharp element

Death or serious personal injury

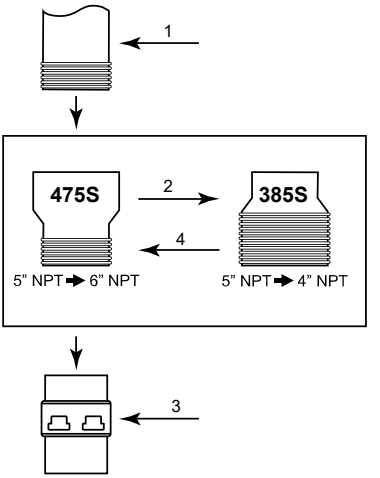
- When mounting the riser pipe, adapter or hose, wear personal protective equipment to avoid cutting on sharp edges on the pump.

Make sure that the riser pipe or hose are properly sized and selected based on the estimated flow rates and friction-loss factors.

6.6.1 If an adapter is required

Install the riser pipe to the pipe adapter. Then install the riser pipe with the adapter to the pump outlet port.

Use a back-up wrench when attaching the riser pipe to the pump. Make sure that the pump is gripped only by the flats on the top of the outlet chamber. The body of the pump, cable guard or motor must not be gripped under any circumstances.



TM050036

Pipe adapters

Pos.	Description
1	Riser pipe
2	Pipe adapters
3	Pump outlet
4	or

6.6.2 If a steel riser pipe is used

Always use steel riser pipes with the large submersible pumps. Use an approved pipe thread compound on all joints. Make sure the joints are adequately tightened to prevent the joints from coming loose when the motor starts and stops.

When tightened, make sure that the first section of the riser pipe does not come in contact with the check valve retainer.

After the first section of the riser pipe is attached to the pump, clamp the lifting wire to the pump, if there is a provision on the pump for a lifting wire. If not, clamp the lifting wire to the first section of the riser pipe.

When raising the pump and riser pipe section to vertical position, make sure not to place bending stress on the pump by picking it up at the pump end only.

Make sure that the power cables are not cut or damaged when the pump is being lowered in the well.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with clips or tape just above and below the splice.

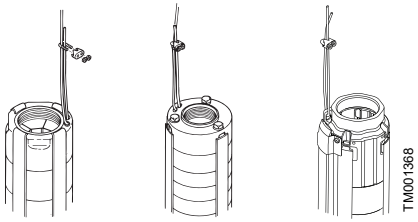
6.6.3 If a plastic or flexible riser pipe is used

Use plastic riser pipes only with the smaller domestic submersible pumps.

Important: Plastic and flexible pipes tend to stretch under load. Take this stretching into account when securing the cable to the riser pipe. Leave 3 to 4 inches (75 to 100 mm) of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch also affects the calculation of the pump installation depth. As a general rule, plastic pipe stretches to approximately 2 % of its length. For example, if a 200 feet (61 m) of plastic riser pipe is installed, the pump may actually be down 204 feet (62 m). If the installation depth is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When a plastic riser pipe is used, attach a safety cable to the pump to lower and raise it.

When plastic pipes are used, secure the pump by an unloaded straining wire to be fastened to the outlet chamber of the pump. See the figure below.



Fixing the straining wire

Contact the pipe manufacturer or representative to ensure that the pipe type and physical characteristics are suitable for this use.

Use the correct joint compound recommended by the pipe manufacturer. In addition, use a torque arrester when using a plastic pipe.

Do not connect the first plastic or flexible riser pipe section directly to the pump. Always attach a metallic nipple or adapter into the valve casing on the top of the pump. When tightened, make sure that the threaded end of the nipple or adapter does not come in contact with the check valve retainer.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Grundfos nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with Grundfos cable clips or tape just above each joint.

Check valves

Always install a check valve on the top of the well. In addition, for installations deeper than 200 feet (61 m), install check valves at no more than 200 ft (61 m) intervals.

Protect the well from contamination

To protect against surface water entering the well and contaminating the water source, make sure that the well is finished off above grade and that a locally approved well seal or pitless adapter unit is utilized.

6.7 Electrical and variable-frequency drive information

DANGER

Electric shock

Death or serious personal injury

- Switch off the power supply before starting any work on the product.
- Make sure that the power supply cannot be accidentally switched on.

USA and Canada: All electrical work must be performed by a qualified electrician and installed in accordance with the National Electrical Code/ Canadian Electrical Code, local codes and regulations.

DANGER

Electric shock

Death or serious personal injury

- Provide acceptable grounding in order to reduce the risk of electric shock during operation of this pump. If the means of connection to the box connected to the power supply is other than a grounded metal conduit, ground the pump by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the terminal box.

Make sure that the voltage, phase number and frequency of the power supply match the motor. Motor voltage, phase number, frequency and full-load current information can be found on the motor nameplate.

The equipment-grounding lead, when one is provided, is the conductor that has an outer surface of insulation that is green with or without one or more yellow stripes.

If voltage variations are larger than ± 10 %, do not operate the pump.

Direct-on-line (DOL) starting is used due to the extremely short run-up time of the motor (maximum 0.1 second), and the low moment of inertia of the pump and motor. DOL starting current (locked rotor current) is between 4 and 6.5 times the full-load current.

If DOL starting is not acceptable and reduced starting current is required, use an autotransformer or resistant starters for 5 to 30 hp motors, depending on the cable length. For motors over 30 hp, use autotransformer starters.

Related information

10.6.1 Grundfos submersible motors, 60 Hz

6.7.1 Engine-driven generators

If the pump is operated by an engine driven generator, contact the manufacturer of the generator to ensure the proper generator is selected and used. See sectionGuide for engine-driven generators in submersible pump applications for generator sizing guide for generator sizing guide.

If power is supplied through transformers, section Transformer capacity required for three-phase submersible motors outlines the minimum KVA rating and capacity required for satisfactory pump operation.

Related information

10.2 Guide for engine-driven generators in submersible pump applications

10.3 Transformer capacity required for three-phase submersible motors

6.7.2 Control box or panel wiring

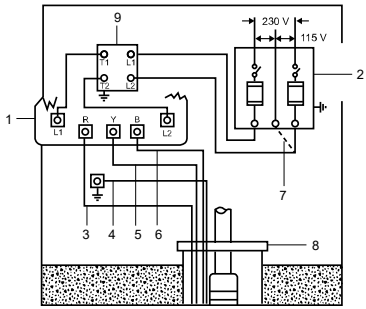
Single-phase motors

Connect single-phase motors as indicated in the motor control box.

A typical single-phase wiring diagram using a Grundfos control box is indicated in the figure below.

Motor burnout protection through CUE, CU331SP, or MP 204.

Use approved dry-run protectio0n, such as MP 204.



TM050037

Single-phase wiring diagram for Grundfos control boxes

Pos.	Description
1	Control box
2	Fused disconnect switch
3	Red
4	Green
5	Yellow
6	Black
7	Use dotted line for 115 V operation
8	Well seal
9	Pressure switch

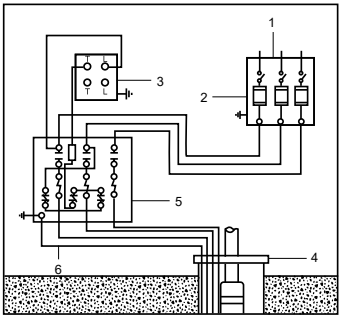
Three-phase motors

Use three-phase motors with the proper motor starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overload current.

Use a proper starter with ambient-compensated, class 10, extra quick-trip overload relays or an MP 204 to provide the best possible motor winding protection.

Each of the three motor legs must be protected with overloads. The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. A three-phase motor wiring diagram is indicated in the figure below.

Ensure that the pump is completely submerged before checking the direction of rotation. Severe damage may be caused to the pump and motor if they are run dry.



TM050038

Three-phase wiring diagram for Grundfos motors and other motor manufacturers

Pos.	Description
1	Power supply
2	Fused disconnect switch
3	Pressure switch
4	Well seal
5	Magnetic starter
6	Green

6.7.3 Variable-frequency drive operation

Grundfos motors

Three-phase Grundfos motors can be connected to a variable frequency drive (VFD).

During variable-frequency drive operation, do not run the motor at a frequency higher than the nominal frequency and not lower than 30 Hz for asynchronous motors or 55 Hz for synchronous motors. In connection with pump operation, never reduce the frequency (and consequently the speed) to such a low level that the necessary flow of the cooling liquid past the motor is no longer ensured.

If a Grundfos MS motor with temperature transmitter is connected to a variable frequency drive, a fuse incorporated in the transmitter melts, and the transmitter becomes inactive. The transmitter cannot be reactivated. This means that from that point on, the motor operates like a motor without a temperature transmitter.

To enable the motor temperature monitoring, install a Pt100 or Pt1000 sensor.

To avoid damage to the pump, make sure that the motor stops when the pump flow falls below 0.1 x rated flow.

Depending on the type of the variable frequency drive, it may expose the motor to detrimental voltage peaks.

The variable frequency drive must have an output sine-wave filter to limit voltage peaks (Upeak) and to reduce dU/dt (or dV/dt) which causes stress on the insulation of the submersible motor. For sine-wave filter location placement within the system, see the figure Location of the sine-wave filter in the system.

Protect the motor from voltage peaks (Upeak) and excess dU/dt (or dV/dt) by using a sine-wave filter if one or more of the following conditions are present:

- The motor nameplate voltage is above 379 V.
- The variable frequency drive (VFD) uses pulse width modulation (PWM) and/or IGBT-BJT switches.
- The VFD voltage rise time is less than 2 msec (NEMA MG 1-2011).
- The power cable length from the VFD to the submersible motor terminals is 0 to 1500 ft (0 to 457 m).
- The power quality is not stable.
- Keep the motor peak voltage (U_{peak}) and dU/dt within the limits listed in the table below.

For recommended best practice, use a resistor-inductor-capacitor (RLC) type sine-wave filter. An equivalent type LC sine-wave filter is acceptable.

Consult the VFD manufacturer for specific sine-wave filter recommendation.

Maximum peak voltage and dU/dt for Grundfos submersible motors		
Motor series	Maximum U_{peak} voltage	Maximum dU/dt
MS 402	650 V phase-phase	2000 V/micro s.
MS 4000	850 V phase-phase	2000 V/micro s.
MS 6000/MS 6000P	850 V phase-phase	2000 V/micro s.
MMS6	850 V phase-ground	500 V/micro s.
MMS 8000	850 V phase-ground	500 V/micro s.
MMS 10000	850 V phase-ground	500 V/micro s.

For asynchronous motors:

Permissible frequency ranges:

- 30-50 Hz
- 30-60 Hz.

Ramp times: maximum 3 seconds from standstill to minimum frequency and vice versa.

For synchronous motors MS6000P:

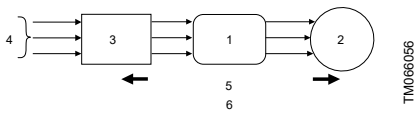
Permissible frequency ranges:

- 55-100 Hz
- 55-120 Hz.

Ramp times: maximum 3 seconds from standstill to minimum frequency and vice versa.

Depending on the type, the frequency converter may cause increased acoustic noise from the motor. Furthermore, it may expose the motor to detrimental voltage peaks. This can be abated by installing an LC filter or a sinus filter between the frequency converter and the motor.

For further details, contact your frequency converter supplier or Grundfos.



Location of the sine-wave filter in the system

Pos.	Description
1	Sine-wave filter
2	Motor
3	VFD
4	379 V or greater incoming power
5	Cable length from VFD to motor
6	0 to 1500 ft (0 to 457 m)

For further details, contact your VFD supplier or Grundfos.

6.7.4 Setting up the CUE frequency converter in an SPE system

The SPE system consists of the following:

- SPE pump set
- Sine-wave filter
- CUE frequency converter.

The CUE has a start up guide. Follow the instructions on the display.

For further information regarding safety and advanced settings, see the CUE Installation and operating instruction.

QR96780034

Installation and operating instructions

http://net.grundfos.com/qr/i/9780034

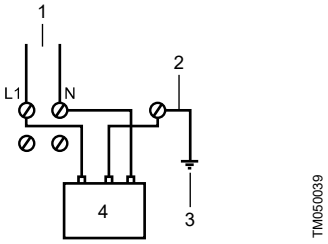
6.7.5 High-voltage surge arresters

Use a high-voltage surge arrester to protect the motor against lightning and switching surges.

Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area.

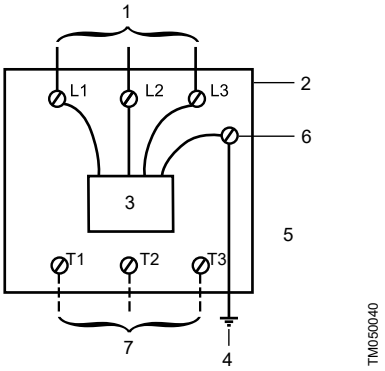
Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

Install the correct voltage-rated surge arrester on the supply side of the control box. See the figures below. The arrester must be grounded in accordance with the National Electrical Code/ Canadian Electrical Code and local codes and regulations.



Single-phase installation

Pos.	Description
1	Single-phase power supply
2	Ground
3	True grounding point
4	Lightning arrester



Three-phase installation

Pos.	Description
1	Three-phase power supply
2	Pump control panel
3	Lightning arrester
4	True grounding point
5	Install lightning protectors before fuses or circuit breaker
6	Ground
7	To MS motor

The warranty on all three-phase submersible motors becomes void in the following cases:

- The motor is operated with single-phase power through a phase converter.
- Three-leg ambient compensated, extra quick-trip overload protectors are not used.
- Three-phase current imbalance is not checked and recorded.
- High-voltage surge arresters are not installed.

Related information

7. Startup

6.7.6 Control box or panel grounding

DANGER

Electric shock

Death or serious personal injury

- The control box or control panel must be permanently grounded in accordance with the National Electrical Code/ Canadian Electrical Code and local codes or regulations.

The ground wire must be a bare copper conductor at least the same size as the submersible drop cable wire size.

Run the ground wire as short a distance as possible and fasten it securely to a true grounding point.

True grounding points are considered to be one of the following:

- a grounding rod driven into the water strata
- a steel well casing submerged into the water lower than the pump installation depth
- steel outlet pipes without insulating couplings.

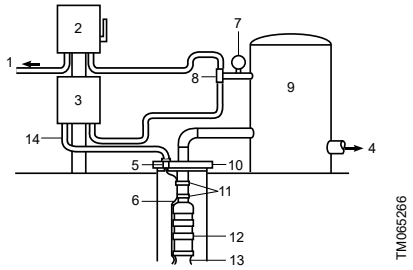
If plastic outlet pipe and well casing are used or if a grounding wire is required by local codes, connect a properly sized, bare copper wire to a stud on the motor and run to the control panel.

DANGER

Explosive environment

Death or serious personal injury

- Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or control panel.



Wiring and installation diagram

Pos.	Description
1	Power supply
2	Electrical disconnect box
3	Control box
4	House supply
5	Conduit connector
6	Submersible drop cable
7	Pressure gauge
8	Pressure switch
9	Pressure tank
10	Well seal
11	Tape
12	Pump
13	Motor
14	Conduit [1)]

1) Conduit for proper support and protection of the cable against damage between the motor and the point of supply connection.

6.7.7 Wiring checks and installation

Before making the final surface wiring connection of the submersible drop cable to the control box or control panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 200 megaohms. See the table below.

If the insulation resistance of the cable and splice is measured at higher than 200 megaohms, run the submersible drop cable through the well seal with a conduit connector to prevent foreign matter from entering the well casing.

Always protect the submersible drop cable with conduit from the pump to the control box or control panel. See the figure Wiring and installation diagram above.

Finish the wiring and make sure that all electrical connections are made according to the wiring diagram.

Make sure that the control box or control panel and high-voltage surge arrester are grounded.

Route conductors properly such as in conduit where called for by Local Code to protect the conductors.

Related information

6.7.8 Insulation resistance and ohm value chart

6.7.6 Control box or panel grounding

6.7.8 Insulation resistance and ohm value chart

The insulation resistance in a submersible pumping system is a measure of the ability of the motors and/or cables to withstand normal - and transient voltage without breakdown and failure. An "adequate" level of insulation resistance is not a constant value, but depends on the installation voltage and conditions, and whether the measured resistance is lowered by a specific weak point or by widely distributed conductance such as in cable insulation material itself. For this reason, values for acceptable resistance cannot be specific.

Insulation resistance measurements

Measure the insulation resistance at the time of initial motor installation and then periodically. In deep set submersible installations, take measurements throughout the installation process to detect potential cable insulation or connection damage before the unit is completely installed. The insulation resistance table in this section describes the condition of the insulation system for a submersible motor system of 600 V or less, based on megohmmeter readings.

Measure the insulation resistance according to local codes and regulations.

The table below indicates suggested values of insulation resistance and the test voltage in relation to the rated voltage of the motor.

Rated voltage	≤ 500 [V]	> 500 [V]
Condition of motor and cable	[MΩ]	[MΩ]
New motor without submersible drop cable	≥ 200	≥ 200
Used motor which can be re-installed in a well	≥ 10	≥ 10
New motor in a well	≥ 20	≥ 20
Motor in good condition in a well	≥ 0.5	≥ 1
Damaged insulation	< 0.5	< 1

If the rated motor voltage is less than or equal to 500 V, the insulation resistance must be measured at a test voltage of 500 VDC.

If the rated motor voltage is greater than 500 V, the insulation resistance must be measured at a test voltage of 1000 VDC.

7. Startup

After the pump is set into the well and the wiring connections have are made, go through the following procedures:

1. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
2. Adjust the gate valve one-third of the way open.
3. On three-phase units, check direction of rotation and current imbalance according to the instructions below. For single-phase units proceed directly to section Developing the well.
4. Do not operate the pump with the outlet valve closed. This can result in damage to the motor and the pump due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

Related information

7.1.3 Developing the well

7.1 Startup with three-phase motors

7.1.1 Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. To make sure the motor is running in the proper direction, follow the procedures below:

1. Start the pump and check the water quantity and pressure.
2. Stop the pump and interchange any two leads.
3. Start the pump and again check the water quantity and pressure.

4. Compare the results observed. The wire connection which gives the highest pressure and largest water quantity is the correct connection.

7.1.2 Check for current imbalance

Current imbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current imbalance be checked in all three-phase systems.

Make sure that the current imbalance between the phases do not exceed 5 % under normal operating conditions.

Determine if the supply power service is a two-transformer or three-transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See section Transformer capacity required for three-phase submersible motors.

The percentage of current imbalance can be calculated with the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% current imbalance} = \frac{\text{Greatest amp difference from the average}}{\text{Average current}} \times 100$$

To determine the percentage of current imbalance, proceed as follows:

1. Measure and record current readings in amps for each leg (hookup 1). Disconnect the power.
2. Shift or roll the motor leads from left to right so the submersible drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads this way does not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect the power.
3. Shift submersible drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start the pump, measure and record current reading on each leg. Disconnect the power.
4. Add the values for each hookup.
5. Divide the total by 3 to obtain the average.
6. Compare each single leg reading from the average to obtain the greatest amp difference.
7. Divide this difference by the average to obtain the percentage of imbalance.

Use the wiring hookup which provides the lowest percentage of imbalance. See section Correcting for three-phase current imbalance for a specific example of correcting for three-phase current imbalance.

Related information

10.3 Transformer capacity required for three-phase submersible motors

10.6.3 Correcting for three-phase current imbalance

7.1.3 Developing the well

After proper rotation and current imbalance are checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating.

Do not stop the pump until the water runs clear.

If the water is clean and clear when the pump is first started, open the valve slowly until the desired flow rate is reached. As the valve is being opened, check the drawdown to ensure that the pump is always submerged.

Make sure that the dynamic water level is always more than 3 feet (0.9 m) above the suction interconnector of the pump.

Disconnect the temporary piping arrangements and complete the final piping connections.

Do not operate the pump with the outlet valve closed. This can result in damage to the motor and the pump due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

8. Operating the product

Check the pump and system periodically for water quantity, pressure, drawdown, periods of cycling and operation of controls.

Related information

9. Troubleshooting

8.1 Minimum flow rate

To ensure the adequate cooling of the motor, do not set the pump flow rate so low that the cooling requirements specified in section cannot be met.

Related information

6.2.2 Pumped liquids

8.1.1 Frequency of starts and stops

Motor type	Number of starts
MS402	Minimum 1 per year. Maximum 100 per hour. Maximum 300 per day.
MS4000	Minimum 1 per year. Maximum 100 per hour. Maximum 300 per day.
MS6000	Minimum 1 per year. Maximum 30 per hour. Maximum 300 per day.
MS6000P	Minimum 1 per year. Maximum 120 per hour. Maximum 360 per day.
MMS6	Minimum 1 per year. Maximum 10 per hour. Maximum 70 per day.
MMS8000	Minimum 1 per year is. Maximum 8 per hour. Maximum 60 per day.
MMS10000	Minimum 1 per year is. Maximum 6 per hour. Maximum 50 per day.

8.2 Soft starter

The starting voltage is minimum 55 % of the value stated on the nameplate.

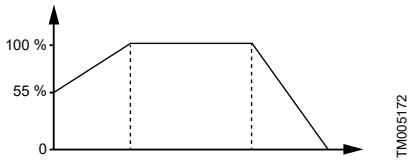
If a high locked-rotor torque is required or if the power supply is not optimal, the starting voltage must be higher.

Run-out time: Maximum 3 seconds.

If the above-mentioned run-up and run-out ramps are followed, unnecessary heating of the motor is avoided.

If the soft starter is fitted with bypass contacts, the soft starter is in operation during run-up and run-out.

Do not use the soft starter in connection with operation with a generator.



Operation with a soft starter

Pos.	Description
1	Voltage
2	Time
3	3 seconds
4	3 seconds

8.3 Maintenance and service

All pumps are easy to service.

Service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service center.

DANGER

Toxic or radio active liquid

Death or serious personal injury

- If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

Contact Grundfos with details about the pumped liquid before returning the product for service. Otherwise Grundfos can refuse to accept the product.

Possible costs of returning the pump are paid by the customer.

8.3.1 SPE

The following is only valid for SPE pump sets.

DANGER

Magnetic field

Death or serious personal injury

- Do not handle the rotor if having a pacemaker.

DANGER

Crushing of hands

Death or serious personal injury

- Keep the rotor surroundings free of magnetic objects and be careful when placing the rotor on a magnetic surface.

DANGER

Electric shock

Death or serious personal injury

- Make sure that motor cable ends are not live before starting work on the product.
- Make sure that the power supply cannot be accidentally switched on.

In case of unintended water flow through a non-energized pump, there is a risk that the moving parts of the pump and the motor may start rotating, and generate voltage over the terminals. The size of the voltage depends on the rotation speed. Therefore, the motor terminals must be considered as live until proven otherwise.

9. Troubleshooting

The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. Start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed:

- a combination of voltmeter and ammeter
- an ohmmeter.

DANGER

Electric shock

Death or serious personal injury

- Use rubber gloves and boots and make sure to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well.

DANGER

Electric shock

Death or serious personal injury

- Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electric shock.

9.1 SPE

The following is only valid for SPE pump sets.

DANGER

Magnetic field

Death or serious personal injury

- Do not handle the rotor if having a pacemaker.

DANGER

Crushing of hands

Death or serious personal injury

- Keep the rotor surroundings free of magnetic objects and be careful when placing the rotor on a magnetic surface.

DANGER

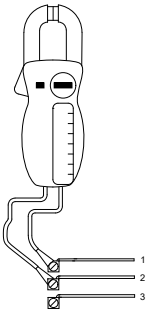
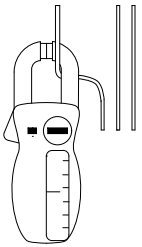
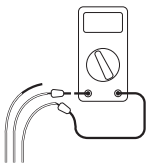
Electric shock

Death or serious personal injury

- Make sure that motor cable ends are not live before starting work on the product.
- Make sure that the power supply cannot be accidentally switched on.

In case of unintended water flow through a non-energized pump, there is a risk that the moving parts of the pump and the motor may start rotating, and generate voltage over the terminals. The size of the voltage depends on the rotation speed. Therefore, the motor terminals must be considered as live until proven otherwise.

9.2 Preliminary tests

Test	How to measure	What it means
Supply voltage  TM001371	With a voltmeter set to the proper scale, measure the voltage at the control box or starter. On single-phase units, measure between line and neutral. On three-phase units, measure between the legs (phases).	When the motor is under load, the voltage must be within ± 10 % of the value stated on the nameplate. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor power supply and the pump must not be operated until these variations are corrected. If the voltage constantly remains high or low, the motor must be changed to the correct supply voltage.
Current  TM001372	With an ampmeter set to the proper scale, measure the current on each power lead at the control box or starter. See section for motor amp draw information. Current must be measured when the pump is operating at a constant outlet pressure with the motor fully loaded.	If the amp draw exceeds the listed service factor amps (SFA), or if the current imbalance is greater than 5 % between each leg on three-phase units, check the following: • Burnt contacts on motor-protective circuit breaker. • Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances. • Supply voltage too high or low. • Motor windings are shortened. • Pump is damaged, causing a motor overload.
Winding resistance  TM050028_0511	Turn off power and disconnect the submersible drop cable leads in the control box or starter. With an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms. Zero-adjust the ohmmeter and measure the resistance between leads. Record the values. Motor resistance values can be found in section Insulation resistance and ohm value chart. Cable resistance values are in section Insulation resistance and ohm value chart.	If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If the ohm value is less than normal, the motors may be shorted. If the ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the submersible drop cable leads are mixed. To verify lead colors, see resistance values in section Insulation resistance and ohm value chart.
Insulation resistance TM050029_0511	Turn off power and disconnect the submersible drop cable leads in the control box or starter. With an ohmmeter or megohmmeter, set the scale selector to Rx 100K and zero adjust the meter. Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).	For ohm values, refer to section Insulation resistance and ohm value chart.. Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance.

Related information

6.7.8 Insulation resistance and ohm value chart

6.7.8 Insulation resistance and ohm value chart

9.3 Checking pump performance

9.3 Checking pump performance

Test the pump performance against its curve based on the Troubleshooting chart below. Perform the following steps:

1. Install a pressure gauge.
2. Start the pump.
3. Gradually close the outlet valve.
4. Read pressure at shut-off.
5. After reading, open the valve to its previous position.
6. To calculate pump performance, first convert psi reading to feet. For water: psi x 2.31 = ____ feet.
7. Add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running.
8. Refer to the specific pump curve for the shut-off head (pressure) for that pump model. If the measured head is close to the curve, the pump is OK.

9.4 Troubleshooting the product

9.4.1 The pump does not run

Cause	Remedy
Supply failure.	• Connect the power supply.
The fuses are blown.	• Replace the fuses.
The motor-protective circuit breaker has tripped.	• Reactivate the motor-protective circuit breaker.
The thermal protection has tripped.	• Reactivate the thermal protection.
The main contacts in the motor-protective circuit breaker are not making contact or the coil is faulty.	• Replace the contacts or the magnetic coil.
The control circuit is defective.	• Repair the control circuit.
The controls are defective.	• Replace worn or defective parts.
The motor and/or cable are defective.	• If an open motor winding or ground is found, pull the pump from the well and re-check values at the surface. • Repair or replace the motor or cable.
The capacitor is defective (single-stage only).	• Check the capacitor with an ohmmeter • If there is no ohmmeter needle movement, replace the capacitor.

9.4.2 The pump runs but does not deliver water

Cause	Remedy
The groundwater level in the well is too low.	• Lower the pump so the water level is at least 3 feet above the suction interconnector or install a water level control.
The integral pump check valve is blocked.	• Pull the pump from the well. • Remove the blockage. • Repair the valve and the valve seat, if necessary, and check for other damage. • Rinse out the pump and re-install it.
The inlet strainer is clogged.	• Pull the pump from the well. • Clean the inlet strainer. • Rinse out the pump and re-install it.
The pump is damaged.	• Pull the pump from the well. • Repair as necessary.

Cause	Remedy
	• Rinse out the pump and re-install it.

9.4.3 The pump runs, but at reduced capacity

Cause	Remedy
The direction of rotation is wrong (three-phase only).	• Correct the wiring and change the leads as required.
The drawdown is larger than anticipated.	• Lower the pump so the water level is at least 3 feet above the suction interconnector or install a water level control.
The outlet piping or the valve are leaking.	• Repair the leaks.
The integral pump check valve is blocked.	• Pull the pump from the well. • Remove the blockage. • Repair the valve and the valve seat, if necessary, and check for other damage. • Rinse out the pump and re-install it.
The inlet strainer is clogged.	• Pull the pump from the well. • Clean the inlet strainer. • Rinse out the pump and re-install it.
The pump is worn.	• Pull the pump from the well. • Repair as necessary. • Rinse out the pump and re-install it.

9.4.4 The pump cycles too much

Cause	Remedy
The pressure switch is not properly adjusted or is defective.	• Re-adjust the switch or replace it if it is defective.
The level control is not properly set or is defective.	• Re-adjust the setting; refer to the manufacturer data. Replace the level control if it is defective.
The pressure in the diaphragm tank is insufficient or the tank or piping is leaking.	• Repair or replace any damaged components.
The snifter valve or bleed orifice are plugged.	• Clean and/or replace any defective snifter valve or bleed orifice.
The tank is too small.	• Replace it with a proper size tank.

9.4.5 Fuses blow or circuit breakers trip

Cause	Remedy
The voltage is too high or low.	• If the cable size is correct, contact the power company. If not, correct and/or replace as necessary.
The three-phase current imbalance is too high.	• If current imbalance is not within ± 5 %, contact the power supply company.
The control box wiring and components are incorrect or defective (single-phase only).	• Correct as required.
The capacitor is defective (single-phase only).	• Check the capacitor with an ohmmeter. • If there is no ohmmeter needle movement, replace the capacitor.
The starting relay is defective (certain types of single-phase only).	• Replace any defective starting relay.

10. Technical data

10.1 Motor cooling requirements

10.1.1 Maximum water temperature - minimum velocity/flow past the motor

Maximum water temperature - minimum velocity/flow past the motor					
Motor type	Minimum well casing or sleeve diameter	Minimum velocity	Minimum flow	Maximum temperature of the pumped liquid	
				Vertical installation	Horizontal installation
	[in (mm)]	[ft/s (m/s)]	[gpm (m^3/h)]	[°F (°C)]	[°F (°C)]
MS 402 / MS 4000	4 (102)	0.00 (0.00)	0.0 (0.0)	86 (30)	Flow sleeve recommended [2)]
MS 402 / MS 4000	4 (102)	0.25 (0.08)	1.2 (0.27)	104 (40)	104 (40)
MS 6000 (T40)	6 (152)	0.50 (0.15)	9 (2)	104 (40)	104 (40)
MS 6000 (T60)	6 (152)	3.30 (1.00)	30 (6.8)	140 (60)	140 (60)
MS 6000P	6 (152)	0.50 (0.15)	9 (2)	140 (60)	140 (60)
MMS 6 (T30)	6 (152)	0.15 (0.05)	13 (3)	86 (30)	86 (30)
MMS 6 (T50)	6 (152)	0.15 (0.05)	13 (3)	122 (50)	122 (50)
MMS 8000 (T30)	8 (203)	0.50 (0.15)	25 (5.7)	86 (30)	86 (30)
MMS 6 (T50)	8 (203)	0.50 (0.15)	25 (5.7)	122 (50)	122 (50)
MS 10000 (175, 200 hp)	10 (254)	0.50 (0.15)	55 (12.5)	86 (30)	86 (30)
MS 10000 (250 hp)	10 (254)	0.50 (0.15)	41 (9.3)	68 (20)	68 (20)

2) A flow inducer or flow sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

ft/s = feet per second

For MMS6, 50 hp and MMS 8000, 150 hp, the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the above table. For MMS10000, 250 hp, temperature is 18 °F (10 °C) lower.

10.2 Guide for engine-driven generators in submersible pump applications

1- or 3-phase motor [Hp]	Generator [kW]	
	Externally regulated	Internally regulated
0.33	1.5	1.2
0.5	2.0	1.5
0.75	3.0	2.0
1	4.0	2.5
1.5	5.0	3.0
2	7.5	4.0
3	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

Note:

- The table is based on typical +176 °F (+80 °C) rise continuous duty generators with 35 % maximum voltage dip during the startup of single- and three-phase motors.
- Contact the manufacturer of the generator to make sure the unit has adequate capacity to run the submersible motor.
- If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25.

10.3 Transformer capacity required for three-phase submersible motors

3-phase motor [Hp]	Minimum total KVA required [3]	Minimum KVA rating for each transformer	
		Two transformers Open Delta or Wye	Three transformers Delta or Wye
1.5	3	2	1
2	4	2	1.5
3	5	3	2
5	7.5	5	3
7.5	10	7.5	5
10	15	10	5
15	20	15	7.5
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

[3] Pump motor KVA requirements only, and does not include allowances for other loads.

10.4 Submersible drop cable selection charts (60 Hz)

The following tables indicate the recommended copper conductor sizes and various cable lengths for submersible motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for +167 °F (+75 °C) wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To ensure adequate starting torque, the maximum cable lengths are calculated to maintain 95 % of the service entrance voltage at the motor when the motor is running at maximum value stated on the nameplate. Cable sizes larger than specified may always be used and reduce power consumption.

Using cables smaller than the recommended sizes void the warranty. Smaller cable sizes may cause reduced starting torque and poor motor operation.

10.4.1 115 V and 230 V, 1-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)														
Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
115 V 1-ph 60 Hz	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1610 (491)	1960 (597)	2390 (728)	2910 (887)	3540 (1079)	4210 (1283)	5060 (1542)
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1190 (363)	1460 (445)	1780 (543)	2160 (658)	2630 (802)	3140 (957)	3770 (1149)
230 V 1-ph 60 Hz	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	6520 (1987)	7960 (2426)	9690 (2954)	11770 (3587)	14320 (4365)	17050 (5197)	20460 (6236)
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	4810 (1466)	5880 (1792)	7170 (2185)	8720 (2658)	10620 (3237)	12660 (3859)	15210 (4636)
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	3580 (1091)	4370 (1332)	5330 (1625)	6470 (1972)	7870 (2399)	9380 (2859)	11250 (3429)
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	2960 (902)	3610 (1100)	4410 (1344)	5360 (1634)	6520 (1987)	7780 (2371)	9350 (2850)
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2320 (707)	2850 (869)	3500 (1067)	4280 (1305)	5240 (1597)	6300 (1920)	7620 (2323)
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	1910 (582)	2360 (719)	2930 (893)	3620 (1103)	4480 (1366)	5470 (1667)	6700 (2042)
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1490 (454)	1850 (564)	2320 (707)	2890 (881)	3610 (1100)	4470 (1362)	5550 (1692)
	5	-	110 [4] (34 [4])	180 (55)	280 (85)	450 (137)	710 (216)	890 (271)	1110 (338)	1390 (424)	1740 (530)	2170 (661)	2680 (817)	3330 (1015)
	7.5	-	-	120 [4] (37 [4])	200 (61)	310 (94)	490 (149)	610 (186)	750 (229)	930 (283)	1140 (347)	1410 (430)	1720 (524)	2100 (640)
	10	-	-	-	160 [4] (49 [4])	250 (76)	390 (119)	490 (149)	600 (183)	750 (229)	930 (283)	1160 (354)	1430 (436)	1760 (536)
	15	-	-	-	-	170 [4] (52 [4])	270 (82)	340 (104)	430 (131)	530 (162)	660 (201)	820 (250)	1020 (311)	1260 (384)

[4] Indicates single conductor only (not jacketed).

Note:

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5. The maximum allowable length of aluminum is considerably shorter than the same copper wire size.
- Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of the service entrance voltage, running at the maximum value stated on the nameplate. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.2 200-208 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)															
Motor rating	[Hp]	AWG copper wire size [ft (m)]													
		14	12	10	8	6	4	3	2	1	0	00	000	0000
200-208 V 3-ph 60 Hz	0.5	710 (216)	1140 (347)	1800 (549)	2840 (866)	4420 (1347)	-	-	-	-	-	-	-	-
	0.75	510 (155)	810 (245)	1280 (390)	2030 (619)	3160 (963)	-	-	-	-	-	-	-	-
	1	430 (131)	690 (210)	1080 (329)	1710 (521)	2670 (814)	4140 (1262)	5140 (1567)	-	-	-	-	-	-
	1.5	310 (94)	500 (152)	790 (241)	1260 (384)	1960 (597)	3050 (930)	3780 (1152)	-	-	-	-	-	-
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)	2360 (719)	2940 (896)	3610 (1100)	4430 (1350)	5420 (1652)	-	-	-
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)	2250 (686)	2760 (841)	3390 (1033)	4130 (1259)	-	-	-
	5	110 [5] ([34 [5]])	170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1350 (411)	1660 (506)	2040 (622)	2490 (759)	3050 (930)	3670 (1119)	4440 (1353)
	7.5	-	-	200 (61)	310 (94)	490 (149)	770 (235)	960 (293)	1180 (360)	1450 (442)	1770 (539)	2170 (661)	2600 (792)	3150 (960)
	10	-	-	-	230 [5] ([70 [5]])	370 (113)	570 (174)	720 (219)	880 (268)	1090 (332)	1330 (405)	1640 (500)	1970 (600)	2390 (728)
	15	-	-	-	160 [5] ([49 [5]])	250 [5] ([76 [5]])	390 (119)	490 (149)	600 (183)	740 (226)	910 (277)	1110 (338)	1340 (408)	1630 (497)
	20	-	-	-	-	190 [5] ([58 [5]])	300 [5] ([91 [5]])	380 (116)	460 (140)	570 (174)	700 (213)	860 (262)	1050 (320)	1270 (387)
	25	-	-	-	-	-	240 [5] ([73 [5]])	300 [5] ([91 [5]])	370 [5] ([113 [5]])	460 (140)	570 (174)	700 (213)	840 (256)	1030 (314)
	30	-	-	-	-	-	-	250 [5] ([76 [5]])	310 [5] ([94 [5]])	380 [5] ([116 [5]])	470 (143)	580 (177)	700 (213)	850 (259)

[5] Indicates single conductor only (not jacketed).

Note:

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5. The maximum allowable length of aluminum is considerably shorter than the same copper wire size.
- Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at the maximum value stated on the nameplate. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.3 230 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)														
Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
230 V 3-ph 60 Hz	0.5	930 (283)	1490 (454)	2350 (716)	3700 (1128)	5760 (1756)	8910 (2716)	-	-	-	-	-	-	-
	0.75	670 (204)	1080 (329)	1700 (518)	2580 (786)	4190 (1277)	6490 (1978)	8060 (2457)	9860 (3005)	-	-	-	-	-
	1	560 (171)	910 (277)	1430 (436)	2260 (689)	3520 (1073)	5460 (1664)	6780 (2067)	8290 (2527)	-	-	-	-	-
	1.5	420 (128)	670 (204)	1060 (323)	1670 (509)	2610 (796)	4050 (1234)	5030 (1533)	6160 (1878)	7530 (2295)	9170 (2795)	-	-	-
	2	320 (98)	510 (155)	810 (247)	1280 (390)	2010 (613)	3130 (954)	3890 (1186)	4770 (1454)	5860 (1786)	7170 (2185)	8780 (2676)	-	-
	3	240 (73)	390 (119)	620 (189)	990 (302)	1540 (469)	2400 (732)	2980 (908)	3660 (1116)	4480 (1366)	5470 (1667)	6690 (2039)	8020 (2444)	9680 (2950)
	5	140 [6] (43 [6])	230 (70)	370 (113)	590 (180)	920 (280)	1430 (436)	1790 (546)	2190 (668)	2690 (820)	3290 (1003)	4030 (1228)	4850 (1478)	5870 (1789)
	7.5	-	160 [6] (49 [6])	260 (79)	420 (128)	650 (198)	1020 (311)	1270 (387)	1560 (475)	1920 (585)	2340 (713)	2870 (875)	3440 (1049)	4160 (1268)
	10	-	-	190 [6] (58 [6])	310 (94)	490 (149)	760 (232)	950 (290)	1170 (357)	1440 (439)	1760 (536)	2160 (658)	2610 (796)	3160 (963)
	15	-	-		210 [6] (64 [6])	330 (101)	520 (158)	650 (198)	800 (244)	980 (299)	1200 (366)	1470 (448)	1780 (543)	2150 (655)
	20	-	-	-	-	250 [6] (76 [6])	400 (122)	500 (152)	610 (186)	760 (232)	930 (283)	1140 (347)	1380 (421)	1680 (512)
	25	-	-	-	-	-	320 [6] (98 [6])	400 (122)	500 (152)	610 (186)	750 (229)	920 (280)	1120 (341)	1360 (415)
	30	-	-	-	-	-	260 [6] (79 [6])	330 [6] (101 [6])	410* (125*)	510 (155)	620 (189)	760 (232)	930 (283)	1130 (344)

6) Indicates single conductor only (not jacketed).

Note:

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5. The maximum permissible length of aluminum is considerably shorter than the same copper wire size.
- Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at the maximum value stated on the nameplate.. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.4 460 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)													
Motor rating	AWG copper wire size [ft (m)]												
[Hp]	14	12	10	8	6	4	3	2	1	0	00	000	0000
0.5	3770 (1149)	6020 (1835)	9460 (2883)	-	-	-	-	-	-	-	-	-	-
0.75	2730 (832)	4350 (1326)	6850 (2088)	-	-	-	-	-	-	-	-	-	-
1	2300 (701)	3670 (1119)	5770 (1759)	9070 (2765)	-	-	-	-	-	-	-	-	-
1.5	1700 (518)	2710 (826)	4270 (1301)	6730 (2051)	-	-	-	-	-	-	-	-	-
2	1300 (396)	2070 (631)	3270 (997)	5150 (1570)	8050 (2454)	-	-	-	-	-	-	-	-
3	1000 (305)	1600 (488)	2520 (768)	3970 (1210)	6200 (1890)	-	-	-	-	-	-	-	-
5	590 (180)	950 (290)	1500 (457)	2360 (719)	3700 (1128)	5750 (1753)	-	-	-	-	-	-	-
7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)	4100 (1250)	5100 (1554)	6260 (1908)	7680 (2341)	-	-	-	-
10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)	3800 (1158)	4680 (1426)	5750 (1753)	7050 (2149)	-	-	-
15	-	340 [7] (104 [7])	540 (165)	850 (259)	1340 (408)	2090 (637)	2600 (792)	3200 (975)	3930 (1198)	4810 (1466)	5900 (1798)	7110 (2167)	-
20	-	-	410 (125)	650 (198)	1030 (314)	1610 (491)	2000 (610)	2470 (753)	3040 (927)	3730 (1137)	4580 (1396)	5530 (1686)	-
25	-	-	330 [7] (101 [7])	530 (162)	830 (253)	1300 (396)	1620 (494)	1990 (607)	2450 (747)	3010 (917)	3700 (1128)	4470 (1362)	5430 (1655)
30	-	-	270* [7] (82 [7])	430 (131)	680 (207)	1070 (326)	1330 (405)	1640 (500)	2030 (619)	2490 (759)	3060 (933)	3700 (1128)	4500 (1372)
40	-	-	-	320 [7] (98 [7])	500 [7] (152 [7])	790 (241)	980 (299)	1210 (369)	1490 (454)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)
50	-	-	-	-	410 [7] (125 [7])	640 (195)	800 (244)	980 (299)	1210 (369)	1480 (451)	1810 (552)	2190 (668)	2650 (808)
60	-	-	-	-	-	540 [7] (165 [7])	670* (204*)	830 (253)	1020 (311)	1250 (381)	1540 (469)	1850 (564)	2240 (683)
75	-	-	-	-	-	440 [7] (134 [7])	550 [7] (168 [7])	680 [7] (207 [7])	840 (256)	1030 (314)	1260 (384)	1520 (463)	1850 (564)
100	-	-	-	-	-	-	-	500 [7] (152 [7])	620 [7] (189 [7])	760 [7] (232 [7])	940 (287)	1130 (344)	1380 (421)
125	-	-	-	-	-	-	-	-	-	600* [7] (183 [7])	740 [7] (226 [7])	890 [7] (271 [7])	1000 (305)

150	-	-	-	-	-	-	-	-	-	-	630 [7] (192 [7])	760 [7] (232 [7])	920 [7] (280 [7])
175	-	-	-	-	-	-	-	-	-	-	-	670 [7] (204 [7])	810 [7] (247 [7])
200	-	-	-	-	-	-	-	-	-	-	-	590 [7] (180 [7])	710 [7] (216 [7])

7) Indicates single conductor only (not jacketed).

Note:

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5. The maximum permissible length of aluminum is considerably shorter than the same copper wire size.
- Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at the maximum value stated on the nameplate.. In general, a voltage drop must be maintained at 3 V/ 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.5 575 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)													
Motor rating	AWG copper wire size [ft (m)]												
[Hp]	14	12	10	8	6	4	3	2	1	0	00	000	0000
0.5	5900 (1798)	9410 (2868)	-	-	-	-	-	-	-	-	-	-	-
0.75	4270 (1301)	6810 (2076)	-	-	-	-	-	-	-	-	-	-	-
1	3630 (1106)	5800 (1768)	9120 (2780)	-	-	-	-	-	-	-	-	-	-
1.5	2620 (799)	4180 (1274)	6580 (2006)	-	-	-	-	-	-	-	-	-	-
2	2030 (619)	3250 (991)	5110 (1558)	8060 (2457)	-	-	-	-	-	-	-	-	-
3	1580 (482)	2530 (771)	3980 (1213)	6270 (1911)	-	-	-	-	-	-	-	-	-
5	920 (280)	1480 (451)	2330 (710)	3680 (1122)	5750 (1753)	-	-	-	-	-	-	-	-
7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)	4150 (1265)	-	-	-	-	-	-	-	-
10	490 (149)	780 (238)	1240 (378)	1950 (594)	3060 (933)	4770 (1454)	5940 (1811)	-	-	-	-	-	-
15	330 [8] (101 [8])	530 (162)	850 (259)	1340 (408)	2090 (637)	3260 (994)	4060 (1237)	-	-	-	-	-	-
20	-	410 [8] (125 [8])	650 (198)	1030 (314)	1610 (491)	2520 (768)	3140 (957)	3860 (1177)	4760 (1451)	5830 (1777)	-	-	-
25	-	-	520 (158)	830 (253)	1300 (396)	2030 (619)	2530 (771)	3110 (948)	3840 (1170)	4710 (1436)	-	-	-
30	-	-	430 [8] (131 [8])	680 (207)	1070 (326)	1670 (509)	2080 (634)	2560 (780)	3160 (963)	3880 (1183)	4770 (1454)	5780 (1762)	7030 (2143)
40	-	-	-	500 [8] (152 [8])	790 (241)	1240 (378)	1540 (469)	1900 (579)	2330 (710)	2860 (872)	3510 (1070)	4230 (1289)	5140 (1567)
50	-	-	-	410* [8] (125 [8])	640 [8] (195 [8])	1000 (305)	1250 (381)	1540 (469)	1890 (576)	2310 (704)	2840 (866)	3420 (1042)	4140 (1262)
60	-	-	-	-	540* [8] (165 [8])	850 (259)	1060 (323)	1300 (396)	1600 (488)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)
75	-	-	-	-	-	690 [8] (210 [8])	860 (262)	1060 (323)	1310 (399)	1600 (488)	1970 (600)	2380 (725)	2890 (881)
100	-	-	-	-	-	-	640 [8] (195 [8])	790 [8] (241 [8])	970 (296)	1190 (363)	1460 (445)	1770 (539)	2150 (655)
125	-	-	-	-	-	-	-	630 [8] (192 [8])	770 [8] (235 [8])	950 (290)	1160 (354)	1400 (427)	1690 (515)

150	-	-	-	-	-	-	-		660 [8] (202 [8])	800 [8] (244 [8])	990* (302*)	1190 (363)	1440 (439)
175	-	-	-	-	-	-	-	-	-	700 [8] (214 [8])	870 [8] (265 [8])	1050 [8] (320 [8])	1270 (387)
200	-	-	-	-	-	-	-	-	-	-	760* [8] (232 [8])	920* [8] (280 [8])	1110 [8] (338 [8])

8) Indicates single conductor only (not jacketed).

10.5 Approvals

SP and SPE, all sizes [9]	NSF_CULUS_WATER_QUALITY_12 Pump End Only MH26400			TM059757
MS6000C and MS6000P motor	NSF_CULUS_WATER_QUALITY_12 Submersible Motor MH26400			TM059757
MS4000 motor	TM067249 Submersible Motor NSF/ANSI 372 MH26400		TM059569	
MS402 motor	TM067249 Submersible Motor NSF/ANSI 372 MH26400		TM059569	TM050001_0411

[9] The Grundfos SP/SPE pumps are certified when driven by a certified motor provided with suitable overheating protection.

10.6 Electrical data

10.6.1 Grundfos submersible motors, 60 Hz

Grundfos submersible motors, 60 Hz										
Hp	Ph	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
4-inch, single-phase, 2-wire motors (control box not required)										
0.5	1	115	1.60	35	15	55.0	12.0	62	76	900
0.5	1	230	1.60	15	7	34.5	6.0	62	76	900
0.75	1	230	1.50	20	9	40.5	8.4	62	75	900
1	1	230	1.40	25	12	48.4	9.8	63	82	900
1.5	1	230	1.30	35	15	62.0	13.1	64	85	900
4-inch, single-phase, 3-wire motors										
0.5	1	115	1.60	35	15	42.5	12.0	61	76	900
0.5	1	230	1.60	15	7	21.5	6.0	62	76	900
0.75	1	230	1.50	20	9	31.4	8.4	62	75	900
1	1	230	1.40	25	12	37.0	9.8	63	82	900
1.5	1	230	1.30	35	15	45.9	11.6	69	89	900
2	1	230	1.25	35	20	57.0	13.2	72	86	1500
3	1	230	1.15	45	30	77.0	17.0	74	93	1500
5	1	230	1.15	70	45	110.0	27.5	77	92	1500
4-inch, three-phase, 3-wire motors										
1.5	3	230	1.30	15	8	40.3	7.3	75	72	900
1.5	3	460	1.30	10	4	20.1	3.7	75	72	900
1.5	3	575	1.30	10	4	16.1	2.9	75	72	900
2	3	230	1.25	20	10	48	8.7	76	75	900
2	3	460	1.25	10	5	24	4.4	76	75	900
2	3	575	1.25	10	4	19.2	3.5	76	75	900
3	3	230	1.15	30	15	56	12.2	77	75	1500
3	3	460	1.15	15	7	28	6.1	77	75	1500
3	3	575	1.15	15	6	22	4.8	77	75	1500
5	3	230	1.15	40	25	108	19.8	80	82	1500
5	3	460	1.15	20	12	54	9.9	80	82	1500
5	3	575	1.15	15	9	54	7.9	80	82	1500
7.5	3	230	1.15	60	30	130	25.0	81	82	1500
7.5	3	460	1.15	35	15	67	13.2	81	82	1500
7.5	3	575	1.15	30	15	67	10.6	81	82	1500
10	3	460	1.15	50	30	90	18	81	80	1500

Single-phase motors (thermally protected): Use with approved motor control that matches the motor input in full load amperes.

Three-phase motors: Use with approved motor control that matches the motor input in full load amperes

with overload element(s) selected or adjusted according to control instructions.

Grundfos submersible motors, 60 Hz										
Hp	P h	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
6-inch, three-phase motors										
7.5	3	208-230	1.15	65	40	114-130	23.4 - 27.5	81	85-84	6070
7.5	3	460	1.15	30	17	68	13.2	81	85	6070
7.5	3	575	1.15	30	17	51	10.2	81	85	6070
10	3	208-230	1.15	90	50	126-142	30.0 - 37.5	82	86-84	6070
10	3	460	1.15	40	25	75	17.4	82	85	6070
10	3	575	1.15	40	25	56.5	13.4	82	85	6070
15	3	208-230	1.15	130	75	198-224	44.5 - 53.5	83	86-84	6070
15	3	460	1.15	60	35	112	25	83	84	6070
15	3	575	1.15	60	35	84	19.4	83	84	6070
20	3	208-230	1.15	175	100	310-350	57.5 - 71.5	84	86-84	6070
20	3	460	1.15	80	45	186	33.5	84	84	6070
20	3	575	1.15	80	45	144	26	84	84	6070
25	3	208-230	1.15	200	125	395-445	71-87	84	87-84	6070
25	3	460	1.15	100	60	236	41	84	84	6070
25	3	575	1.15	100	60	180	32	84	84	6070
30	3	208-230	1.15	250	150	445-500	81-104	84	87-84	6070
30	3	460	1.15	125	70	265	48	85	85	6070
30	3	575	1.15	125	70	194	37	85	85	6070
40	3	460	1.15	170	90	330	65	85	84	6070
40	3	575	1.15	170	90	250	49.5	85	84	6070
50	3	460	1.15	225	125	405	73.0	83	83	6182
8-inch, three-phase motors										
40	3	460	1.15	175	100	380	55.7	83	85	13000
50	3	460	1.15	225	125	550	67.8	84	85	13000
60	3	460	1.15	250	150	640	80.4	86	85	13000
75	3	460	1.15	300	175	580	97.4	86	86	13000
100	3	460	1.15	400	225	570	130.4	87	86	13000
125	3	460	1.15	500	300	600	160.0	87	87	13000
150	3	460	1.15	600	350	580	191.3	86	87	13000
10-inch, three-phase motors										
175	3	460	1.15	700	400	570	230.4	88	85	13000
200	3	460	1.15	800	500	620	265.2	87	82	13000
250	3	460	1.15	1100	600	610	352.2	87	79	13000

Grundfos submersible permanent-magnet motors, 60 Hz								
Hp	Ph	Volt [V]	SF	Amperage		Full load		Max. thrust [lbs]
				Start [A]	Max. [A]	Eff. [%]	Power factor	
6-inch, three-phase permanent-magnet motors								
5	3	410	1.15	8.8	8.8	87.2	96	6070
7.5	3	410	1.15	12.4	12.4	89.4	92	6070
10	3	410	1.15	16.2	16.2	90.1	88	6070
15	3	410	1.15	24.5	24.5	92.4	94	6070
20	3	410	1.15	32.2	32.2	92.8	90	6070
25	3	410	1.15	39.0	39.0	93.0	88	6070
30	3	410	1.15	44.8	44.8	93.0	92	6070
40	3	410	1.15	60.0	60.0	93.0	91	6070
50	3	410	1.15	82.6	82.6	92.5	86	6070

CUE 3 x 380 - 480V, UL compliant, maximum recommended fuzes							
Motor power [hp]	CUE 3 x 380 - 500V Nema 4x outdoor	CUE 3 x 380 - 500 V Nema 1 indoor	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	SIBA Type RK1	Littelfuse Type RK1
5	99619042	99616714	KTS-R-20	JKS-20	JJS-20	5017906-020	KLN-R-20
7.5	99619043	99616715	KTS-R-25	JKS-25	JJS-25	5017906-025	KLN-R-25
10	99619044	99616716	KTS-R-30	JKS-30	JJS-30	5012406-032	KLN-R-30
15	99619045	99616717	KTS-R-40	JKS-40	JJS-40	5014006-040	KLS-R-40
20	99619046	99616718	KTS-R-50	JKS-50	JJS-50	5014006-050	KLN-R-50
25	99619047	99616719	KTS-R-50	JKS-50	JJS-50	5014006-050	KLN-R-50
30	99619048	99616720	KTS-R-60	JKS-60	JJS-60	5014006-063	KLN-R-60
40	99619049	99616721	KTS-R-80	JKS-80	JJS-80	2028220-120	KLN-R-80
50	99619051	99616723	KTS-R-100	JKS-100	JJS-100	2028220-125	KLN-R-100

CUE 3 x 380-480V, UL compliant, maximum recommended fuzes						
Motor power [hp]	CUE 3 x 380 - 500V Nema 4x outdoor	CUE 3 x 380 - 500 V Nema 1 indoor	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1	Bussmann Type JFHR2	Ferraz-Shawmut J
5	99619042	99616714	ATM-R-20	A6K-20-R	FWH-20	HSJ-20
7.5	99619043	99616715	ATM-R-25	A6K-25-R	FWH-25	HSJ-25
10	99619044	99616716	ATM-R-30	A6K-30-R	FWH-30	HSJ-30
15	99619045	99616717	-	A6K-40-R	FWH-40	
20	99619046	99616718	-	A6K-50-R	FWH-50	HSJ-50
25	99619047	99616719	-	A6K-50-R	FWH-50	HSJ-50

30	99619048	99616720	-	A6K-60-R	FWH-60	HSJ-60
40	99619049	99616721	-	A6K-80-R	FWH-80	HSJ-80
50	99619051	99616723	-	A6K-100-R	FWH-100	HSJ-100

10.6.2 Other motor manufacturers

Refer to the other motor manufacturers' application maintenance manual.

10.6.3 Correcting for three-phase current imbalance

Example: Check for current imbalance for a 230 V, three-phase, 60 Hz submersible motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each submersible drop cable lead for hookups 1, 2 and 3.

Observe that hookup 3 must be used since it shows the least amount of current imbalance. Therefore, the motor operates at maximum efficiency and reliability.

By comparing the current values recorded on each leg, it can be noted that the highest value is always on the same leg, L_3. This indicates the imbalance is in the power source. If the high current values are on a different leg each time the leads are changed, the imbalance would be caused by the motor or a poor connection.

If the current imbalance is greater than 5 %, contact the power supply company for.

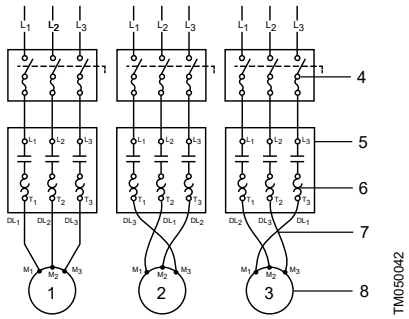
For a detailed explanation of three-phase balance procedures, see section Check for current imbalance.

	Step 1 (hookup 1)	Step 2 (hookup 2)	Step 3 (hookup 3)
(T_1)	DL_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)	DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)	DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4	Total = 75 amps	Total = 75 amps	Total = 75 amps

Step 5	Average current = $\frac{\text{total current}}{\text{3 readings}} = \frac{75}{3}$	= 25 amps

Step 6	Greatest amp difference from the average:	(hookup 1) = 25 - 23 = 2 (hookup 2) = 26 - 25 = 1 (hookup 3) = 25.5 - 25 = 0.5

Step 7	% imbalance	(hookup 1) = 2/25 x 100 = 8 (hookup 2) = 1/25 x 100 = 4 (hookup 3) = 0.5/25 x 100 = 2



Correcting for three-phase current imbalance

Pos.	Description
1	Hookup 1
2	Hookup 2
3	Hookup 3
4	Fused disconnect switch
5	Magnetic starter
6	Manual reset of thermal overload with extra quick trip heaters
7	Submersible drop cable
8	Motor

Related information

7.1.2 Check for current imbalance

11. Disposing of the product

This product or parts of it must be disposed of in an environmentally sound way.

1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

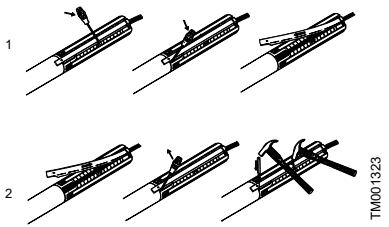
The crossed-out wheelie bin symbol on a product means that it must be disposed of separately from household waste. When a product marked with this symbol reaches its end of life, take it to a collection point designated by the local waste disposal authorities. The separate collection and recycling of such products will help protect the environment and human health.

See also end-of-life information at *www.grundfos.com/product-recycling*.

Appendix A

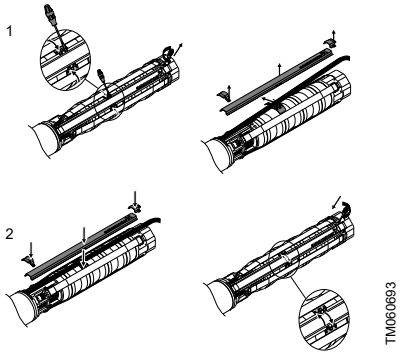
A.1. Appendix

Removing and fitting of cable guard



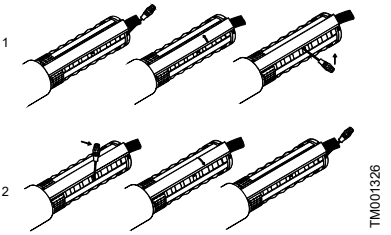
Removing and fitting of cable guard for SP 5S, 7S, 10S, 16S, and 25S (smooth shaft)

Pos.	Description
1	Removing cable guard
2	Fitting cable guard



Removing and fitting of cable guard for SP 35S, 45S, 62S, 77S, 150S, 230S, and 300S

Pos.	Description
1	Removing cable guard
2	Fitting cable guard

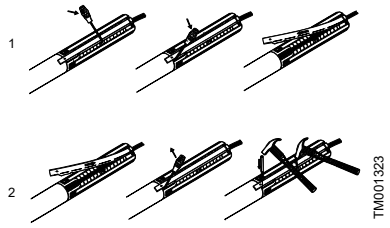


Removing and fitting of cable guard for SP 385S, 475S, 625S, 800S, and 1100S

Pos.	Description
1	Removing cable guard
2	Fitting cable guard

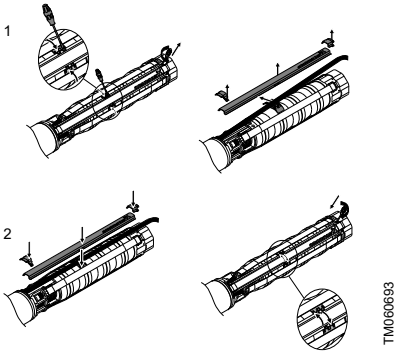
A.2. Annexe

Dépose et fixation du protège-câble



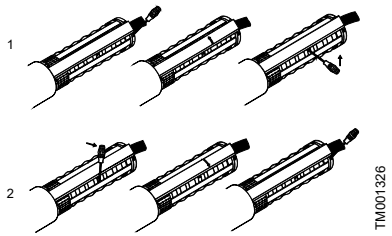
Dépose et fixation du protège-câble pour SP 5S, 7S, 10S, 16S, et 25S (arbre lisse)

Pos.	Description
1	Dépose du protège-câble
2	Fixation du protège-câble



Dépose et fixation du protège-câble pour SP 35S, 45S, 62S, 77S, 150S, 230S, et 300S

Pos.	Description
1	Dépose du protège-câble
2	Fixation du protège-câble

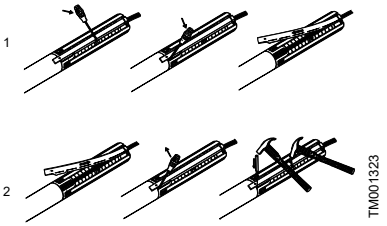


Dépose et fixation du protège-câble pour SP 385S, 475S, 625S, 800S, et 1100S

Pos.	Description
1	Dépose du protège-câble
2	Fixation du protège-câble

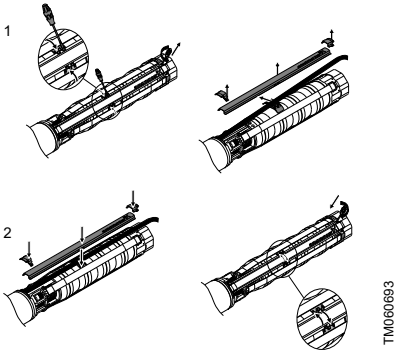
A.3. Apéndice

Desmontaje e instalación del protector de cable



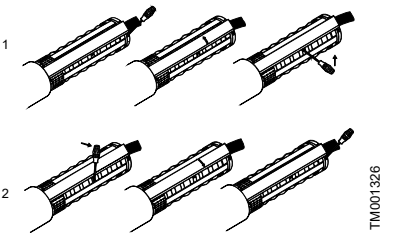
Desmontaje e instalación de la cubierta del cable para bombas SP 5S, 7S, 10S, 16S y 25S (eje flexible)

Pos.	Descripción
1	Desmontaje de la cubierta del cable
2	Instalación de la cubierta del cable



Desmontaje e instalación de la cubierta del cable para bombas SP 35S, 45S, 62S, 77S, 150S, 230S y 300S

Pos.	Descripción
1	Desmontaje de la cubierta del cable
2	Instalación de la cubierta del cable



Desmontaje e instalación de la cubierta del cable para bombas SP 385S, 475S, 625S, 800S y 1100S

Pos.	Descripción
1	Desmontaje de la cubierta del cable
2	Instalación de la cubierta del cable

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ECM: 1382270

www.grundfos.com

GRUNDFOS

6" SUBMERSIBLE MOTORS

These motors are built for dependable operation in 6" diameter or larger water wells.

BASIC FEATURES

- Double flanged NEMA mounting design
- Stainless steel splined shaft
- StatorShield™, Franklin's six-feature encapsulation system
- High-capacity, Kingsbury-type, water-lubricated thrust bearing
- Factory-filled with Franklin's non-toxic water soluble fill solution
- Field replaceable lead using Franklin's exclusive Water-Bloc™ technology
- Full 3,450 rpm 60 Hz design point
- External sand slinger on shaft
- Mechanical face seal at shaft exit
- Copper bar rotor
- All models variable frequency drive (VFD) compatible
- Single-phase models must be used with a Franklin Electric control box

SPECIAL FEATURES

- Sand Fighter™ and 316 stainless steel models are equipped with Franklin's exclusive Sand Fighter™ sealing system for sand or other abrasives, as well as Franklin's exclusive on-winding SubTrol™ heat sensor for use with SubMonitor™
- Consult factory for other voltage, hertz, and horsepower ratings not listed in this catalog
- Specifications are subject to change without notice; contact Franklin Electric if current materials are required for bid specifications
- Overmolded motor leads on all 10 GA leads

6" SUBMERSIBLE MOTORS - SPECIFICATIONS AND MATERIALS

MOTOR SPECIFICATIONS

Hz	Model	Phase	HP Range	kW Range	Poles	RPM	Max. Ambient Temp.	Duty Rating
50	Standard*	1	5 - 15	3.7 - 11	2	2875	86 °F / 30 °C	Continuous*
50		3	5 - 40	3.7 - 45			86 °F / 30 °C	
50		3	50 - 60	37 - 45			122 °F / 50 °C	
50	High-Temp 90°C**	3	5 - 40	3.7 - 30			195 °F / 90 °C	
60	Standard*	1	5 - 15	3.7 - 11		3450	86 °F / 30 °C	
60		3	5 - 40	3.7 - 30			86 °F / 30 °C	
60		3	50 - 60	37 - 45			122 °F / 50 °C	
60	High-Temp 90°C**	3	5 - 40	3.7 - 30			195 °F / 90 °C	

**At 0.5 ft/sec flow past motor; motors are rated for continuous duty up to 86°F (30 °C) water temperature*

***At 0.5 ft/sec flow past motor, motors are rated for continuous duty up to 195°F (90 °C) water temperature and up to 86 °F (30 °C) water temperature with NO FLOW in lakes or in wells 12 inches or larger in diameter.*

CONSTRUCTION MATERIALS

Component	Construction Type				
	Standard Water Well	Sand Fighter™	Corrosion Resistant (316 SS)	Hi-Temp 90°C (300 SS Shell)	Hi-Temp 90°C (316 SS)
UL Insulation Class Rating	Class F	Per standard water well	Per standard water well	Class F	Class F
Motor Ambient Temp. Rating	86 °F / 30 °C (5-40 hp) 122 °F / 50 °C (50-60 hp)			194 °F / 90 °C (5-40 hp)	194 °F / 90 °C (5-40 hp)
Stator Resin Type	Standard (5-40 hp) / Hi-Temp (50-60 hp)			FE Hi-Temp	FE Hi-Temp
Motor Fill Solution (Water Soluble/Non-Toxic)	FES91			FES92	FES92
Top End Bell & Thrust Housing	Epoxy-coated gray iron		316 SS	Epoxy-coated gray iron	316 SS
On Winding SubTrol™ heat sensor	No (5-40 hp) / Yes (50-60 hp)	Yes	Yes	Not Available	Not Available
Stator Shell	300 series SS	Per standard water well	316 SS	300 series SS	316 SS
Stator Ends	Carbon steel			Carbon steel	316 SS
Shaft Extension	300 Series SS (5-30 hp) / 17-4 SS (40-60 hp)		17-4 SS	300 SS (5-20 hp), 17-4 SS (25-40 hp)	17-4 SS
Bushing	Bronze		316 SS	Bronze	316 SS
Bushing Retainer	300 series SS			300 series SS	316 SS
Shaft Mechanical Seal	Carbon ceramic (5-40 hp) Sand Fighter™ Seal System (50-60 hp)	Sand Fighter™ Seal System	Sand Fighter™ Seal System	Sand Fighter™ Seal System	Sand Fighter™ Seal System
Mechanical Seal / Rubber Components	Nitrile (5-40 hp) / FKM (50-60 hp)	Per standard water well	Per standard water well	FKM	FKM
Diaphragm Material	Nitrile (5-40 hp) / FKM (50-60 hp)			FKM	FKM
Diaphragm Plate	300 series SS		316 SS	300 series SS	316 SS
Diaphragm Spring	300 series SS		25-6 MO SS	300 series SS	25-6 MO SS
Shaft Slinger	Nitrile (5-40 hp) / FKM (50-60 hp)		Nitrile	FKM	FKM
Lead Wire	Overmolded		Per standard water well	XLPO	XLPO
Lead Potting	Epoxy			Epoxy	Epoxy
Lead Jam Nut	Brass		316 SS	Brass	316 SS
Thrust Bearing Rating (86 °F / 30 °C)	3500 lbs (5-30 hp) 6000 lbs (40-60 hp)		Per standard water well	Standard 5-20 hp • 4,500 lbs Standard 25-40 hp • 7,500 lbs	Standard 5-20 hp • 4,500 lbs Standard 25-40 hp • 7,500 lbs
Method Of Connecting System Ground To Motor	Ground wire in power lead connector			Ground wire in power lead connector	Ground wire in power lead connector

NOTE: Specifications subject to change without notice; contact Franklin Electric if current material types are required for bid specifications

6" SUBMERSIBLE MOTORS - ORDERING INFORMATION

SINGLE-PHASE MODELS

HP	Description	Volts	Hz	S.F.	Motor Lead	Model No.	In Stock	Thrust Rating	Wt. (lbs)
5	Water Well	230	60	1.15	DOL (3)	2261109020	Yes	3500	110
	Sand Fighter™	230	60	1.15	DOL (3)	2261108020	Yes	3500	110
	316 SS	230	60	1.15	DOL (3)	2261103920	-	3500	110
7.5	Water Well	230	60	1.15	DOL (3)	2261119020	Yes	3500	123
	Sand Fighter™	230	60	1.15	DOL (3)	2261118020	Yes	3500	123
	316 SS	230	60	1.15	DOL (3)	2261113920	-	3500	123
10	Water Well	230	60	1.15	DOL (3)	2261129020	Yes	3500	141
	Sand Fighter™	230	60	1.15	DOL (3)	2261128020	Yes	3500	141
	316 SS	230	60	1.15	DOL (3)	2261123920	-	3500	141
15	Water Well	230	60	1.15	DOL (3)	2261139020	Yes	3500	154
	Sand Fighter™	230	60	1.15	DOL (3)	2261138020	Yes	3500	154
	316 SS	230	60	1.15	DOL (3)	2261133920	-	3500	154

THREE-PHASE MODELS

HP	Description	Volts	Hz	S.F.	Motor Lead	Model No.	In Stock	Thrust Rating	Wt. (lbs)
5	Water Well	200	60	1.15	DOL (3)	2366509020	Yes	3500	101
		220	50	1.0	DOL (3)	2366809020	-	3500	101
		230	60	1.15	DOL (3)	2366009020	Yes	3500	101
		230	60	1.15	Y-Δ (6)	2367209020	-	3500	106
		380	60	1.15	DOL (3)	2366609020	-	3500	101
		380	60	1.15	Y-Δ (6)	2367809020	-	3500	106
		415	50	1.0	DOL (3)	2366909020	-	3500	101
		460/380	60/50	1.15/1.0	DOL (3)	2366109020	Yes	3500	101
		460/380	60/50	1.15/1.0	Y-Δ (6)	2367109020	-	3500	106
		575	60	1.15	DOL (3)	2366209020	-	3500	101
	Sand Fighter™	200	60	1.15	DOL (3)	2366508120	Yes	3500	101
		220	50	1.0	DOL (3)	2366808120	-	3500	101
		230	60	1.15	DOL (3)	2366008120	Yes	3500	101
		380	60	1.15	DOL (3)	2366608120	-	3500	101
		460/380	60/50	1.15/1.0	DOL (3)	2366108120	Yes	3500	101
		460/380	60/50	1.15/1.0	Y-Δ (6)	2367108120	-	3500	106
		575	60	1.15	DOL (3)	2366208120	Yes	3500	101
	316 SS w/SubTrol™	200	60	1.15	DOL (3)	2366504020	-	3500	101
		230	60	1.15	DOL (3)	2366004020	Yes	3500	101
		380	60	1.15	DOL (3)	2366604020	-	3500	101
		460/380	60/50	1.15/1.0	DOL (3)	2366104020	Yes	3500	101
		460/380	60/50	1.15/1.0	Y-Δ (6)	2367104020	-	3500	106
		575	60	1.15	DOL (3)	2366204020	-	3500	101
	Hi-Temp 90°C	200	60	1.15	DOL (3)	2766500003	-	4500	116
		230	60	1.15	DOL (3)	2766000003	-	4500	116
		380	60	1.15	DOL (3)	2766600003	-	4500	116
		460/380	60/50	1.15/1.0	DOL (3)	2766100003	-	4500	116
		460/380	60/50	1.15/1.0	Y-Δ (6)	2767100003	-	4500	121
		575	60	1.15	DOL (3)	2766200003	-	4500	116
	Hi-Temp 90°C - 316 SS	200	60	1.15	DOL (3)	2766503003	-	4500	116
		230	60	1.15	DOL (3)	2766003003	-	4500	116
		380	60	1.15	DOL (3)	2766603003	-	4500	116
		460/380	60/50	1.15/1.0	DOL (3)	2766103003	-	4500	116
		575	60	1.15	DOL (3)	2766203003	-	4500	116

6" SUBMERSIBLE MOTORS - DIMENSIONS AND WEIGHTS

STANDARD

HP / kW	Construction	"L" (in)	Motor Carton Size (in)			Shipping Wt.	
			W	H	L	lbs	kg
5 / 3.7	304 SS 3-Lead	22.9	7.50	10.75	34.50	101	46
	316 SS 3-Lead	22.5	7.50	10.75	34.50	101	46
7.5 / 5.5	304 SS 3-Lead	24.2	7.50	10.75	34.50	108	49
	316 SS 3-Lead	23.8	7.50	10.75	34.50	108	49
10 / 7.5	304 SS 3-Lead	25.4	7.50	10.75	34.50	116	53
	316 SS 3-Lead	25.0	7.50	10.75	34.50	116	53
15 / 11	304 SS 3-Lead	28.0	7.50	10.75	34.50	129	59
	316 SS 3-Lead	27.6	7.50	10.75	34.50	129	59
20 / 15	304 SS 3-Lead	30.6	7.50	10.75	37.00	145	66
	316 SS 3-Lead	30.2	7.50	10.75	37.00	145	66
25 / 18.5	304 SS 3-Lead	33.1	7.50	10.75	42.25	156	71
	316 SS 3-Lead	32.7	7.50	10.75	42.25	156	71
30 / 22	304 SS 3-Lead	35.7	7.50	10.75	42.25	174	79
	316 SS 3-Lead	35.3	7.50	10.75	42.25	174	79
40 / 30	304 SS 3-Lead	40.8	7.50	10.75	47.25	202	92
	316 SS 3-Lead	40.4	7.50	10.75	47.25	202	92
50 / 37	304 SS 3-Lead	55.3	8.75	10.50	71.75	300	136
	316 SS 3-Lead	59.2	8.75	10.50	71.75	300	136
60 - 45	304 SS 3-Lead	61.3	8.75	10.50	71.75	330	150
	316 SS 3-Lead	65.2	8.75	10.50	71.75	330	150

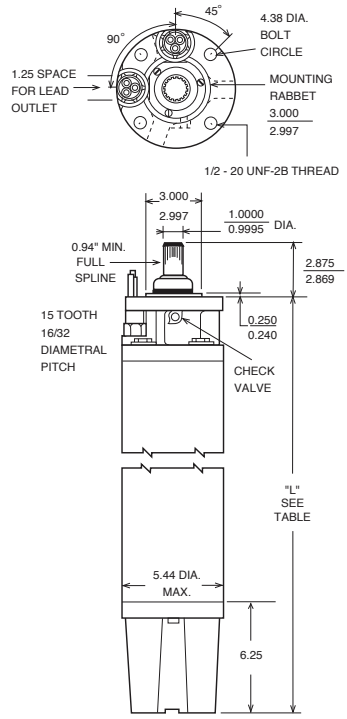
NOTE: 6-Lead Y-Δ models available (add 5 lbs to shipping weight)

HIGH-TEMP 90

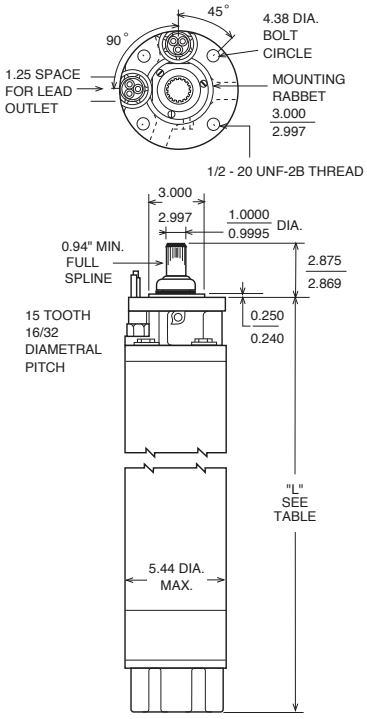
HP / kW	Construction	L (in)	Motor Carton Size (in)			Shipping Wt.	
			W	H	L	lbs	kg
5 / 3.7	304 SS 3-Lead	26.4	9	11	35	116	53
	316 SS 3-Lead	26.4	9	11	35	116	53
7.5 / 5.5	304 SS 3-Lead	28.96	9	11	37	129	59
	316 SS 3-Lead	28.96	9	11	37	129	59
10 / 7.5	304 SS 3-Lead	31.52	9	11	42	145	66
	316 SS 3-Lead	31.52	9	11	42	145	66
15 / 11	304 SS 3-Lead	34.09	9	11	42	156	71
	316 SS 3-Lead	34.09	9	11	42	156	71
20 / 15	304 SS 3-Lead	36.65	9	11	51	174	79
	316 SS 3-Lead	36.65	9	11	51	174	79
25 / 18.5	304 SS 3-Lead	41.77	9	11	51	202	92
	316 SS 3-Lead	41.77	9	11	51	202	92
30 / 22	304 SS 3-Lead	58.14	9	11	72	300	136
	316 SS 3-Lead	58.14	9	11	72	300	136
40 / 30	304 SS 3-Lead	64.14	9	11	72	330	150
	316 SS 3-Lead	64.14	9	11	72	330	150

NOTE: 6-Lead Y-Δ models available (add 5 lbs to shipping weight)

Standard Water Well



316 Stainless



2015 EDITION

AIM MANUAL

SUBMERSIBLE MOTORS

APPLICATION | INSTALLATION | MAINTENANCE

60 Hz, Single-Phase and Three-Phase Motors

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Franklin Electric

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FRANKLIN ELECTRIC GLOBAL HEADQUARTERS &
ENGINEERING DEVELOPMENT CENTER, FORT WAYNE, INDIANA

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SERIOUS OR FATAL ELECTRICAL SHOCK MAY RESULT FROM FAILURE TO CONNECT THE MOTOR, CONTROL ENCLOSURES, METAL PLUMBING, AND ALL OTHER METAL NEAR THE MOTOR OR CABLE, TO THE POWER SUPPLY GROUND TERMINAL USING WIRE NO SMALLER THAN MOTOR CABLE WIRES. TO REDUCE RISK OF ELECTRICAL SHOCK, DISCONNECT POWER BEFORE WORKING ON OR AROUND THE WATER SYSTEM. DO NOT USE MOTOR IN SWIMMING AREAS.

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PUEDE OCURRIR UN CHOQUE ELECTRICO, SERIO O FATAL DEBIDO A UNA ERRONEA CONECCION DEL MOTOR, DE LOS TABLEROS ELECTRICOS, DE LA TUBERIA, DE CUALQUIER OTRA PARTE METALICA QUE ESTA CERCA DEL MOTOR O POR NO UTILIZAR UN CABLE PARA TIERRA DE CALIBRE IGUAL O MAYOR AL DE LA ALIMENTACION. PARA REDUCIR EL RIESGO DE CHOQUE ELECTRIC, DESCONECTAR LA ALIMENTACION ELECTRICA ANTES DE INICIAR A TRABAJAR EN EL SISTEMA HIDRAULICO. NO UTILIZAR ESTE MOTOR EN ALBERCAS O AREAS EN DONDE SE PRACTIQUE NATACION.

60 Hz, Single-Phase and Three-Phase

SUBMERSIBLE MOTOR

Application • Installation • Maintenance Manual

The submersible motor is a reliable, efficient and trouble-free means of powering a pump. Its needs for a long operational life are simple. They are:

1. A suitable operating environment
2. An adequate supply of electricity
3. An adequate flow of cooling water over the motor
4. An appropriate pump load

All considerations of application, installation, and maintenance of submersible motors relating to these four areas are presented in this manual. Franklin Electric's web page, www.franklin-electric.com, should be checked for the latest updates.

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Storage

Franklin Electric submersible motors are a water-lubricated design. The fill solution consists of a mixture of deionized water and Propylene Glycol (a non-toxic antifreeze). The solution will prevent damage from freezing in temperatures to -40 °F (-40 °C); motors should be stored in areas that do not go below this temperature. The solution will partially freeze below 27 °F (-3 °C), but no damage occurs. Repeated freezing and thawing should be avoided to prevent possible loss of fill solution.

There may be an interchange of fill solution with well water during operation. Care must be taken with motors removed from wells during freezing conditions to prevent damage.

When the storage temperature does not exceed 100 °F (37 °C), storage time should be limited to two years. Where temperatures reach 100° to 130 °F, storage time should be limited to one year.

Loss of a few drops of liquid will not damage the motor as an excess amount is provided, and the filter check valve will allow lost liquid to be replaced by filtered well water upon installation. If there is reason to believe there has been a considerable amount of leakage, consult the factory for checking procedures.

Frequency of Starts

The average number of starts per day over a period of months or years influences the life of a submersible pumping system. Excessive cycling affects the life of control components such as pressure switches, starters, relays, and capacitors. Rapid cycling can also cause motor spline damage, bearing damage, and motor overheating. All these conditions can lead to reduced motor life.

The pump size, tank size, and other controls should be selected to keep the starts per day as low as practical for longest life. The maximum number of starts per 24-hour period is shown in Table 3.

Motors should run a minimum of one minute to dissipate heat build up from starting current. Six inch and larger motors should have a minimum of 15 minutes between starts or starting attempts.

Table 3 Number of Starts

MOTOR RATING		MAXIMUM STARTS PER 24 HR PERIOD	
HP	KW	SINGLE-PHASE	THREE-PHASE
Up to 0.75	Up to 0.55	300	300
1 thru 5.5	0.75 thru 4	100	300
7.5 thru 30	5.5 thru 22	50	100*
40 and over	30 and over	-	100

* Keeping starts per day within the recommended numbers provides the best system life. However, when used with a properly configured Reduced Voltage Starter (RVS) or Variable Frequency Drive (VFD), 7.5 thru 30 hp three-phase motors can be started up to 200 times per 24 hour period.

Mounting Position

Franklin submersible motors are designed primarily for operation in the vertical, shaft-up position.

During acceleration, the pump thrust increases as its output head increases. In cases where the pump head stays below its normal operating range during startup and full speed condition, the pump may create upward thrust. This creates upward thrust on the motor upthrust bearing. This is an acceptable operation for short periods at each start, but running continuously with upthrust will cause excessive wear on the upthrust bearing.

With certain additional restrictions as listed in this section and the Inline Booster Pump Systems sections of this manual, motors are also suitable for operation in positions from shaft-up to shaft-horizontal. As the mounting position becomes further from vertical and closer to horizontal, the probability of shortened thrust bearing life increases. For normal motor life expectancy with motor positions other than shaft-up, follow these recommendations:

1. Minimize the frequency of starts, preferably to fewer than per 24-hour period. Six and eight inch motors should have a minimum of 20 minutes between starts or starting attempts
2. Do not use in systems which can run even for short periods at full speed without thrust toward the motor.

Transformer Capacity - Single-Phase or Three-Phase

Distribution transformers must be adequately sized to satisfy the kVA requirements of the submersible motor. When transformers are too small to supply the load, there is a reduction in voltage to the motor.

Table 4 references the motor horsepower rating, single-phase and three-phase, total effective kVA required, and the smallest transformer required for open or closed three-phase systems. Open systems require larger transformers since only two transformers are used.

Other loads would add directly to the kVA sizing requirements of the transformer bank.

Table 4 Transformer Capacity

MOTOR RATING		TOTAL EFFECTIVE KVA REQUIRED	SMALLEST KVA RATING-EACH TRANSFORMER	
HP	KW		OPEN WYE OR DELTA 2- TRANSFORMERS	CLOSED WYE OR DELTA 3- TRANSFORMERS
1.5	1.1	3	2	1
2	1.5	4	2	1.5
3	2.2	5	3	2
5	3.7	7.5	5	3
7.5	5.5	10	7.5	5
10	7.5	15	10	5
15	11	20	15	7.5
20	15	25	15	10
25	18.5	30	20	10
30	22	40	25	15
40	30	50	30	20
50	37	60	35	20
60	45	75	40	25
75	55	90	50	30
100	75	120	65	40
125	93	150	85	50
150	110	175	100	60
175	130	200	115	70
200	150	230	130	75

NOTE: Standard kVA ratings are shown. If power company experience and practice allows transformer loading higher than standard, higher loading values may be used to meet total effective kVA required, provided correct voltage and balance is maintained.

Effects of Torque

During starting of a submersible pump, the torque developed by the motor must be supported through the pump, delivery pipe or other supports. Most pumps rotate in the direction which causes unscrewing torque on right-handed threaded pipe or pump stages. All threaded joints, pumps and other parts of the pump support system must be capable of withstanding the maximum torque repeatedly without loosening or breaking. Unscrewing joints will break electrical cable and may cause loss of the pump-motor unit.

To safely withstand maximum unscrewing torques with a minimum safety factor of 1.5, tightening all threaded joints to at least 10 lb-ft per motor horsepower is recommended (Table 4A). It may be necessary to tack or strap weld pipe joints on high horsepower pumps, especially at shallower settings.

Table 4A Torque Required (Examples)

MOTOR RATING		MINIMUM SAFE TORQUE-LOAD
HP	KW	
1 hp & Less	0.75 kW & Less	10 lb-ft
20 hp	15 kW	200 lb-ft
75 hp	55 kW	750 lb-ft
200 hp	150 kW	2000 lb-ft

Use of Engine Driven Generators – Single-Phase or Three-Phase

Table 5 lists minimum generator sizes based on typical 80 °C rise continuous duty generators, with 35% maximum voltage dip during starting, for Franklin's three-wire motors, single- or three-phase.

This is a general chart. The generator manufacturer should be consulted whenever possible, especially on larger sizes.

There are two types of generators available: externally and internally regulated. Most are externally regulated. They use an external voltage regulator that senses the output voltage. As the voltage dips at motor start-up, the regulator increases the output voltage of the generator.

Internally regulated (self-excited) generators have an extra winding in the generator stator. The extra winding senses the output current to automatically adjust the output voltage.

Generators must be sized to deliver at least 65% of the rated voltage during starting to ensure adequate starting torque. Besides sizing, generator frequency is important as the motor speed varies with the frequency (Hz). Due to pump affinity laws, a pump running at 1 to 2 Hz below motor nameplate frequency design will not meet its performance curve. Conversely, a pump running at 1 to 2 Hz above may trip overloads.

Generator Operation

Always start the generator before the motor is started and always stop the motor before the generator is shut down. The motor thrust bearing may be damaged if the generator is allowed to coast down with the motor running. This same condition occurs when the generator is allowed to run out of fuel.

Follow generator manufacturer's recommendations for de-rating at higher elevations or using natural gas.

Table 5 Engine Driven Generators

NOTE: This chart applies to 3-wire or 3-phase motors. For best starting of 2-wire motors, the minimum generator rating is 50% higher than shown.

MOTOR RATING		MINIMUM RATING OF GENERATOR			
		EXTERNALLY REGULATED		INTERNALLY REGULATED	
HP	KW	KW	KVA	KW	KVA
1/3	0.25	1.5	1.9	1.2	1.5
1/2	0.37	2	2.5	1.5	1.9
3/4	0.55	3	3.8	2	2.5
1	0.75	4	5.0	2.5	3.13
1.5	1.1	5	6.25	3	3.8
2	1.5	7.5	9.4	4	5
3	2.2	10	12.5	5	6.25
5	3.7	15	18.75	7.5	9.4
7.5	5.5	20	25.0	10	12.5
10	7.5	30	37.5	15	18.75
15	11	40	50	20	25
20	15	60	75	25	31
25	18.5	75	94	30	37.50
30	22	100	125	40	50
40	30	100	125	50	62.5
50	37	150	188	60	75
60	45	175	220	75	94
75	55	250	313	100	125
100	75	300	375	150	188
125	93	375	469	175	219
150	110	450	563	200	250
175	130	525	656	250	313
200	150	600	750	275	344

WARNING: To prevent accidental electrocution, automatic or manual transfer switches must be used any time a generator is used as standby or back up on power lines. Contact power company for use and approval.

Use of Check Valves

It is recommended that one or more check valves always be used in submersible pump installations. If the pump does not have a built-in check valve, a line check valve should be installed in the discharge line within 25 feet of the pump and below the draw down level of the water supply. For deeper settings, check valves should be installed per the manufacturer's recommendations. More than one check valve may be required, but more than the recommended number of check valves should not be used.

Swing type check valves are **not** acceptable and should never be used with submersible motors/pumps. Swing type check valves have a slower reaction time which can cause water hammer (see next page). Internal pump check valves or spring loaded check valves close quickly and help eliminate water hammer.

Check valves are used to hold pressure in the system when the pump stops. They also prevent backspin, water hammer and upthrust. Any of these can lead to early pump or motor failure.

NOTE: Only positive sealing check valves should be used in submersible installations. Although drilling the check valves or using drain-back check valves may prevent back spinning, they create upthrust and water hammer problems.

A. **Backspin –** With no check valve or a failed check valve, the water in the drop pipe and the water in the system can flow down the discharge pipe when the motor stops. This can cause the pump to rotate in a reverse direction. If the motor is started while it is backspinning, an excessive force is placed across the pump-motor assembly that can cause impeller damage, motor or pump shaft breakage, excessive bearing wear, etc.

B. **Upthrust –** With no check valve, a leaking check valve, or drilled check valve, the unit starts under a zero head condition. This causes an uplifting or upthrust on the impeller-shaft assembly in the pump. This upward movement carries across the pump-motor coupling and creates an upthrust condition in the motor. Repeated upthrust can cause premature failure of both the pump and the motor.

C. **Water Hammer –** If the lowest check valve is more than 30 feet above the standing (lowest static) water level, or a lower check valve leaks and the check valve above holds, a vacuum is created in the discharge piping. On the next pump start, water moving at very high velocity fills the void and strikes the closed check valve and the stationary water in the pipe above it, causing a hydraulic shock. This shock can split pipes, break joints and damage the pump and/or motor. Water hammer can often be heard or felt. When discovered, the system should be shut down and the pump installer contacted to correct the problem.

All Motors

APPLICATION

Wells – Large Diameter, Uncased, Top Feeding and Screened Sections

Franklin Electric submersible motors are designed to operate with a cooling flow of water over and around the full length of the motor.

If the pump installation does not provide the minimum flow shown in Table 6, a flow inducer sleeve (flow sleeve) must be used. The conditions requiring a flow sleeve are:

- Well diameter is too large to meet Table 6 flow requirements
- Pump is in an open body of water
- Pump is in a rock well or below the well casing
- The well is "top-feeding" (a.k.a. cascading)
- Pump is set in or below screens or perforations

Water Temperature and Flow

Franklin Electric's standard submersible motors, except Hi-Temp designs (see note below), are designed to operate up to maximum service factor horsepower in water up to 86 °F (30 °C). A flow of 0.25 ft/s for 4" motors rated 3 hp and higher, and 0.5 ft/s for 6" and 8" motors is required for proper cooling. Table 6 shows minimum flow rates, in gpm, for various well diameters and motor sizes.

If a standard motor is operated in water over 86 °F (30 °C), water flow past the motor must be increased to maintain safe motor operating temperatures. See HOT WATER APPLICATIONS on page 7.

NOTE: Franklin Electric offers a line of Hi-Temp motors designed to operate in water at higher temperatures or lower flow conditions. Consult factory for details.

Table 6 Required Cooling Flow

MINIMUM GPM REQUIRED FOR MOTOR COOLING IN WATER UP TO 86 °F (30 °C)			
CASING OR SLEEVE ID INCHES (MM)	4" MOTOR (3-10 HP) 0.25 FT/S GPM (L/M)	6" MOTOR 0.50 FT/S GPM (L/M)	8" MOTOR 0.50 FT/S GPM (L/M)
4 (102)	1.2 (4.5)	-	-
5 (127)	7 (26.5)	-	-
6 (152)	13 (49)	9 (34)	-
7 (178)	20 (76)	25 (95)	-
8 (203)	30 (114)	45 (170)	10 (40)
10 (254)	50 (189)	90 (340)	55 (210)
12 (305)	80 (303)	140 (530)	110 (420)
14 (356)	110 (416)	200 (760)	170 (645)
16 (406)	150 (568)	280 (1060)	245 (930)

0.25 ft/s = 7.62 cm/sec 0.50 ft/s = 15.24 cm/sec 1 inch = 2.54 cm

Flow Inducer Sleeve

If the flow rate is less than specified, then a flow inducer sleeve must be used. A flow sleeve is always required in an open body of water. FIG. 1 shows a typical flow inducer sleeve construction.

EXAMPLE: A 6" motor and pump that delivers 60 gpm will be installed in a 10" well.

From Table 6, 90 gpm would be required to maintain proper cooling. In this case adding an 8" or smaller flow sleeve provides the required cooling.

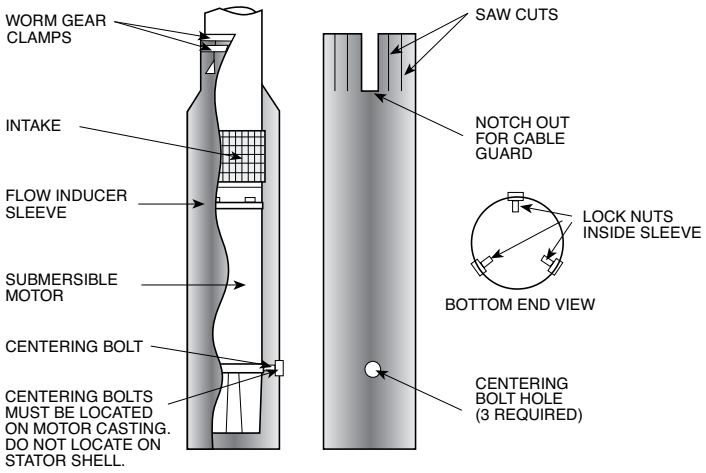

FIG. 1

Head Loss From Flow Past Motor

Table 7 lists the approximate head loss due to flow between an average length motor and smooth casing or flow inducer sleeve.

Table 7 Head Loss in Feet (Meters) at Various Flow Rates

MOTOR DIAMETER		4"	4"	4"	6"	6"	6"	8"	8"
CASING ID IN INCHES (MM)		4 (102)	5 (127)	6 (152)	6 (152)	7 (178)	8 (203)	8.1 (206)	10 (254)
Flow Rate in gpm (l/m)	25 (95)	0.3 (.09)							
	50 (189)	1.2 (.37)							
	100 (378)	4.7 (1.4)	0.3 (.09)		1.7 (.52)				
	150 (568)	10.2 (3.1)	0.6 (.18)	0.2 (.06)	3.7 (1.1)				
	200 (757)		1.1 (.34)	0.4 (.12)	6.3 (1.9)	0.5 (.15)		6.8 (2.1)	
	250 (946)		1.8 (.55)	0.7 (.21)	9.6 (2.9)	0.8 (.24)		10.4 (3.2)	
	300 (1136)		2.5 (.75)	1.0 (.30)	13.6 (4.1)	1.2 (.37)	0.2 (.06)	14.6 (4.5)	
	400 (1514)				23.7 (7.2)	2.0 (.61)	0.4 (.12)	24.6 (7.5)	
	500 (1893)					3.1 (.94)	0.7 (.21)	37.3 (11.4)	0.6 (0.2)
	600 (2271)					4.4 (1.3)	1.0 (.30)	52.2 (15.9)	0.8 (0.3)
	800 (3028)								1.5 (0.5)
	1000 (3785)								2.4 (0.7)

Hot Water Applications (Standard Motors)

Franklin Electric offers a line of Hi-Temp motors which are designed to operate in water with various temperatures up to 194 °F (90 °C) without increased flow. When a standard pump-motor operates in water hotter than 86 °F (30 °C), a flow rate of at least 3 ft/s is required. When selecting the motor to drive a pump in over 86 °F (30 °C) water, the motor horsepower must be de-rated per the following procedure.

1. Using Table 7A, determine pump gpm required for different well or sleeve diameters. If necessary, add a flow sleeve to obtain at least 3 ft/s flow rate.

Table 7A Minimum gpm (l/m) Required for 3 ft/s (.91 m/sec) Flow Rate

CASING OR SLEEVE ID		4" HIGH THRUST MOTOR		6" MOTOR		8" MOTOR	
INCHES	(MM)	GPM	(L/M)	GPM	(L/M)	GPM	(L/M)
4	(102)	15	(57)				
5	(127)	80	(303)				
6	(152)	160	(606)	52	(197)		
7	(178)			150	(568)		
8	(203)			260	(984)	60	(227)
10	(254)			520	(1970)	330	(1250)
12	(305)					650	(2460)
14	(356)					1020	(3860)
16	(406)					1460	(5530)

Continued on next page

2. Determine pump horsepower required from the pump manufacturer's curve.

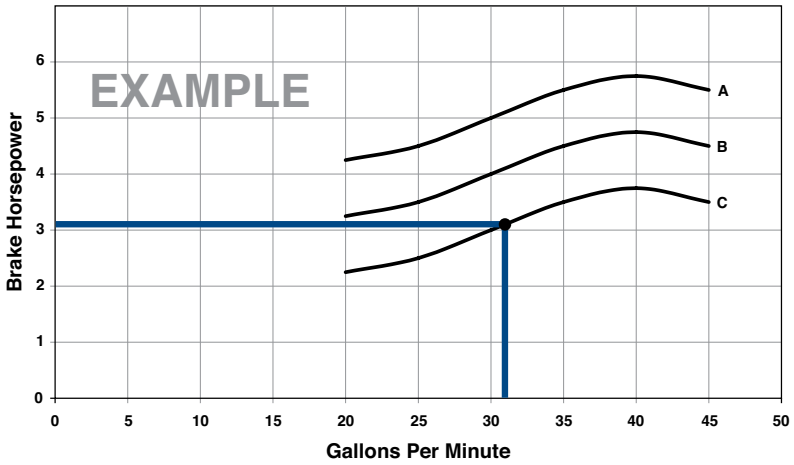

FIG. 2 MANUFACTURER'S PUMP CURVE

3. Multiply the pump horsepower required by the heat factor multiplier from Table 8.

Table 8 Heat Factor Multiplier at 3 ft/s (.91 m/sec) Flow Rate

MAXIMUM WATER TEMPERATURE	1/3 - 5 HP .25 - 3.7 KW	7 1/2 - 30 HP 5.5 - 22 KW	OVER 30 HP OVER 22 KW
140 °F (60 °C)	1.25	1.62	2.00
131 °F (55 °C)	1.11	1.32	1.62
122 °F (50 °C)	1.00	1.14	1.32
113 °F (45 °C)	1.00	1.00	1.14
104 °F (40 °C)	1.00	1.00	1.00
95 °F (35 °C)	1.00	1.00	1.00

4. Select a rated hp motor on Table 8A whose Service Factor Horsepower is at least the value calculated in Item 3.

Table 8A Service Factor Horsepower

HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP	HP	KW	SFHP
1/3	0.25	0.58	3	2.2	3.45	25	18.5	28.75	100	75	115.00
1/2	0.37	0.80	5	3.7	5.75	30	22.0	34.50	125	93	143.75
3/4	0.55	1.12	7.5	5.5	8.62	40	30.0	46.00	150	110	172.50
1	0.75	1.40	10	7.5	11.50	50	37.0	57.50	175	130	201.25
1.5	1.10	1.95	15	11.0	17.25	60	45.0	69.00	200	150	230.00
2	1.50	2.50	20	15.0	23.00	75	55.0	86.25			

Hot Water Applications - Example

EXAMPLE: A 6" pump end requiring 39 hp input will pump 124 °F water in an 8" well at a delivery rate of 140 gpm. From Table 7A, a 6" flow sleeve will be required to increase the flow rate to at least 3 ft/s.

Using Table 8, the 1.62 heat factor multiplier is selected because the hp required is over 30 hp and water temperature is above 122 °F. Multiply 39 hp x 1.62 (multiplier), which equals 63.2 hp. This is the minimum rated service factor horsepower usable at 39 hp in 124 °F. Using Table 8A, select a motor with a rated service factor horsepower above 63.2 hp. A 60 hp motor has a service factor horsepower of 69, so a 60 hp motor may be used.

Drawdown Seals

Allowable motor temperature is based on atmospheric pressure or higher surrounding the motor. “Drawdown seals,” which seal the well to the pump above its intake to maximize delivery are not recommended, since the suction created can be lower than atmospheric pressure.

Grounding Control Boxes and Panels

The National Electrical Code requires that the control box or panel-grounding terminal always be connected to supply ground. If the circuit has no grounding conductor and no metal conduit from the box to supply panel, use a wire at least as large as line conductors and connect as required by the National Electrical Code, from the grounding terminal to the electrical supply ground.

WARNING: Failure to ground the control frame can result in a serious or fatal electrical shock hazard.

Grounding Surge Arrestors

An above ground surge arrestor must be grounded, metal to metal, all the way to the lowest draw down water strata for the surge arrestor to be effective. GROUNDING THE ARRESTOR TO THE SUPPLY GROUND OR TO A DRIVEN GROUND ROD PROVIDES LITTLE OR NO SURGE PROTECTION FOR THE MOTOR.

Control Box, Pumptec Products, and Panel Environment

Franklin Electric control boxes, Pumptec products and three-phase panels meet UL requirements for NEMA Type 3R enclosures. They are suitable for indoor and outdoor applications within temperatures of +14 °F (-10 °C) to 122 °F (50 °C). Operating control boxes below +14 °F can cause reduced starting torque and loss of overload protection when overloads are located in control boxes.

Control boxes, Pumptec products, and three-phase panels should never be mounted in direct sunlight or high temperature locations. This will cause shortened capacitor life (where applicable) and unnecessary tripping of overload protectors. A ventilated enclosure painted white to reflect heat is recommended for an outdoor, high temperature location.

A damp well pit, or other humid location, accelerates component failure from corrosion.

Control boxes with voltage relays are designed for vertical upright mounting only. Mounting in other positions will affect the operation of the relay.

Equipment Grounding

WARNING: Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing, and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires.

The primary purpose of grounding the metal drop pipe and/or metal well casing in an installation is safety. It is done to limit the voltage between nonelectrical (exposed metal) parts of the system and ground, thus minimizing dangerous shock hazards. Using wire at least the size of the motor cable wires provides adequate current-carrying capability for any ground fault that might occur. It also provides a low resistance path to ground, ensuring that the current to ground will be large enough to trip any overcurrent device designed to detect faults (such as a ground fault circuit interrupter, or GFCI).

Normally, the ground wire to the motor would provide the primary path back to the power supply ground for any ground fault. There are conditions, however, where the ground wire connection could become compromised. One such example would be the case where the water in the well is abnormally corrosive or aggressive. In this example, a grounded metal drop pipe or casing would then become the primary path to ground.

However, the many installations that now use plastic drop pipes and/or casings require further steps to be taken for safety purposes, so that the water column itself does not become the conductive path to ground.

When an installation has abnormally corrosive water AND the drop pipe or casing is plastic, Franklin Electric recommends the use of a GFCI with a 10 mA set-point. In this case, the motor ground wire should be routed through the current-sensing device along with the motor power leads. Wired this way, the GFCI will trip only when a ground fault has occurred AND the motor ground wire is no longer functional.

3-Wire Control Boxes

Single-phase three-wire submersible motors require the use of control boxes. Operation of motors without control boxes or with incorrect boxes can result in motor failure and voids warranty.

Control boxes contain starting capacitors, a starting relay, and, in some sizes, overload protectors, running capacitors, and contactors.

Ratings through 1 hp may use either a Franklin Electric solid state QD or a potential (voltage) type starting relay, while larger ratings use potential relays.

Potential (Voltage) Relays

Potential relays have normally closed contacts. When power is applied, both start and main motor windings are energized, and the motor starts. At this instant, the voltage across the start winding is relatively low and not enough to open the contacts of the relay.

As the motor accelerates, the increasing voltage across the start winding (and the relay coil) opens the relay contacts. This opens the starting circuit and the motor continues to run on the main winding alone, or the main plus run capacitor circuit. After the motor is started the relay contacts remain open.

CAUTION: The control box and motor are two pieces of one assembly. Be certain that the control box and motor hp and voltage match. Since a motor is designed to operate with a control box from the same manufacturer, we can promise warranty coverage only when a Franklin control box is used with a Franklin motor.

2-Wire Motor Solid State Controls

BIAC Switch Operation

When power is applied the bi-metal switch contacts are closed, so the triac is conducting and energizes the start winding. As rpm increases, the voltage in the sensor coil generates heat in the bi-metal strip, causing the bi-metal strip to bend and open the switch circuit. This removes the starting winding and the motor continues to run on the main winding alone.

Approximately 5 seconds after power is removed from the motor, the bi-metal strip cools sufficiently to return to its closed position and the motor is ready for the next start cycle. If, during operation, the motor speed drops, the lowered voltage in the sensor coil allows the bi-metal contacts to close, and bring the motor back to operating speed.

Rapid Cycling

The BIAC starting switch will reset within approximately 5 seconds after the motor is stopped. If an attempt is made to restart the motor before the starting switch has reset, the motor may not start; however, there will be current in the main winding until the overload protector interrupts the circuit. The time for the protector to reset is longer than the reset of the starting switch. Therefore, the start switch will have closed and the motor will operate.

A waterlogged tank will cause fast cycling. When a waterlogged condition does occur, the user will be alerted to the problem during the off time (overload reset time) since the pressure will drop drastically. When the waterlogged tank condition is detected, the condition should be corrected to prevent nuisance tripping of the overload protector.

Bound Pump (Sandlocked)

When the motor is not free to turn, as with a sandlocked pump, the BIAC switch creates a “reverse impact torque” in the motor in either direction. When the sand is dislodged, the motor will start and operate in the correct direction.

CAUTION: Restarting the motor within 5 seconds after power is removed may cause the motor overload to trip.

QD Relays (Solid State)

There are two elements in the relay: a reed switch and a triac. The reed switch consists of two tiny rectangular blade-type contacts, which bend under magnetic flux. It is hermetically sealed in glass and is located within a coil, which conducts line current. When power is supplied to the control box, the main winding current passing through the coil immediately closes the reed switch contacts. This turns on the triac, which supplies voltage to the start winding, thus starting the motor.

Once the motor is started, the operation of the QD relay is an interaction between the triac, the reed switch, and the motor windings. The solid state switch senses motor speed through the changing phase relationship between start winding current and line current. As the motor approaches running speed, the phase angle between the start current and the line current becomes nearly in phase. At this point, the reed switch contacts open, turning off the triac. This removes voltage from the start winding and the motor continues to run on the main winding only. With the reed switch contacts open and the triac turned off, the QD relay is ready for the next starting cycle.

Single-Phase Motors

APPLICATION

2- or 3-Wire Cable, 60 Hz (Service Entrance to Motor - Maximum Length In Feet)

Table 11

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870		
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520		
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240		
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480		
	3	2.2	**120**	190	300	470	750	1190	1490	1850	2320	2890	3610		
	5	3.7	0	0	**180**	280	450	710	890	1110	1390	1740	2170	2680	
	7.5	5.5	0	0	0	**200**	310	490	610	750	930	1140	1410	1720	
	10	7.5	0	0	0	0	**250**	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	**170**	**270**	340	430	530	660	820	1020	1260

Table 11A

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE												
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000
115	1/2	.37	100	160	250	390	620	960	1190	1460	1780	2160	2630	3140	3770
230	1/2	.37	400	650	1020	1610	2510	3880	4810	5880	7170	8720			
	3/4	.55	300	480	760	1200	1870	2890	3580	4370	5330	6470	7870	9380	
	1	.75	250	400	630	990	1540	2380	2960	3610	4410	5360	6520	7780	9350
	1.5	1.1	190	310	480	770	1200	1870	2320	2850	3500	4280	5240	6300	7620
	2	1.5	150	250	390	620	970	1530	1910	2360	2930	3620	4480	5470	6700
	3	2.2	**120**	190	300	470	750	1190	1490	1850	2320	2890	3610	4470	5550
	5	3.7	0	**110**	180	280	450	710	890	1110	1390	1740	2170	2680	3330
	7.5	5.5	0	0	**120**	200	310	490	610	750	930	1140	1410	1720	2100
	10	7.5	0	0	0	**160**	250	390	490	600	750	930	1160	1430	1760
	15	11	0	0	0	0	**170**	270	340	430	530	660	820	1020	1260

1 Foot = .3048 Meter

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors 60 °C or 75 °C in free air or water, not in magnetic enclosures, conduit or direct buried.

Lengths NOT in bold meet the NEC ampacity requirements for either individual conductors or jacketed 60 °C or 75 °C cable and can be in conduit or direct buried. Flat molded and web/ribbon cable are considered jacketed cable.

If any other cable is used, the NEC and local codes should be observed.

Cable lengths in Tables 11 & 11A allow for a 5% voltage drop running at maximum nameplate amperes. If 3% voltage drop is desired, multiply Table 11 and 11A lengths by 0.6 to get maximum cable length.

The portion of the total cable length, which is between the supply and single-phase control box with a line contactor, should not exceed 25% of total maximum allowable to ensure reliable contactor operation. Single-phase control boxes without line contactors may be connected at any point in the total cable length.

Tables 11 & 11A are based on copper wire. If aluminum wire is used, it must be two sizes larger than copper wire and oxidation inhibitors must be used on connections.

EXAMPLE: If Tables 11 & 11A call for #12 copper wire, #10 aluminum wire would be required.

Contact Franklin Electric for 90 °C cable lengths.

See pages 15, 50, and 51 for applications using 230 V motors on 208 V power systems.

Single-Phase Motors

APPLICATION

Two or More Different Cable Sizes Can Be Used

Depending on the installation, any number of combinations of cable may be used.

For example, in a replacement/upgrade installation, the well already has 160 feet of buried #10 cable between the service entrance and the wellhead. A new 3 hp, 230-volt, single-phase motor is being installed to replace a smaller motor. The question is: Since there is already 160 feet of #10 AWG installed, what size cable is required in the well with a 3 hp, 230-volt, single-phase motor setting at 310 feet?

From Tables 11 & 11A, a 3 hp motor can use up to 300 feet of #10 AWG cable.

The application has 160 feet of #10 AWG copper wire installed.

Using the formula below, 160 feet (actual) ÷ 300 feet (max allowable) is equal to 0.533. This means 53.3% (0.533 x 100) of the allowable voltage drop or loss, which is allowed between the service entrance and the motor, occurs in this wire. This leaves us 46.7% (1.00 - 0.533 = 0.467) of some other wire size to use in the remaining 310 feet "down hole" wire run.

The table shows #8 AWG copper wire is good for 470 feet. Using the formula again, 310 feet (used) ÷ 470 feet (allowed) = 0.660; adding this to the 0.533 determined earlier; 0.533 + 0.660 = 1.193. This combination is greater than 1.00, so the voltage drop will not meet US National Electrical Code recommendations.

Tables 11 & 11A show #6 AWG copper wire is good for 750 feet. Using the formula, 310 ÷ 750 = 0.413, and using these numbers, 0.533 + 0.413 = 0.946, we find this is less than 1.00 and will meet the NEC recommended voltage drop.

This works for two, three or more combinations of wire and it does not matter which size wire comes first in the installation.

$$\text{Formula:} \quad \frac{\text{Actual Length}}{\text{Max Allowed}} + \frac{\text{Actual Length}}{\text{Max Allowed}} = 1.00$$

EXAMPLE: 3 hp, 230-Volt, Single-Phase Motor

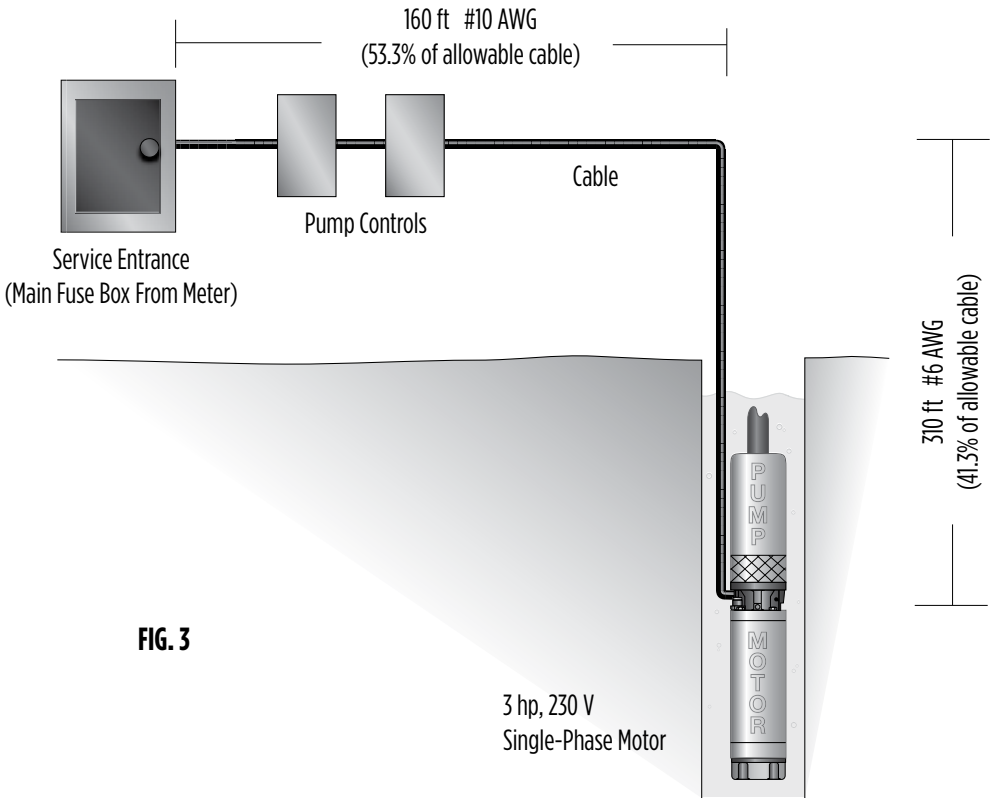

FIG. 3

Single-Phase Motors

APPLICATION

Table 13 Single-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		WINDING (1) RES. IN OHMS	EFFICIENCY %		POWER FACTOR %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	(2) AMPS	WATTS	(2) AMPS	WATTS	M=MAIN RES. S=START RES.	S.F.	F.L.	S.F.	F.L.		
4" 2-WIRE	244504	1/2	0.37	115	60	1.6	10.0	670	12.0	960	1.0-1.3	62	56	73	58	64.4	R
	244505	1/2	0.37	230	60	1.6	5.0	670	6.0	960	4.2-5.2	62	56	73	58	32.2	R
	244507	3/4	0.55	230	60	1.5	6.8	940	8.0	1310	3.0-3.6	64	59	74	62	40.7	N
	244508	1	0.75	230	60	1.4	8.2	1210	10.4	1600	2.2-2.7	65	62	74	63	48.7	N
	244309	1.5	1.1	230	60	1.3	10.6	1770	13.1	2280	1.5-2.1	64	63	83	76	66.2	M
4" 3-WIRE	214504	1/2	0.37	115	60	1.6	Y10.0 B10.0 R0	670	Y12.0 B12.0 R0	960	M1.0-1.3 S4.1-5.1	62	56	73	58	50.5	M
	214505	1/2	0.37	230	60	1.6	Y5.0 B5.0 R0	670	Y6.0 B6.0 R0	960	M4.2-5.2 S16.7-20.5	62	56	73	58	23	M
	214507	3/4	0.55	230	60	1.5	Y6.8 B6.8 R0	940	Y8.0 B8.0 R0	1310	M3.0-3.6 S10.7-13.1	64	59	74	62	34.2	M
	214508	1	0.75	230	60	1.4	Y8.2 B8.2 R0	1210	10.4 10.4 R0	1600	M2.2-2.7 S9.9-12.1	65	62	74	63	41.8	L
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	60	1.6	Y3.2 B3.7 R2.0	655	Y4.3 B4.0 R2.0	890	M4.2-5.2 S16.7-20.5	67	57	90	81	23	M
	214507	3/4	0.55	230	60	1.5	Y4.4 B5.0 R3.2	925	Y5.7 B5.2 R3.1	1220	M3.0-3.6 S10.7-13.1	69	60	92	84	34.2	M
	214508	1	0.75	230	60	1.4	Y5.6 B5.7 R3.4	1160	Y8.1 B6.2 R3.3	1490	M2.2-2.7 S9.9-12.1	70	64	92	86	41.8	L
4" 3-WIRE	214508 W/1-1.5 CB	1	0.75	230	60	1.4	Y6.6 B6.6 R1.3	1130	Y8.0 B7.9 R1.3	1500	M2.2-2.7 S9.9-12.1	70	66	82	72	43	L
	224300	1.5	1.1	230	60	1.3	Y10.0 B9.9 R1.3	1620	Y11.5 B11.0 R1.3	2080	M1.7-2.1 S7.5-9.2	70	69	85	79	51.4	J
	224301	2	1.5	230	60	1.25	Y10.0 B9.3 R2.6	2025	Y13.2 B11.9 R2.6	2555	M1.8-2.3 S5.5-7.2	73	74	95	94	53.1	G
	224302 (3)	3	2.2	230	60	1.15	Y14.0 B11.2 R6.1	3000	Y17.0 B12.6 R6.0	3400	M1.1-1.4 S4.0-4.8	75	75	99	99	83.4	H
	224303 (4)	5	3.7	230	60	1.15	Y23.0 B15.9 R11.0	4830	Y27.5 B19.1 R10.8	5500	M.71-.82 S1.8-2.2	78	77	100	100	129	G
6"	226110 (5)	5	3.7	230	60	1.15	Y23.0 B14.3 R10.8	4910	Y27.5 B17.4 R10.5	5570	M.55-.68 S1.3-1.7	77	76	100	99	99	E
	226111	7.5	5.5	230	60	1.15	Y36.5 B34.4 R5.5	7300	Y42.1 B40.5 R5.4	8800	M.36-.50 S.88-1.1	73	74	91	90	165	F
	226112	10	7.5	230	60	1.15	Y44.0 B39.5 R9.3	9800	Y51.0 B47.5 R8.9	11300	M.27-.33 S.80-.99	76	77	96	96	204	E
	226113	15	11	230	60	1.15	Y62.0 B52.0 R17.5	13900	Y75.0 B62.5 R16.9	16200	M.17-.22 S.68-.93	79	80	97	98	303	E

(1) Main winding - yellow to black Start winding - yellow to red

(2) Y = Yellow lead - line amps
B = Black lead - main winding amps
R = Red lead - start or auxiliary winding amps

(3) Control Boxes date coded 02C and older have **35 MFD** run capacitors. Current values should be Y14.0 @ FL and Y17.0 @ Max Load.
B12.2 B14.5
R4.7 R4.5

(4) Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 4" motor will be Y23.0 @ FL - Y27.5 @ Max Load.
B19.1 B23.2
R8.0 R7.8

(5) Control Boxes date coded 01M and older have **60 MFD** run capacitors and the current values on a 6" motor will be Y23.0 @ FL -Y27.5 @ Max Load.
B18.2 B23.2
R8.0 R7.8

Performance is typical, not guaranteed, at specified voltages and specified capacitor values. Performance at voltage ratings not shown is similar, except amps vary inversely with voltage.

Single-Phase Motors

APPLICATION

Table 14 Single-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
4" 2-WIRE	244504	1/2	0.37	115	35	20	30	30	15	30
	244505	1/2	0.37	230	20	10	15	15	8	15
	244507	3/4	0.55	230	25	15	20	20	10	20
	244508	1	0.75	230	30	20	25	25	11	25
	244309	1.5	1.1	230	35	20	30	35	15	30
4" 3-WIRE	214504	1/2	0.37	115	35	20	30	30	15	30
	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE W/CRC CB	214505	1/2	0.37	230	20	10	15	15	8	15
	214507	3/4	0.55	230	25	15	20	20	10	20
	214508	1	0.75	230	30	20	25	25	11	25
4" 3-WIRE	214508 W/ 1-1.5 CB	1	0.75	230	30	20	25	25	11	25
	224300	1.5	1.1	230	35	20	30	30	15	30
	224301	2	1.5	230	30	20	25	30	15	25
	224302	3	2.2	230	45	30	40	45	20	40
	224303	5	3.7	230	80	45	60	70	30	60
6"	226110	5	3.7	230	80	45	60	70	30	60
	226111	7.5	5.5	230	125	70	100	110	50	100
	226112	10	7.5	230	150	80	125	150	60	125
	226113	15	11	230	200	125	175	200	90	175

Single-Phase Motors

APPLICATION

Auxiliary Running Capacitors

Added capacitors must be connected across "Red" and "Black" control box terminals, in parallel with any existing running capacitors. The additional capacitor(s) should be mounted in an auxiliary box. The values of additional running capacitors most likely to reduce noise are given below. The tabulation gives the **max.** S.F. amps normally in each lead with the added capacitor.

Although motor amps decrease when auxiliary run capacitance is added, the load on the motor does not. If a motor is overloaded with normal capacitance, it will still be overloaded with auxiliary run capacitance, even though motor amps may be within nameplate values.

Table 15 Auxiliary Capacitor Sizing

MOTOR RATING		NORMAL RUNNING CAPACITOR(S)	AUXILIARY RUNNING CAPACITORS FOR NOISE REDUCTION			MAXIMUM AMPS WITH RUN CAP		
HP	VOLTS	MFD	MFD	MIN. VOLTS	FRANKLIN PART	YELLOW	BLACK	RED
1/2	115	0	60(1)	370	TWO 155327101	8.4	7.0	4.0
1/2	230	0	15(1)	370	ONE 155328101	4.2	3.5	2.0
3/4		0	20(1)	370	ONE 155328103	5.8	5.0	2.5
1		0	25(1)	370	ONE EA. 155328101 155328102	7.1	5.6	3.4
1.5		10	20	370	ONE 155328103	9.3	7.5	4.4
2		20	10	370	ONE 155328102	11.2	9.2	3.8
3		45	NONE	370		17.0	12.6	6.0
5		80	NONE	370		27.5	19.1	10.8
7.5		45	45	370	ONE EA. 155327101 155328101	37.0	32.0	11.3
10		70	30	370	ONE 155327101	49.0	42.0	13.0
15		135	NONE			75.0	62.5	16.9

(1) Do not add running capacitors to 1/3 through 1 hp control boxes, which use solid state switches or QD relays. Adding capacitors will cause switch failure. If the control box is converted to use a voltage relay, the specified running capacitance can be added.

Buck-Boost Transformers

When the available power supply voltage is not within the proper range, a buck-boost transformer is often used to adjust voltage to match the motor. The most common usage on submersible motors is boosting a 208 volt supply to use a standard 230 volt single-phase submersible motor and control. While tables to give a wide range of voltage boost or buck are published by transformer manufacturers, the following table shows Franklin's recommendations. The table, based on boosting the voltage 10%, shows the minimum rated transformer kVA needed and the common standard transformer kVA.

Table 15A Buck-Boost Transformer Sizing

MOTOR HP	1/3	1/2	3/4	1	1.5	2	3	5	7.5	10	15
LOAD KVA	1.02	1.36	1.84	2.21	2.65	3.04	3.91	6.33	9.66	11.70	16.60
MINIMUM XFMR KVA	0.11	0.14	0.19	0.22	0.27	0.31	0.40	0.64	0.97	1.20	1.70
STANDARD XFMR KVA	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.75	1.00	1.50	2.00

Buck-Boost transformers are power transformers, not control transformers. They may also be used to lower voltage when the available power supply voltage is too high.

Three-Phase Motors

APPLICATION

Table 16 Three-Phase 60 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420													
	3/4	0.55	510	810	1280	2030	3160													
	1	0.75	430	690	1080	1710	2670	4140	5140											
	1.5	1.1	310	500	790	1260	1960	3050	3780											
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420								
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130								
	5	3.7	**110**	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030				
	7.5	5.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560				
	10	7.5	0	0	0	**230**	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420
	15	11	0	0	0	**160**	**250**	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980
	20	15	0	0	0	0	**190**	**300**	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360
	25	18.5	0	0	0	0	0	**240**	**300**	**370**	460	570	700	840	1030	1170	1330	1500	1640	1900
	30	22	0	0	0	0	0	0	**250**	**310**	**380**	470	580	700	850	970	1110	1250	1360	1590
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910												
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860										
	1	0.75	560	910	1430	2260	3520	5460	6780	8290										
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170								
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780							
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680					
	5	3.7	**140**	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220	
	7.5	5.5	0	**160**	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510
	10	7.5	0	0	**190**	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840
	15	11	0	0	0	**210**	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940
	20	15	0	0	0	0	**250**	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120
	25	18.5	0	0	0	0	0	**320**	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520
	30	22	0	0	0	0	0	**260**	**330**	**410**	510	620	760	930	1130	1280	1470	1650	1800	2110
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730															
	3/4	0.55	2000	3190	5010	7860														
	1	0.75	1620	2580	4060	6390	9980													
	1.5	1.1	1230	1970	3100	4890	7630													
	2	1.5	870	1390	2180	3450	5400	8380												
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830										
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830								
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780						
	10	7.5	**200**	**320**	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340			
	15	11	0	0	**370**	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990	
	20	15	0	0	0	**440**	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	5840	6510	7120	8190
	25	18.5	0	0	0	**360**	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590
	30	22	0	0	0	0	**470**	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490
	40	30	0	0	0	0	0	**530**	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990
	50	37	0	0	0	0	0	0	**540**	**660**	820	1000	1220	1480	1770	2010	2290	2550	2780	3190
	60	45	0	0	0	0	0	0	0	**560**	**690**	850	1030	1250	1500	1700	1940	2150	2350	2700
	75	55	0	0	0	0	0	0	0	0	**570**	**700**	**860**	1050	1270	1440	1660	1850	2030	2350
	100	75	0	0	0	0	0	0	0	0	0	**510**	**630**	**760**	910	1030	1180	1310	1430	1650
	125	93	0	0	0	0	0	0	0	0	0	0	0	**620**	**740**	**840**	**950**	1060	1160	1330
	150	110	0	0	0	0	0	0	0	0	0	0	0	0	**620**	**700**	**790**	**880**	**960**	1090
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	0	**650**	**750**	**840**	**920**	1070
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**630**	**700**	**760**	**880**

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Three-Phase Motors

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Table 17 Three-Phase 60 °C Cable (Continued)

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460															
	3/4	0.55	2730	4350	6850															
	1	0.75	2300	3670	5770	9070														
	1.5	1.1	1700	2710	4270	6730														
	2	1.5	1300	2070	3270	5150	8050													
	3	2.2	1000	1600	2520	3970	6200													
	5	3.7	590	950	1500	2360	3700	5750												
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680									
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050								
	15	11	0	**340**	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	15	0	0	**410**	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	18.5	0	0	0	**530**	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	22	0	0	0	**430**	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	30	0	0	0	0	**500**	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	37	0	0	0	0	0	**640**	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	45	0	0	0	0	0	**540**	**670**	**830**	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	55	0	0	0	0	0	0	0	**680**	**840**	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	75	0	0	0	0	0	0	0	0	**620**	**760**	**940**	1130	1380	1560	1790	2010	2190	2550
	125	93	0	0	0	0	0	0	0	0	0	0	**740**	**890**	**1000**	1220	1390	1560	1700	1960
	150	110	0	0	0	0	0	0	0	0	0	0	0	**760**	**920**	**1050**	**1190**	1340	1460	1690
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	**810**	**930**	**1060**	**1190**	1300	1510
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	**810**	**920**	**1030**	**1130**	1310
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																
	3/4	0.55	4270	6810																
	1	0.75	3630	5800	9120															
	1.5	1.1	2620	4180	6580															
	2	1.5	2030	3250	5110	8060														
	3	2.2	1580	2530	3980	6270														
	5	3.7	920	1480	2330	3680	5750													
	7.5	5.5	660	1060	1680	2650	4150													
	10	7.5	490	780	1240	1950	3060	4770	5940											
	15	11	**330**	530	850	1340	2090	3260	4060											
	20	15	0	**410**	650	1030	1610	2520	3140	3860	4760	5830								
	25	18.5	0	0	**520**	830	1300	2030	2530	3110	3840	4710								
	30	22	0	0	**430**	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	30	0	0	0	**500**	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	37	0	0	0	0	**640**	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	45	0	0	0	0	0	**850**	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	55	0	0	0	0	0	**690**	**860**	**1060**	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370
	100	75	0	0	0	0	0	0	0	**790**	**970**	**1190**	1460	1770	2150	2440	2790	3140	3430	3990
	125	93	0	0	0	0	0	0	0	0	**770**	**950**	**1160**	1400	1690	1920	2180	2440	2650	3070
	150	110	0	0	0	0	0	0	0	0	0	**800**	**990**	**1190**	1440	1630	1860	2080	2270	2640
	175	130	0	0	0	0	0	0	0	0	0	0	**870**	**1050**	**1270**	**1450**	1650	1860	2030	2360
	200	150	0	0	0	0	0	0	0	0	0	0	0	**920**	**1110**	**1260**	**1440**	1620	1760	2050

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See 11 for additional details.

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Three-Phase Motors

APPLICATION

Table 18 Three-Phase 60 °C Cable (Continued)

60 °C

MOTOR RATING			60 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540				
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340				
	10	7.5	**80**	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630
	15	11	0	0	**140**	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470
	20	15	0	0	0	**170**	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540
	25	18.5	0	0	0	**140**	**220**	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850
	30	22	0	0	0	0	**180**	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970				
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750	
	10	7.5	**110**	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760
	15	11	0	0	**190**	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910
	20	15	0	0	**140**	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680
	25	18.5	0	0	0	**190**	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780
	30	22	0	0	0	**150**	**240**	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800										
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010								
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390						
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780				
	20	15	**160**	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760		
	25	18.5	0	**210**	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880
	30	22	0	0	**270**	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230
	40	30	0	0	0	**320**	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980
	50	37	0	0	0	**250**	**400**	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780
	60	45	0	0	0	0	**340**	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050
	75	55	0	0	0	0	0	**450**	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520
	100	75	0	0	0	0	0	0	**420**	**520**	640	760	940	1140	1360	1540	1770	1960	2140	2470
	125	93	0	0	0	0	0	0	0	**400**	**490**	**600**	730	930	1110	1260	1420	1590	1740	1990
	150	110	0	0	0	0	0	0	0	0	**420**	**510**	**620**	750	930	1050	1180	1320	1440	1630
	175	130	0	0	0	0	0	0	0	0	**360**	**440**	**540**	660	780	970	1120	1260	1380	1600
	200	150	0	0	0	0	0	0	0	0	0	0	**480**	**580**	**690**	790	940	1050	1140	1320
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620												
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390										
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620									
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850							
	20	15	**230**	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290						
	25	18.5	**190**	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140					
	30	22	0	**250**	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790			
	40	30	0	0	**300**	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370			
	50	37	0	0	0	**370**	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270
	60	45	0	0	0	**320**	**500**	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150
	75	55	0	0	0	0	**420**	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160
	100	75	0	0	0	0	0	**500**	**610**	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820
	125	93	0	0	0	0	0	0	**470**	**590**	**730**	880	1110	1330	1500	1830	2080	2340	2550	2940
	150	110	0	0	0	0	0	0	0	**510**	**630**	**770**	950	1140	1380	1570	1790	2000	2180	2530
	175	130	0	0	0	0	0	0	0	0	**550**	**680**	**830**	1000	1220	1390	1580	1780	1950	2270
	200	150	0	0	0	0	0	0	0	0	0	**590**	**730**	**880**	1070	1210	1380	1550	1690	1970
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620													
	7.5	5.5	990	1590	2520	3970	6220													
	10	7.5	730	1170	1860	2920	4590	7150	8910											
	15	11	490	790	1270	2010	3130	4890	6090											
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740								
	25	18.5	**300**	490	780	1240	1950	3040	3790	4660	5760	7060								
	30	22	**240**	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670						
	40	30	0	**300**	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740				
	50	37	0	0	**380**	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790	
	60	45	0	0	0	**500**	**790**	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610
	75	55	0	0	0	**420**	**660**	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050
	100	75	0	0	0	0	**400**	**780**	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980
	125	93	0	0	0	0	0	**600**	**740**	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600
	150	110	0	0	0	0	0	0	**650**	**800**	**990**	1210	1480	1780	2160	2450	2790	3120	3410	3950
	175	130	0	0	0	0	0	0	0	**700**	**860**	1060	1300	1570	1910	2170	2480	2780	3040	3540
	200	150	0	0	0	0	0	0	0	0	**760**	**930**	1140	1370	1670	1890	2160	2420	2640	3070

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

Three-Phase Motors

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Table 19 Three-Phase 75 °C Cable, 60 Hz (Service Entrance to Motor) Maximum Length in Feet

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	710	1140	1800	2840	4420													
	3/4	0.55	510	810	1280	2030	3160													
	1	0.75	430	690	1080	1710	2670	4140	5140											
	1.5	1.1	310	500	790	1260	1960	3050	3780											
	2	1.5	240	390	610	970	1520	2360	2940	3610	4430	5420								
	3	2.2	180	290	470	740	1160	1810	2250	2760	3390	4130								
	5	3.7	**110**	170	280	440	690	1080	1350	1660	2040	2490	3050	3670	4440	5030				
	7.5	5.5	0	0	200	310	490	770	960	1180	1450	1770	2170	2600	3150	3560				
	10	7.5	0	0	**150**	230	370	570	720	880	1090	1330	1640	1970	2390	2720	3100	3480	3800	4420
	15	11	0	0	0	**160**	250	390	490	600	740	910	1110	1340	1630	1850	2100	2350	2570	2980
	20	15	0	0	0	0	**190**	300	380	460	570	700	860	1050	1270	1440	1650	1850	2020	2360
	25	18.5	0	0	0	0	0	**240**	300	370	460	570	700	840	1030	1170	1330	1500	1640	1900
	30	22	0	0	0	0	0	**200**	**250**	310	380	470	580	700	850	970	1110	1250	1360	1590
230 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	930	1490	2350	3700	5760	8910												
	3/4	0.55	670	1080	1700	2580	4190	6490	8060	9860										
	1	0.75	560	910	1430	2260	3520	5460	6780	8290										
	1.5	1.1	420	670	1060	1670	2610	4050	5030	6160	7530	9170								
	2	1.5	320	510	810	1280	2010	3130	3890	4770	5860	7170	8780							
	3	2.2	240	390	620	990	1540	2400	2980	3660	4480	5470	6690	8020	9680					
	5	3.7	**140**	230	370	590	920	1430	1790	2190	2690	3290	4030	4850	5870	6650	7560	8460	9220	
	7.5	5.5	0	**160**	260	420	650	1020	1270	1560	1920	2340	2870	3440	4160	4710	5340	5970	6500	7510
	10	7.5	0	0	**190**	310	490	760	950	1170	1440	1760	2160	2610	3160	3590	4100	4600	5020	5840
	15	11	0	0	0	**210**	330	520	650	800	980	1200	1470	1780	2150	2440	2780	3110	3400	3940
	20	15	0	0	0	**160**	**250**	400	500	610	760	930	1140	1380	1680	1910	2180	2450	2680	3120
	25	18.5	0	0	0	0	**200**	320	400	500	610	750	920	1120	1360	1540	1760	1980	2160	2520
	30	22	0	0	0	0	0	**260**	330	410	510	620	760	930	1130	1280	1470	1650	1800	2110
380 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	2690	4290	6730															
	3/4	0.55	2000	3190	5010	7860														
	1	0.75	1620	2580	4060	6390	9980													
	1.5	1.1	1230	1970	3100	4890	7630													
	2	1.5	870	1390	2180	3450	5400	8380												
	3	2.2	680	1090	1710	2690	4200	6500	8020	9830										
	5	3.7	400	640	1010	1590	2490	3870	4780	5870	7230	8830								
	7.5	5.5	270	440	690	1090	1710	2640	3260	4000	4930	6010	7290	8780						
	10	7.5	**200**	320	510	800	1250	1930	2380	2910	3570	4330	5230	6260	7390	8280	9340			
	15	11	0	0	370	590	920	1430	1770	2170	2690	3290	4000	4840	5770	6520	7430	8250	8990	
	20	15	0	0	**280**	440	700	1090	1350	1670	2060	2530	3090	3760	4500	5110	2840	6510	7120	8190
	25	18.5	0	0	0	**360**	570	880	1100	1350	1670	2050	2510	3040	3640	4130	4720	5250	5740	6590
	30	22	0	0	0	**290**	470	730	910	1120	1380	1700	2080	2520	3020	3430	3920	4360	4770	5490
	40	30	0	0	0	0	0	**530**	660	820	1010	1240	1520	1840	2200	2500	2850	3170	3470	3990
	50	37	0	0	0	0	0	**440**	**540**	660	820	1000	1220	1480	1770	2010	2290	2550	2780	3190
	60	45	0	0	0	0	0	**370**	**460**	**560**	690	850	1030	1250	1500	1700	1940	2150	2350	2700
	75	55	0	0	0	0	0	0	0	**460**	**570**	700	860	1050	1270	1440	1660	1850	2030	2350
	100	75	0	0	0	0	0	0	0	0	**420**	**510**	**630**	760	910	1030	1180	1310	1430	1650
	125	93	0	0	0	0	0	0	0	0	0	0	**510**	**620**	**740**	840	950	1060	1160	1330
	150	110	0	0	0	0	0	0	0	0	0	0	0	**520**	**620**	**700**	**790**	880	960	1090
	175	130	0	0	0	0	0	0	0	0	0	0	0	0	**560**	**650**	**750**	**840**	920	1070
	200	150	0	0	0	0	0	0	0	0	0	0	0	0	0	**550**	**630**	**700**	**760**	880

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Three-Phase Motors

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Table 20 Three-Phase 75 °C Cable (Continued)

75 °C

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
460 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	3770	6020	9460															
	3/4	0.55	2730	4350	6850															
	1	0.75	2300	3670	5770	9070														
	1.5	1.1	1700	2710	4270	6730														
	2	1.5	1300	2070	3270	5150	8050													
	3	2.2	1000	1600	2520	3970	6200													
	5	3.7	590	950	1500	2360	3700	5750												
	7.5	5.5	420	680	1070	1690	2640	4100	5100	6260	7680									
	10	7.5	310	500	790	1250	1960	3050	3800	4680	5750	7050								
	15	11	0	**340**	540	850	1340	2090	2600	3200	3930	4810	5900	7110						
	20	15	0	0	410	650	1030	1610	2000	2470	3040	3730	4580	5530						
	25	18.5	0	0	**330**	530	830	1300	1620	1990	2450	3010	3700	4470	5430					
	30	22	0	0	**270**	430	680	1070	1330	1640	2030	2490	3060	3700	4500	5130	5860			
	40	30	0	0	0	**320**	**500**	790	980	1210	1490	1830	2250	2710	3290	3730	4250			
	50	37	0	0	0	0	**410**	640	800	980	1210	1480	1810	2190	2650	3010	3420	3830	4180	4850
	60	45	0	0	0	0	0	**540**	**670**	830	1020	1250	1540	1850	2240	2540	2890	3240	3540	4100
	75	55	0	0	0	0	0	**440**	**550**	**680**	840	1030	1260	1520	1850	2100	2400	2700	2950	3440
	100	75	0	0	0	0	0	0	0	**500**	**620**	**760**	940	1130	1380	1560	1790	2010	2190	2550
	125	93	0	0	0	0	0	0	0	0	0	**600**	**740**	**890**	1000	1220	1390	1560	1700	1960
	150	110	0	0	0	0	0	0	0	0	0	0	**630**	**760**	**920**	1050	1190	1340	1460	1690
	175	130	0	0	0	0	0	0	0	0	0	0	0	**670**	**810**	**930**	1060	1190	1300	1510
	200	150	0	0	0	0	0	0	0	0	0	0	0	**590**	**710**	**810**	**920**	1030	1130	1310
575 V 60 Hz Three-Phase 3 - Lead	1/2	0.37	5900	9410																
	3/4	0.55	4270	6810																
	1	0.75	3630	5800	9120															
	1.5	1.1	2620	4180	6580															
	2	1.5	2030	3250	5110	8060														
	3	2.2	1580	2530	3980	6270														
	5	3.7	920	1480	2330	3680	5750													
	7.5	5.5	660	1060	1680	2650	4150													
	10	7.5	490	780	1240	1950	3060	4770	5940											
	15	11	**330**	530	850	1340	2090	3260	4060											
	20	15	0	**410**	650	1030	1610	2520	3140	3860	4760	5830								
	25	18.5	0	0	520	830	1300	2030	2530	3110	3840	4710								
	30	22	0	0	**430**	680	1070	1670	2080	2560	3160	3880	4770	5780	7030	8000				
	40	30	0	0	0	**500**	790	1240	1540	1900	2330	2860	3510	4230	5140	5830				
	50	37	0	0	0	**410**	**640**	1000	1250	1540	1890	2310	2840	3420	4140	4700	5340	5990	6530	7580
	60	45	0	0	0	0	**540**	850	1060	1300	1600	1960	2400	2890	3500	3970	4520	5070	5530	6410
	75	55	0	0	0	0	0	**690**	860	1060	1310	1600	1970	2380	2890	3290	3750	5220	4610	5370
	100	75	0	0	0	0	0	0	**640**	**790**	970	1190	1460	1770	2150	2440	2790	3140	3430	3990
	125	93	0	0	0	0	0	0	0	**630**	**770**	**950**	1160	1400	1690	1920	2180	2440	2650	3070
	150	110	0	0	0	0	0	0	0	0	**660**	**800**	**990**	1190	1440	1630	1860	2080	2270	2640
	175	130	0	0	0	0	0	0	0	0	0	**700**	**870**	**1050**	1270	1450	1650	1860	2030	2360
	200	150	0	0	0	0	0	0	0	0	0	0	**760**	**920**	**1110**	1260	1440	1620	1760	2050

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

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Three-Phase Motors

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75 °C

Table 21 Three-Phase 75 °C Cable

MOTOR RATING			75 °C INSULATION - AWG COPPER WIRE SIZE													MCM COPPER WIRE SIZE				
VOLTS	HP	KW	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	350	400	500
200 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	160	250	420	660	1030	1620	2020	2490	3060	3730	4570	5500	6660	7540				
	7.5	5.5	110	180	300	460	730	1150	1440	1770	2170	2650	3250	3900	4720	5340				
	10	7.5	**80**	130	210	340	550	850	1080	1320	1630	1990	2460	2950	3580	4080	4650	5220	5700	6630
	15	11	0	0	140	240	370	580	730	900	1110	1360	1660	2010	2440	2770	3150	3520	3850	4470
	20	15	0	0	**120**	170	280	450	570	690	850	1050	1290	1570	1900	2160	2470	2770	3030	3540
	25	18.5	0	0	0	**140**	220	360	450	550	690	850	1050	1260	1540	1750	1990	2250	2460	2850
	30	22	0	0	0	**120**	**180**	294	370	460	570	700	870	1050	1270	1450	1660	1870	2040	2380
230 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	210	340	550	880	1380	2140	2680	3280	4030	4930	6040	7270	8800	9970				
	7.5	5.5	150	240	390	630	970	1530	1900	2340	2880	3510	4300	5160	6240	7060	8010	8950	9750	
	10	7.5	**110**	180	280	460	730	1140	1420	1750	2160	2640	3240	3910	4740	5380	6150	6900	7530	8760
	15	11	0	**130**	190	310	490	780	970	1200	1470	1800	2200	2670	3220	3660	4170	4660	5100	5910
	20	15	0	0	**140**	230	370	600	750	910	1140	1390	1710	2070	2520	2860	3270	3670	4020	4680
	25	18.5	0	0	**120**	190	300	480	600	750	910	1120	1380	1680	2040	2310	2640	2970	3240	3780
	30	22	0	0	0	**150**	240	390	490	610	760	930	1140	1390	1690	1920	2200	2470	2700	3160
380 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	600	960	1510	2380	3730	5800	7170	8800										
	7.5	5.5	400	660	1030	1630	2560	3960	4890	6000	7390	9010								
	10	7.5	300	480	760	1200	1870	2890	3570	4360	5350	6490	7840	9390						
	15	11	210	340	550	880	1380	2140	2650	3250	4030	4930	6000	7260	8650	9780				
	20	15	**160**	260	410	660	1050	1630	2020	2500	3090	3790	4630	5640	6750	7660	4260	9760		
	25	18.5	0	**210**	330	540	850	1320	1650	2020	2500	3070	3760	4560	5460	6190	7080	7870	8610	9880
	30	22	0	0	**270**	430	700	1090	1360	1680	2070	2550	3120	3780	4530	5140	5880	6540	7150	8230
	40	30	0	0	**210**	320	510	790	990	1230	1510	1860	2280	2760	3300	3750	4270	4750	5200	5980
	50	37	0	0	0	**250**	400	630	810	990	1230	1500	1830	2220	2650	3010	3430	3820	4170	4780
	60	45	0	0	0	0	**340**	540	660	840	1030	1270	1540	1870	2250	2550	2910	3220	3520	4050
	75	55	0	0	0	0	**290**	450	550	690	855	1050	1290	1570	1900	2160	2490	2770	3040	3520
	100	75	0	0	0	0	0	**340**	**420**	520	640	760	940	1140	1360	1540	1770	1960	2140	2470
	125	93	0	0	0	0	0	0	**340**	**400**	**490**	600	730	930	1110	1260	1420	1590	1740	1990
	150	110	0	0	0	0	0	0	0	**350**	**420**	**510**	620	750	930	1050	1180	1320	1440	1630
	175	130	0	0	0	0	0	0	0	0	**360**	**440**	**540**	660	780	970	1120	1260	1380	1600
	200	150	0	0	0	0	0	0	0	0	0	**410**	**480**	**580**	690	790	940	1050	1140	1320
460 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	880	1420	2250	3540	5550	8620												
	7.5	5.5	630	1020	1600	2530	3960	6150	7650	9390										
	10	7.5	460	750	1180	1870	2940	4570	5700	7020	8620									
	15	11	310	510	810	1270	2010	3130	3900	4800	5890	7210	8850							
	20	15	230	380	610	970	1540	2410	3000	3700	4560	5590	6870	8290						
	25	18.5	**190**	310	490	790	1240	1950	2430	2980	3670	4510	5550	6700	8140					
	30	22	0	**250**	410	640	1020	1600	1990	2460	3040	3730	4590	5550	6750	7690	8790			
	40	30	0	0	**300**	480	750	1180	1470	1810	2230	2740	3370	4060	4930	5590	6370			
	50	37	0	0	**250**	370	590	960	1200	1470	1810	2220	2710	3280	3970	4510	5130	5740	6270	7270
	60	45	0	0	0	**320**	500	810	1000	1240	1530	1870	2310	2770	3360	3810	4330	4860	5310	6150
	75	55	0	0	0	0	**420**	660	810	1020	1260	1540	1890	2280	2770	3150	3600	4050	4420	5160
	100	75	0	0	0	0	**310**	**500**	610	760	930	1140	1410	1690	2070	2340	2680	3010	3280	3820
	125	93	0	0	0	0	0	**390**	**470**	**590**	730	880	1110	1330	1500	1830	2080	2340	2550	2940
	150	110	0	0	0	0	0	0	**420**	**510**	**630**	770	950	1140	1380	1570	1790	2000	2180	2530
	175	130	0	0	0	0	0	0	0	**450**	**550**	**680**	830	1000	1220	1390	1580	1780	1950	2270
	200	150	0	0	0	0	0	0	0	0	**480**	**590**	**730**	880	1070	1210	1380	1550	1690	1970
575 V 60 Hz Three-Phase 6 - Lead Y-D	5	3.7	1380	2220	3490	5520	8620													
	7.5	5.5	990	1590	2520	3970	6220													
	10	7.5	730	1170	1860	2920	4590	7150	8910											
	15	11	490	790	1270	2010	3130	4890	6090											
	20	15	370	610	970	1540	2410	3780	4710	5790	7140	8740								
	25	18.5	**300**	490	780	1240	1950	3040	3790	4660	5760	7060								
	30	22	**240**	400	645	1020	1600	2500	3120	3840	4740	5820	7150	8670						
	40	30	0	**300**	480	750	1180	1860	2310	2850	3490	4290	5260	6340	7710	8740				
	50	37	0	0	**380**	590	960	1500	1870	2310	2830	3460	4260	5130	6210	7050	8010	8980	9790	
	60	45	0	0	**330**	500	790	1270	1590	1950	2400	2940	3600	4330	5250	5950	6780	7600	8290	9610
	75	55	0	0	0	**420**	660	1030	1290	1590	1960	2400	2950	3570	4330	4930	5620	6330	6910	8050
	100	75	0	0	0	0	**400**	780	960	1180	1450	1780	2190	2650	3220	3660	4180	4710	5140	5980
	125	93	0	0	0	0	0	**600**	740	920	1150	1420	1740	2100	2530	2880	3270	3660	3970	4600
	150	110	0	0	0	0	0	**520**	**650**	800	990	1210	1480	1780	2160	2450	2790	3120	3410	3950
	175	130	0	0	0	0	0	0	**570**	**700**	860	1060	1300	1570	1910	2170	2480	2780	3040	3540
	200	150	0	0	0	0	0	0	**500**	**610**	**760**	930	1140	1370	1670	1890	2160	2420	2640	3070

Lengths in **BOLD** only meet the US National Electrical Code ampacity requirements for individual conductors in free air or water. Lengths NOT in bold meet NEC ampacity requirements for either individual conductors or jacketed cable. See page 11 for additional details.

Three-Phase Motors

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Table 22 Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
4"	234501	1/2	0.37	200	60	1.6	2.8	585	3.4	860	6.6-8.4	70	64	17.5	N
	234511			230	60	1.6	2.4	585	2.9	860	9.5-10.9	70	64	15.2	N
	234541			380	60	1.6	1.4	585	2.1	860	23.2-28.6	70	64	9.2	N
	234521			460	60	1.6	1.2	585	1.5	860	38.4-44.1	70	64	7.6	N
	234531			575	60	1.6	1.0	585	1.2	860	58.0-71.0	70	64	6.1	N
	234502	3/4	0.55	200	60	1.5	3.6	810	4.4	1150	4.6-5.9	73	69	24.6	N
	234512			230	60	1.5	3.1	810	3.8	1150	6.8-7.8	73	69	21.4	N
	234542			380	60	1.5	1.9	810	2.5	1150	16.6-20.3	73	69	13	N
	234522			460	60	1.5	1.6	810	1.9	1150	27.2-30.9	73	69	10.7	N
	234532			575	60	1.5	1.3	810	1.6	1150	41.5-50.7	73	69	8.6	N
	234503	1	0.75	200	60	1.4	4.5	1070	5.4	1440	3.8-4.5	72	70	30.9	M
	234513			230	60	1.4	3.9	1070	4.7	1440	4.9-5.6	72	70	26.9	M
	234543			380	60	1.4	2.3	1070	2.8	1440	12.2-14.9	72	70	16.3	M
	234523			460	60	1.4	2	1070	2.4	1440	19.9-23.0	72	70	13.5	M
	234533			575	60	1.4	1.6	1070	1.9	1440	30.1-36.7	72	70	10.8	M
	234504	1.5	1.1	200	60	1.3	5.8	1460	6.8	1890	2.5-3.0	76	76	38.2	K
	234514			230	60	1.3	5	1460	5.9	1890	3.2-4.0	76	76	33.2	K
	234544			380	60	1.3	3	1460	3.6	1890	8.5-10.4	76	76	20.1	K
	234524			460	60	1.3	2.5	1460	3.1	1890	13.0-16.0	76	76	16.6	K
	234534			575	60	1.3	2	1460	2.4	1890	20.3-25.0	76	76	13.3	K
	234305	2	1.5	200	60	1.25	7.7	1960	9.3	2430	1.8-2.4	76	76	50.3	K
	234315			230	60	1.25	6.7	1960	8.1	2430	2.3-3.0	76	76	45.0	K
	234345			380	60	1.25	4.1	1960	4.9	2430	6.6-8.2	76	76	26.6	K
	234325			460	60	1.25	3.4	1960	4.1	2430	9.2-12.0	76	76	22.5	K
	234335			575	60	1.25	2.7	1960	3.2	2430	14.6-18.7	76	76	17.8	K
	234306	3	2.2	200	60	1.15	10.9	2920	12.5	3360	1.3-1.7	77	77	69.5	K
	234316			230	60	1.15	9.5	2920	10.9	3360	1.8-2.2	77	77	60.3	K
	234346			380	60	1.15	5.8	2920	6.6	3360	4.7-6.0	77	77	37.5	K
	234326			460	60	1.15	4.8	2920	5.5	3360	7.2-8.8	77	77	31.0	K
	234336			575	60	1.15	3.8	2920	4.4	3360	11.4-13.9	77	77	25.1	K
	234307	5	3.7	200	60	1.15	18.3	4800	20.5	5500	.68-.83	78	78	116	K
	234317			230	60	1.15	15.9	4800	17.8	5500	.91-1.1	78	78	102	K
	234347			380	60	1.15	9.6	4800	10.8	5500	2.6-3.2	78	78	60.2	K
	234327			460	60	1.15	8.0	4800	8.9	5500	3.6-4.4	78	78	53.7	K
	234337			575	60	1.15	6.4	4800	7.1	5500	5.6-6.9	78	78	41.8	K
	234308	7.5	5.5	200	60	1.15	26.5	7150	30.5	8200	.43-.53	78	78	177	K
	234318			230	60	1.15	23.0	7150	26.4	8200	.60-.73	78	78	152	K
	234348			380	60	1.15	13.9	7150	16.0	8200	1.6-2.0	78	78	92.7	K
	234328			460	60	1.15	11.5	7150	13.2	8200	2.3-2.8	78	78	83.8	K
	234338			575	60	1.15	9.2	7150	10.6	8200	3.6-4.5	78	78	64.6	K
	234549	10	7.5	380	60	1.15	19.3	10000	21.0	11400	1.2-1.6	75	75	140	L
	234595			460	60	1.15	15.9	10000	17.3	11400	1.8-2.3	75	75	116.0	L
	234598			575	60	1.15	12.5	10000	13.6	11400	2.8-3.5	75	75	92.8	L
	234646	15	11	380	60	1.15	27.6	14600	31.2	16800	.86-1.1	77	76	178	J
	234626			460	60	1.15	22.8	14600	25.8	16800	1.2-1.5	77	76	147	J
	234636			575	60	1.15	18.2	14600	20.7	16800	1.9-2.4	77	76	118	J

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Table 23 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
4"	234501	1/2	0.37	200	10	5	8	10	4	15
	234511			230	8	4.5	6	8	4	15
	234541			380	5	2.5	4	5	2	15
	234521			460	4	2.25	3	4	2	15
	234531			575	3	1.8	3	3	1.4	15
	234502	3/4	0.55	200	15	7	10	12	5	15
	234512			230	10	5.6	8	10	5	15
	234542			380	6	3.5	5	6	3	15
	234522			460	5	2.8	4	5	3	15
	234532			575	4	2.5	4	4	1.8	15
	234503	1	0.75	200	15	8	15	15	6	15
	234513			230	15	7	10	12	6	15
	234543			380	8	4.5	8	8	4	15
	234523			460	6	3.5	5	6	3	15
	234533			575	5	2.8	4	5	2.5	15
	234504	1.5	1.1	200	20	12	15	20	8	15
	234514			230	15	9	15	15	8	15
	234544			380	10	5.6	8	10	4	15
	234524			460	8	4.5	8	8	4	15
	234534			575	6	3.5	5	6	3	15
	234305	2	1.5	200	25	15	20	25	11	20
	234315			230	25	12	20	25	10	20
	234345			380	15	8	15	15	6	15
	234325			460	15	6	10	11	5	15
	234335			575	10	5	8	10	4	15
	234306	3	2.2	200	35	20	30	35	15	30
	234316			230	30	17.5	25	30	12	25
	234346			380	20	12	15	20	8	15
	234326			460	15	9	15	15	6	15
	234336			575	15	7	10	11	5	15
	234307	5	3.7	200	60	35	50	60	25	50
	234317			230	50	30	40	45	20	40
	234347			380	30	17.5	25	30	12	25
	234327			460	25	15	20	25	10	20
	234337			575	20	12	20	20	8	20
	234308	7.5	5.5	200	90	50	70	80	35	70
	234318			230	80	45	60	70	30	60
	234348			380	45	25	40	40	20	40
	234328			460	40	25	30	35	15	30
	234338			575	30	17.5	25	30	12	25
	234349	10	7.5	380	70	40	60	60	25	60
	234329			460	60	30	45	50	25	45
	234339			575	45	25	35	40	20	35
	234549			380	70	35	60	60	25	60
	234595			460	60	30	45	50	25	45
	234598			575	45	25	35	40	20	35
	234646	15	11	380	90	50	70	80	35	70
	234626			460	80	45	60	70	30	60
	234636			575	60	35	50	60	25	50

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Table 24 Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
6" STD.	236650	5	3.7	200	60	1.15	17.5	4700	20.0	5400	.77-.93	79	79	99	H
	236600			230	60	1.15	15	4700	17.6	5400	1.0-1.2	79	79	86	H
	236660			380	60	1.15	9.1	4700	10.7	5400	2.6-3.2	79	79	52	H
	236610			460	60	1.15	7.5	4700	8.8	5400	3.9-4.8	79	79	43	H
	236620			575	60	1.15	6	4700	7.1	5400	6.3-7.7	79	79	34	H
	236651	7.5	5.5	200	60	1.15	25.1	7000	28.3	8000	.43-.53	80	80	150	H
	236601			230	60	1.15	21.8	7000	24.6	8000	.64-.78	80	80	130	H
	236661			380	60	1.15	13.4	7000	15	8000	1.6-2.1	80	80	79	H
	236611			460	60	1.15	10.9	7000	12.3	8000	2.4-2.9	80	80	65	H
	236621			575	60	1.15	8.7	7000	9.8	8000	3.7-4.6	80	80	52	H
	236652	10	7.5	200	60	1.15	32.7	9400	37	10800	.37-.45	79	79	198	H
	236602			230	60	1.15	28.4	9400	32.2	10800	.47-.57	79	79	172	H
	236662			380	60	1.15	17.6	9400	19.6	10800	1.2-1.5	79	79	104	H
	236612			460	60	1.15	14.2	9400	16.1	10800	1.9-2.4	79	79	86	H
	236622			575	60	1.15	11.4	9400	12.9	10800	3.0-3.7	79	79	69	H
	236653	15	11	200	60	1.15	47.8	13700	54.4	15800	.24-.29	81	81	306	H
	236603			230	60	1.15	41.6	13700	47.4	15800	.28-.35	81	81	266	H
	236663			380	60	1.15	25.8	13700	28.9	15800	.77-.95	81	81	161	H
	236613			460	60	1.15	20.8	13700	23.7	15800	1.1-1.4	81	81	133	H
	236623			575	60	1.15	16.6	13700	19	15800	1.8-2.3	81	81	106	H
	236654	20	15	200	60	1.15	61.9	18100	69.7	20900	.16-.20	82	82	416	J
	236604			230	60	1.15	53.8	18100	60.6	20900	.22-.26	82	82	362	J
	236664			380	60	1.15	33	18100	37.3	20900	.55-.68	82	82	219	J
	236614			460	60	1.15	26.9	18100	30.3	20900	.8-1.0	82	82	181	J
	236624			575	60	1.15	21.5	18100	24.2	20900	1.3-1.6	82	82	145	J
	236655	25	18.5	200	60	1.15	77.1	22500	86.3	25700	.12-.15	83	83	552	J
	236605			230	60	1.15	67	22500	76.4	25700	.15-.19	83	83	480	J
	236665			380	60	1.15	41	22500	46	25700	.46-.56	83	83	291	J
	236615			460	60	1.15	33.5	22500	38.2	25700	.63-.77	83	83	240	J
	236625			575	60	1.15	26.8	22500	30	25700	1.0-1.3	83	83	192	J
	236656	30	22	200	60	1.15	90.9	26900	104	31100	.09-.11	83	83	653	J
	236606			230	60	1.15	79	26900	90.4	31100	.14-.17	83	83	568	J
	236666			380	60	1.15	48.8	26900	55.4	31100	.35-.43	83	83	317	J
	236616			460	60	1.15	39.5	26900	45.2	31100	.52-.64	83	83	284	H
	236626			575	60	1.15	31.6	26900	36.2	31100	.78-.95	83	83	227	J
	236667	40	30	380	60	1.15	66.5	35600	74.6	42400	.26-.33	83	83	481	J
	236617			460	60	1.15	54.9	35600	61.6	42400	.34-.42	83	83	397	J
	236627			575	60	1.15	42.8	35600	49.6	42400	.52-.64	83	83	318	H
	236668	50	37	380	60	1.15	83.5	45100	95	52200	.21-.25	82	83	501	H
	236618			460	60	1.15	67.7	45100	77	52200	.25-.32	82	83	414	H
	236628			575	60	1.15	54.2	45100	61.6	52200	.40-.49	82	83	331	H
	276668			380	60	1.15	82.4	45100	94.5	52200	.21 - .25	82	83	501	H
	276618			460	60	1.15	68.1	45100	78.1	52200	.25 - .32	82	83	414	H
	276628			575	60	1.15	54.5	45100	62.5	52200	.40 - .49	82	83	331	H
	276029	60/50	37/45	380	60	1.15	98.1	53500	111.8	61700	.15 - .18	84	84	627	H
	276009			460	60	1.15	81.0	53500	92.3	61700	.22 - .27	84	84	518	H
	276059			575	60	1.15	64.8	53500	73.9	61700	.35 - .39	84	84	414	H
	236669	60	45	380	60	1.15	98.7	53500	111	61700	.15-.18	84	84	627	H
	236619			460	60	1.15	80.5	53500	91	61700	.22-.27	84	84	518	H
	236629			575	60	1.15	64.4	53500	72.8	61700	.35-.39	84	84	414	H
	276669			380	60	1.15	98.1	53500	111.8	61700	.15 - .18	84	84	627	H
	276619			460	60	1.15	81.0	53500	92.3	61700	.22 - .27	84	84	518	H
	276629			575	60	1.15	64.8	53500	73.9	61700	.35 - .39	84	84	414	H

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

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Table 25 6" Three-Phase Motor Specifications (60 Hz) 3450 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	WATTS	AMPS	WATTS		S.F.	F.L.		
6" HI-TEMP 90 °C	276650	5	3.7	200	60	1.15	17.2	5200	19.8	5800	.53 - .65	73	72	124	K
	276600			230	60	1.15	15.0	5200	17.2	5800	.68 - .84	73	72	108	K
	276660			380	60	1.15	9.1	5200	10.4	5800	2.0 - 2.4	73	72	66.0	K
	276610			460	60	1.15	7.5	5200	8.6	5800	2.8 - 3.4	73	72	54.0	K
	276620			575	60	1.15	6.0	5200	6.9	5800	4.7 - 5.7	73	72	43.0	K
	276651	7.5	5.5	200	60	1.15	24.8	7400	28.3	8400	.30 - .37	77	76	193	K
	276601			230	60	1.15	21.6	7400	24.6	8400	.41 - .50	77	76	168	K
	276661			380	60	1.15	13.1	7400	14.9	8400	1.1 - 1.4	77	76	102	K
	276611			460	60	1.15	10.8	7400	12.3	8400	1.7 - 2.0	77	76	84.0	K
	276621			575	60	1.15	8.6	7400	9.9	8400	2.6 - 3.2	77	76	67.0	K
	276652	10	7.5	200	60	1.15	32.0	9400	36.3	10700	.21 - .26	80	79	274	L
	276602			230	60	1.15	27.8	9400	31.6	10700	.28 - .35	80	79	238	L
	276662			380	60	1.15	16.8	9400	19.2	10700	.80 - .98	80	79	144	L
	276612			460	60	1.15	13.9	9400	15.8	10700	1.2 - 1.4	80	79	119	L
	276622			575	60	1.15	11.1	9400	12.7	10700	1.8 - 2.2	80	79	95.0	L
	276653	15	11	200	60	1.15	48.5	14000	54.5	15900	.15 - .19	81	80	407	L
	276603			230	60	1.15	42.2	14000	47.4	15900	.19 - .24	81	80	354	L
	276663			380	60	1.15	25.5	14000	28.7	15900	.52 - .65	81	80	214	L
	276613			460	60	1.15	21.1	14000	23.7	15900	.78 - .96	81	80	177	L
	276623			575	60	1.15	16.9	14000	19.0	15900	1.2 - 1.4	81	80	142	L
	276654	20	15	200	60	1.15	64.9	18600	73.6	21300	.10 - .12	80	80	481	K
	276604			230	60	1.15	56.4	18600	64.0	21300	.14 - .18	80	80	418	K
	276664			380	60	1.15	34.1	18600	38.8	21300	.41 - .51	80	80	253	K
	276614			460	60	1.15	28.2	18600	32.0	21300	.58 - .72	80	80	209	K
	276624			575	60	1.15	22.6	18600	25.6	21300	.93 - 1.15	80	80	167	K
	276655	25	18.5	200	60	1.15	80.0	22600	90.6	25800	.09 - .11	83	82	665	L
	276605			230	60	1.15	69.6	22600	78.8	25800	.11 - .14	83	82	578	L
	276665			380	60	1.15	42.1	22600	47.7	25800	.27 - .34	83	82	350	L
	276615			460	60	1.15	34.8	22600	39.4	25800	.41 - .51	83	82	289	L
	276625			575	60	1.15	27.8	22600	31.6	25800	.70 - .86	83	82	231	L
	276656	30	22	200	60	1.15	95.0	28000	108.6	31900	.07 - .09	81	80	736	K
	276606			230	60	1.15	82.6	28000	94.4	31900	.09 - .12	81	80	640	K
	276666			380	60	1.15	50.0	28000	57.2	31900	.23 - .29	81	80	387	K
	276616			460	60	1.15	41.3	28000	47.2	31900	.34 - .42	81	80	320	K
	276626			575	60	1.15	33.0	28000	37.8	31900	.52 - .65	81	80	256	K
	276667	40	30	380	60	1.15	67.2	35900	76.0	42400	.18 - .23	84	83	545	L
	276617			460	60	1.15	55.4	35900	62.8	42400	.23 - .29	84	83	450	L
	276627			575	60	1.15	45.2	35900	50.2	42400	.34 - .43	84	83	360	L

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

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Table 26 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX		RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
	STD	HI-TEMP	HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
6" STD. & HI-TEMP	236650	276650	5	3.7	200	60	35	45	50	25	45
	236600	276600			230	45	30	40	45	20	40
	236660	276660			380	30	17.5	25	30	12	25
	236610	276610			460	25	15	20	25	10	20
	236620	276620			575	20	12	15	20	8	15
	236651	276651	7.5	5.5	200	80	45	70	80	35	70
	236601	276601			230	70	40	60	70	30	60
	236661	276661			380	45	25	35	40	20	35
	236611	276611			460	35	20	30	35	15	30
	236621	276621			575	30	17.5	25	25	11	25
	236652	276652	10	7.5	200	100	60	90	100	45	90
	236602	276602			230	90	50	80	90	40	80
	236662	276662			380	60	35	45	50	25	45
	236612	276612			460	45	25	40	45	20	40
	236622	276622			575	35	20	30	35	15	30
	236653	276653	15	11	200	150	90	125	150	60	125
	236603	276603			230	150	80	110	125	60	110
	236663	276663			380	80	50	70	80	35	70
	236613	276613			460	70	40	60	60	30	60
	236623	276623			575	60	30	45	50	25	45
	236654	276654	20	15	200	200	110	175	175	80	175
	236604	276604			230	175	100	150	175	70	150
	236664	276664			380	100	60	90	100	45	90
	236614	276614			460	90	50	70	80	35	70
	236624	276624			575	70	40	60	70	30	60
	236655	276655	25	18.5	200	250	150	200	225	100	200
	236605	276605			230	225	125	175	200	90	175
	236665	276665			380	125	80	110	125	50	110
	236615	276615			460	110	60	90	100	45	90
	236625	276625			575	90	50	70	80	35	70
	236656	276656	30	22	200	300	175	250	300	125	250
	236606	276606			230	250	150	225	250	100	200
	236666	276666			380	150	90	125	150	60	125
	236616	276616			460	125	70	110	125	50	100
	236626	276626			575	100	60	90	100	40	80
	236667	276667	40	30	380	200	125	175	200	90	175
	236617	276617			460	175	100	150	175	70	150
	236627	276627			575	150	80	110	125	60	110
	236668	276668	50	37	380	250	150	225	250	110	225
	236618	276618			460	225	125	175	200	90	175
	236628	276628			575	175	100	150	175	70	150
	236669	276669	60	45	380	300	175	250	300	125	250
	236619	276619			460	250	150	225	250	100	225
	236629	276629			575	200	125	175	200	80	175

Three-Phase Motors

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Table 27 Three-Phase Motor Specifications (60 Hz) 3525 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
8" STD.	239660	40	30	380	60	1.15	64	35	72	40	.16-.20	86	86	479	J
	239600			460	60	1.15	53	35	60	40	.24-.30	86	86	396	J
	239610			575	60	1.15	42	35	48	40	.39-.49	86	86	317	J
	239661	50	37	380	60	1.15	79	43	88	49	.12-.16	87	87	656	K
	239601			460	60	1.15	64	43	73	49	.18-.22	87	87	542	K
	239611			575	60	1.15	51	43	59	49	.28-.34	87	87	434	K
	239662	60	45	380	60	1.15	92	52	104	60	.09-.11	88	87	797	K
	239602			460	60	1.15	76	52	86	60	.14-.17	88	87	658	K
	239612			575	60	1.15	61	52	69	60	.22-.28	88	87	526	K
	239663	75	55	380	60	1.15	114	64	130	73.5	.06-.09	88	88	1046	L
	239603			460	60	1.15	94	64	107	73.5	.10-.13	88	88	864	L
	239613			575	60	1.15	76	64	86	73.5	.16-.21	88	88	691	L
	239664	100	75	380	60	1.15	153	85	172	97.5	.05-.06	89	89	1466	L
	239604			460	60	1.15	126	85	142	97.5	.07-.09	89	89	1211	L
	239614			575	60	1.15	101	85	114	97.5	.11-.13	89	89	969	L
	239165	125	93	380	60	1.15	202	109	228	125	.03-.04	87	86	1596	K
	239105			460	60	1.15	167	109	188	125	.05-.07	87	86	1318	K
	239115			575	60	1.15	134	109	151	125	.08-.11	87	86	1054	K
	239166	150	110	380	60	1.15	235	128	266	146	.02-.03	88	87	1961	K
	239106			460	60	1.15	194	128	219	146	.04-.05	88	87	1620	K
	239116			575	60	1.15	164	128	182	146	.06-.08	88	87	1296	K
	239167	175	130	380	60	1.15	265	150	302	173	.02-.04	88	88	1991	J
	239107			460	60	1.15	219	150	249	173	.04-.05	88	88	1645	J
	239117			575	60	1.15	175	150	200	173	.06-.08	88	88	1316	J
	239168	200	150	380	60	1.15	298	169	342	194	.02-.03	88	88	2270	J
	239108			460	60	1.15	246	169	282	194	.03-.05	88	88	1875	J
	239118			575	60	1.15	197	169	226	194	.05-.07	88	88	1500	J

Table 27A 8" Three-Phase Motor Specifications (60 Hz) 3525 rpm

TYPE	MOTOR MODEL PREFIX	RATING					FULL LOAD		MAXIMUM LOAD		LINE TO LINE RESISTANCE OHMS	EFFICIENCY %		LOCKED ROTOR AMPS	KVA CODE
		HP	KW	VOLTS	HZ	S.F.	AMPS	KILOWATTS	AMPS	KILOWATTS		S.F.	F.L.		
8" HI-TEMP	279160	40	30	380	60	1.15	69.6	38	78.7	43	.11 - .14	79	78	616	M
	279100			460	60	1.15	57.5	38	65.0	43	.16 - .19	79	78	509	M
	279110			575	60	1.15	46.0	38	52.0	43	.25 - .31	79	78	407	M
	279161	50	37	380	60	1.15	84.3	47	95.4	53	.07 - .09	81	80	832	M
	279101			460	60	1.15	69.6	47	78.8	53	.11 - .14	81	80	687	M
	279111			575	60	1.15	55.7	47	63.0	53	.18 - .22	81	80	550	M
	279162	60	45	380	60	1.15	98.4	55	112	62	.06 - .07	83	82	1081	N
	279102			460	60	1.15	81.3	55	92.1	62	.09 - .11	83	82	893	N
	279112			575	60	1.15	65.0	55	73.7	62	.13 - .16	83	82	715	N
	279163	75	56	380	60	1.15	125	68	141	77	.05 - .06	83	82	1175	L
	279103			460	60	1.15	100	68	114	77	.07 - .09	83	82	922	L
	279113			575	60	1.15	80	68	92	77	.11 - .14	83	82	738	L
	279164	100	75	380	60	1.15	159	88	181	100	.04 - .05	86	85	1508	M
	279104			460	60	1.15	131	88	149	100	.05 - .07	86	85	1246	M
	279114			575	60	1.15	105	88	119	100	.08 - .10	86	85	997	M
	279165	125	93	380	60	1.15	195	109	223	125	.03 - .04	86	85	1793	L
	279105			460	60	1.15	161	109	184	125	.04 - .06	86	85	1481	L
	279115			575	60	1.15	129	109	148	125	.07 - .09	86	85	1185	L
	279166	150	110	380	60	1.15	235	133	269	151	.02 - .03	85	84	2012	K
	279106			460	60	1.15	194	133	222	151	.03 - .05	85	84	1662	K
	279116			575	60	1.15	155	133	178	151	.05 - .07	85	84	1330	K

Model numbers above are for three-lead motors. Six-lead motors with different model numbers have the same running performance, but when Wye connected for starting have locked rotor amps 33% of the values shown. Six-lead individual phase resistance = table X 1.5.

Three-Phase Motors

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Table 28 Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
8" STD.	239660	40	30	380	200	125	175	200	80	175
	239600			460	175	100	150	175	70	150
	239610			575	150	80	110	125	60	110
	239661	50	37	380	250	150	200	225	100	200
	239601			460	200	125	175	200	80	175
	239611			575	175	90	150	150	70	150
	239662	60	45	380	300	175	250	300	125	250
	239602			460	250	150	200	225	100	200
	239612			575	200	110	175	175	80	175
	239663	75	55	380	350	200	300	350	150	300
	239603			460	300	175	250	300	125	250
	239613			575	250	150	200	225	100	200
	239664	100	75	380	500	275	400	450	200	400
	239604			460	400	225	350	400	175	350
	239614			575	350	200	300	300	125	300
	239165	125	93	380	700	400	600	600	250	600
	239105			460	500	300	450	500	225	450
	239115			575	450	250	350	400	175	350
	239166	150	110	380	800	450	600	700	300	600
	239106			460	600	350	500	600	250	500
	239116			575	500	300	400	450	200	400
	239167	175	130	380	800	500	700	800	350	700
	239107			460	700	400	600	700	300	600
	239117			575	600	350	450	600	225	450
	239168	200	150	380	1000	600	800	1000	400	800
	239108			460	800	450	700	800	350	700
	239118			575	600	350	500	600	250	500

Table 28A 8" Three-Phase Motor Fuse Sizing

TYPE	MOTOR MODEL PREFIX	RATING			CIRCUIT BREAKERS OR FUSE AMPS (MAXIMUM PER NEC)			CIRCUIT BREAKERS OR FUSE AMPS (TYPICAL SUBMERSIBLE)		
		HP	KW	VOLTS	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER	STANDARD FUSE	DUAL ELEMENT TIME DELAY FUSE	CIRCUIT BREAKER
8" HI-TEMP	279160	40	30	380	225	125	175	200	90	175
	279100			460	175	110	150	175	70	150
	279110			575	150	90	125	125	60	125
	279161	50	37	380	250	150	225	225	110	225
	279101			460	200	125	175	200	90	175
	279111			575	175	100	150	150	70	150
	279162	60	45	380	300	175	250	300	125	250
	279102			460	275	150	225	250	100	225
	279112			575	200	125	175	175	80	175
	279163	75	56	380	400	200	350	350	150	350
	279103			460	300	175	275	300	125	275
	279113			575	275	150	225	225	100	225
	279164	100	75	380	500	300	450	450	200	450
	279104			460	400	250	350	400	175	350
	279114			575	350	200	300	300	125	300
	279165	125	93	380	700	400	600	600	250	600
	279105			460	500	300	450	500	225	450
	279115			575	450	250	350	400	175	350
	279166	150	110	380	800	450	600	700	300	600
	279106			460	600	350	500	600	250	500
	279116			575	500	300	400	450	200	400

Three-Phase Motors

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Overload Protection of Three-Phase Submersible Motors

Class 10 Protection Required

The characteristics of submersible motors are different than standard motors and special overload protection is required.

If the motor is locked, the overload protection must trip within 10 seconds to protect the motor windings. Subtrol/ SubMonitor, a Franklin-approved adjustable overload relay, or a Franklin-approved fixed heater must be used.

Fixed heater overloads must be the ambient-compensated quick-trip type to maintain protection at high and low air temperatures.

All heaters and amp settings shown are based on total line amps. When determining amperage settings or making heater selections for a six-lead motor with a Wye-Delta starter, divide motor amps by 1.732.

Pages 29, 30 and 31 list the correct selection and settings for some manufacturers. Approval for other manufacturers' types not listed may be requested by calling Franklin's Technical Service Hotline at 800-348-2420.

Refer to notes on page 30.

Table 29 - 60 Hz 4" Motors

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
1/2	0.37	200	00	K31	L380A	3.2	3.4
		230	00	K28	L343A	2.7	2.9
		380	00	K22	L211A	1.7	1.8
		460	00	-	L174A	1.4	1.5
		575	00	-	-	1.2	1.3
3/4	0.55	200	00	K34	L510A	4.1	4.4
		230	00	K32	L420A	3.5	3.8
		380	00	K27	L282A	2.3	2.5
		460	00	K23	L211A	1.8	1.9
		575	00	K21	L193A	1.5	1.6
1	0.75	200	00	K37	L618A	5.0	5.4
		230	00	K36	L561A	4.4	4.7
		380	00	K28	L310A	2.6	2.8
		460	00	K26	L282A	2.2	2.4
		575	00	K23	L211A	1.8	1.9
1.5	1.1	200	00	K42	L750A	6.3	6.8
		230	00	K39	L680A	5.5	5.9
		380	00	K32	L420A	3.3	3.6
		460	00	K29	L343A	2.8	3.0
		575	00	K26	L282A	2.2	2.4
2	1.5	200	0	K50	L111B	8.6	9.3
		230	0	K49	L910A	7.5	8.1
		380	0	K36	L561A	4.6	4.9
		460	00	K33	L463A	3.8	4.1
		575	00	K29	L380A	3.0	3.2
3	2.2	200	0	K55	L147B	11.6	12.5
		230	0	K52	L122B	10.1	10.9
		380	0	K41	L750A	6.1	6.6
		460	0	K37	L618A	5.1	5.5
		575	0	K34	L510A	4.1	4.4
5	3.7	200	1	K62	L241B	19.1	20.5
		230	1	K61	L199B	16.6	17.8
		380	0	K52	L122B	10.0	10.8
		460	0	K49	L100B	8.3	8.9
		575	0	K42	L825A	6.6	7.1
7.5	5.5	200	1	K68	L322B	28.4	30.5
		230	1	K67	L293B	24.6	26.4
		380	1	K58	L181B	14.9	16.0
		460	1	K55	L147B	12.3	13.2
		575	1	K52	L122B	9.9	10.6
10	7.5	380	1	K62	L241B	19.5	21.0
		460	1	K60	L199B	16.1	17.3
		575	1	K56	L165B	12.9	13.6
15	11	380	2 (1)	K70	L322B	29	31.2
		460	2 (1)	K67	L265B	24.0	25.8
		575	2 (1)	K62	L220B	19.3	20.7

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Table 30 – 60 Hz 6" Standard & Hi-Temp Motors

HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
				FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
5	3.7	200	1	K61	L220B	17.6	19.1
		230	1	K61	L199B	15.4	16.6
		380	0	K52	L122B	9.4	10.1
		460	0	K49	L100B	7.7	8.3
		575	0	K42	L825A	6.1	6.6
7.5	5.5	200	1	K67	L322B	26.3	28.3
		230	1	K64	L293B	22.9	24.6
		380	1	K57	L165B	13.9	14.9
		460	1	K54	L147B	11.4	12.3
		575	1	K52	L111B	9.1	9.8
10	7.5	200	2(1)	K72	L426B	34.4	37.0
		230	2(1)	K70	L390B	29.9	32.2
		380	1	K61	L220B	18.1	19.5
		460	1	K58	L181B	15.0	16.1
		575	1	K55	L147B	12.0	12.9
15	11	200	3(1)	K76	L650B	50.7	54.5
		230	2	K75	L520B	44.1	47.4
		380	2(1)	K68	L322B	26.7	28.7
		460	2(1)	K64	L265B	22.0	23.7
		575	2(1)	K61	L220B	17.7	19.0
20	15	200	3	K78	L787B	64.8	69.7
		230	3(1)	K77	L710B	56.4	60.6
		380	2	K72	L426B	34.1	36.7
		460	2	K69	L352B	28.2	30.3
		575	2	K64	L393B	22.7	24.4
25	18.5	200	3	K86	L107C	80.3	86.3
		230	3	K83	L866B	69.8	75.0
		380	2	K74	L520B	42.2	45.4
		460	2	K72	L426B	34.9	37.5
		575	2	K69	L352B	27.9	30.0
30	22	200	4(1)	K88	L126C	96.7	104.0
		230	3	K87	L107C	84.1	90.4
		380	3(1)	K76	L650B	50.9	54.7
		460	3(1)	K74	L520B	42.0	45.2
		575	3(1)	K72	L390B	33.7	36.2
40	30	380	3	K83	L866B	69.8	75.0
		460	3	K77	L710B	57.7	62.0
		575	3	K74	L593B	46.1	49.6
50	37	380	3	K87	L107C	86.7	93.2
		460	3	K83	L950B	71.6	77.0
		575	3	K77	L710B	57.3	61.6
60	45	380	4(1)	K89	L126C	102.5	110.2
		460	4(1)	K87	L107C	84.6	91.0
		575	4(1)	K78	L866B	67.7	72.8

Footnotes for Tables 29, 30, 31, and 31A

NOTE 1: Furnas intermediate sizes between NEMA starter sizes apply where (1) is shown in tables, size 1.75 replacing 2, 2.5 replacing 3, 3.5 replacing 4, and 4.5 replacing 5. Heaters were selected from Catalog 294, table 332 and table 632 (starter size 00, size B). Size 4 starters are heater type 4 (JG). Starters using these heater tables include classes 14, 17, and 18 (inNOVA), classes 36 and 37 (reduced voltage), and classes 87, 88, and 89 (pump and motor control centers). Overload relay adjustments should be set no higher than 100% unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum. Heater selections for class 16 starters (Magnetic Definite Purpose) will be furnished upon request.

NOTE 2: General Electric heaters are type CR123 usable only on type CR124 overload relays and were selected from Catalog GEP-1260J, page 184. Adjustment should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum.

NOTE 3: Adjustable overload relay amp settings apply to approved types listed. Relay adjustment should be set at the specified SET amps. Only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX value shown.

NOTE 4: Heaters shown for ratings requiring NEMA size 5 or 6 starters are all used with current transformers per manufacturer standards. Adjustable relays may or may not use current transformers depending on design.

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Table 31 - 60 Hz 8" Motors

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
					FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
239660	40	30	380	3	K78	L866B	68	73
239600			460	3	K77	L710B	56	60
239610			575	3	K73	L520B	45	48
239661	50	37	380	3	K86	L107C	81	87
239601			460	3	K78	L866B	68	73
239611			575	3	K77	L710B	56	60
239662	60	45	380	4(1)	K89	L126C	101	108
239602			460	4(1)	K86	L107C	83	89
239612			575	4(1)	K78	L787B	64	69
239663	75	55	380	4	K92	L142C	121	130
239603			460	4(1)	K89	L126C	100	107
239613			575	4(1)	K85	L950C	79	85
239664	100	75	380	5(1)	K28	L100B	168	181
239604			460	4	K92	L155C	134	144
239614			575	4	K90	L142C	108	116
239165	125	93	380	5	K32	L135B	207	223
239105			460	5(1)	K29	L111B	176	189
239115			575	5(1)	K26	L825A	140	150
239166	150	110	380	5	-	L147B	248	267
239106			460	5(1)	K32	L122B	206	221
239116			575	5(1)	K28	L100B	169	182
239167	175	130	380	6	K26	-	270	290
239107			460	5	K33	L147B	233	250
239117			575	5	K31	L111B	186	200
239168	200	150	380	6	K27	-	316	340
239108			460	5	K33	L165B	266	286
239118			575	5	K32	L135B	213	229

Table 31A - 60 Hz 8" Hi-Temp 75°C Motors

MOTOR MODEL PREFIX	HP	KW	VOLTS	NEMA STARTER SIZE	HEATERS FOR OVERLOAD RELAYS		ADJUSTABLE RELAYS (NOTE 3)	
					FURNAS (NOTE 1)	G.E. (NOTE 2)	SET	MAX.
279160	40	30	380	3	K83	L866B	73	79
279100			460	3	K77	L710B	60	65
279110			575	3	K74	L593B	48	52
279161	50	37	380	3	K87	L107C	89	95
279101			460	3	K83	L866B	73	79
279111			575	3	K77	L710B	59	63
279162	60	45	380	4(1)	K89	L126C	104	112
279102			460	4(1)	K87	L107C	86	92
279112			575	4(1)	K78	L866B	69	74
279163	75	56	380	4	K92	L155C	131	141
279103			460	4(1)	K89	L126C	106	114
279113			575	4(1)	K87	L950C	86	92
279164	100	75	380	5(1)	K28	L100B	168	181
279104			460	5(1)	K26	L825A	139	149
279114			575	4	K90	L142C	111	119
279165	125	93	380	5	K32	L135B	207	223
279105			460	5(1)	K29	L111B	171	184
279115			575	5(1)	K26	L825A	138	148
279166	150	110	380	5	-	L147B	250	269
279106			460	5(1)	K32	L122B	206	222
279116			575	5(1)	K28	L100B	166	178

Note: Other relay types from these and other manufacturers may or may not provide acceptable protection, and they should not be used without approval of Franklin Electric.

Some approved types may only be available for part of the listed motor ratings. When relays are used with current transformers, relay setting is the specified amps divided by the transformer ratio.

Recommended Adjustable Overload Relays

Advance Controls: MDR3 Overload

AEG Series: B17S, B27S, B27-2

ABB Type: RVH 40, RVH65, RVP160, T25DU, T25CT, TA25DU

AGUT: MT03, R1K1, R1L0, R1L3, TE set Class 5

Allen Bradley: Bulletin 193, SMP-Class 10 only

Automatic Switch Types: DQ, LR1-D, LR1-F, LR2 Class 10

Benshaw: RSD6 (Class 10) Soft Start

Bharita C-H: MC 305 ANA 3

Clipsal: 6CTR, 6MTR

Cutler-Hammer: C316F, C316P, C316S, C310-set at 6 sec max, Advantage Class10

Fanal Types: K7 or K7D through K400

Franklin Electric: Subtrol-Plus, SubMonitor, IPS, SSP, IPS-RV, and SPS-RV

Fuji Types: TR-0Q, TR-0QH, TR-2NQ, TR- 3NQ, TR-4NQ, TR-6NQ, RCa 3737-ICQ & ICQH

Furnas Types: US15 48AG & 48BG, 958L, ESP100-Class 10 only, 3RB10-Class 10

General Electric: CR4G, CR7G, RT*1, RT*2, RTF3, RT*4, CR324X-Class 10 only

Kasuga: RU Set Operating Time Code = 10 & time setting 6 sec max

Klockner-Moeller Types: Z00, Z1, Z4, PKZM1, PKZM3 & PKZ2

Lovato: RC9, RC22, RC80, RF9, RF25 & RF95

Matsushita: FKT-15N, 15GN, 15E, 15GE, FT-15N, FHT-15N

Mitsubishi: ET, TH-K12ABKP, TH-K20KF, TH-K20KP, TH-K20TAKF, TH-K60KF, TH-K60TAKF

Omron: K2CM Set Operating Timing Code = 10 & time setting 6 sec max, SE-KP24E time setting 6 sec max

Riken: PM1, PM3

Samwha: EOCRS Set for Class 5, EOCR-ST, EOCR-SE, EOCR-AT time setting 6 sec max

Siemens Types: 3UA50, -52, -54, -55, -58, -59, -60, -61, -62, -66, -68, -70, 3VU13, 3VE, 3UB (Class 5)

Sprecher and Schuh Types: CT, CT1, CTA 1, CT3K, CT3-12 thru CT3-42, KTA3, CEF1 & CET3 set at 6 sec max, CEP 7 Class 10, CT4, 6, & 7, CT3, KT7

Square D/Telemecanique: Class 9065 Types: TD, TE, TF, TG, TJ, TK, TR, TJE &TJF (Class 10), LR1-D, LR1-F, LR2 Class 10, Types 18A, 32A, SS-Class 10, SR-Class 10 and 63-A-LB Series. Integral 18,32,63, GV2-L, GV2-M, GV2-P, GV3-M (1.6-10 amp only) LR9D, SF Class 10, ST Class 10, LT6 (Class 5 or 10), LRD (Class 10), Motor Logic (Class10)

Toshiba Type: 2E RC820, set at 8 sec max.

WEG: RW2

Westinghouse Types: FT13, FT23, FT33, FT43, K7D, K27D, K67D, Advantage (Class 10), MOR, IQ500 (Class 5)

Westmaster: 0LWR00 and 0LWT00 suffix D thru P

Form 2207 – Action Facts

SUBMERSIBLE MOTOR INSTALLATION RECORD

INFORMATION SUPPLEMENT

1.0 MOTOR

1.1 Verify motor nameplate data meets the application – hp, voltage, phase, and Hertz.

1.2 Check that the motor shaft rotates freely by hand on the second of two complete rotations. (On large motors, this usually requires a motor coupling with a cheater handle welded to it.)

1.3 Check that the motor lead assembly is not damaged.

1.4 Measure insulation resistance to ground at 500 volts – BEFORE SUBMERGED. It should be a minimum of 200 megohms or 200,000,000 ohms.

1.5 Measure insulation resistance to ground at 500 volts – AFTER SUBMERGED. It should be a minimum of 0.5 megohms or 500,000 ohms.

1.6 Verify the system is operating within the ±10% of nameplate voltage requirement.

1.7 Verify the system will not ever operate in excess of the maximum amps indicated on the nameplate.

1.8 Verify the system is operating at 5% or less current unbalance.

Notice:

- If current unbalance exceeds 5%, the maximum operating amps must be derated to the nameplate Full Load Amps.
- Warning - System current unbalance can not exceed 10% without causing heating and mechanical wear issues.
- The submersible motor amperage % unbalance is typically 6x greater than its voltage % unbalance.
- Thus, 0.8% voltage unbalance = greater than 5% current unbalance, and 1.7% voltage unbalance = greater than 10% current unbalance.

2.0 PUMP

2.1 Verify the pump nameplate and curve data meets the application hp, rpm, and flow/TDH requirements.

2.2 Verify the pump NPSH requirement will be met at all times.

2.3 Check that the pump shaft rotates freely by hand before installation.

2.4 Check that the pump shaft moves up about ¼ inch when it is coupled to the motor.

2.5 Check that the pump guard is not pinching the motor leads, especially where it enters and exits the guard.

Notice:

- Pumps and motors 5 hp and above should be assembled in a vertical position to ensure correct alignment.
- A motor-pump assembly 5 hp and above should never be lifted from a non-vertical position by the pump discharge because it can bend the shaft in one or both of the products.

3.0 POWER SUPPLY (3-PHASE)

3.1 Verify the transformer kVA rating is adequate for the motor per the Franklin Application (AIM) manual requirement.

3.2 Verify that all transformers have the same kVA rating.

3.3 Verify the 3-Ph pump panel fuses or its circuit breaker are correctly sized per the Franklin Application (AIM) manual requirement.

3.4 Verify the 3-Ph pump panel motor contactor is correctly sized per the Franklin Application (AIM) manual requirement.

3.5 Verify the 3-Ph pump panel motor overload is ambient compensated.

3.6 Verify the 3-Ph pump panel motor overload has a NEMA Class 10 trip curve.

3.7 Verify the 3-Ph pump panel motor overload heaters or its dial setting are correctly selected based on the system's operating point and not just arbitrarily set at the maximum motor operating amps.

3.8 At no time should the system operating amps or the motor overload system running point setting be higher than the motor nameplate maximum amp rating.

Notice:

- Electronic overloads should be set at the normal system operation point.
- Electronic overloads have a built-in multiplier of 115-125% times the input amps to determine the overload trip point.

4.0 POWER SUPPLY (1-PHASE)

4.1 Verify the transformer kVA rating is adequate for the motor per the Franklin Application (AIM) manual requirement.

Form 2207 – Action Facts

SUBMERSIBLE MOTORS INSTALLATION RECORD

4.2 Verify the motor control box and the motor are made by the same manufacturer.

4.3 Verify the motor control box hp rating and its voltage match the motor rating exactly. If not, a premature failure of the control box or motor should be expected.

5.0 HIGH SURGE PROTECTION

5.1 Verify the submersible motor has a dedicated surge arrestor.
All submersible motors require a dedicated surge arrestor.
Motors 5 hp and smaller marked "Equipped with Lightning Arrestors", have a built-in surge arrestor.

5.2 Verify the surge arrestor is mounted as close to the motor as practical.
The location is usually in the pump panel, but sometimes it is placed at the well head in a separate electrical box.

5.3 Verify the surge arrestor is grounded below the lowest drawdown water level.
This is usually accomplished by attaching the drop cable ground wire to the motor lead or the motor ground lug.

5.4 Verify the ground conductor size meets the minimum requirements of the National Electric Code and all other relevant national, state, regional and local codes.

5.5 Verify the motor is connected to both the electrical system ground and the motor.

6.0 ELECTRICAL DROP CABLE

6.1 Verify the temperature rating of the drop cable – typically 60 °C, 75 °C, 90 °C or 125 °C.

6.2 Verify if the cable is single conductor or jacketed conductor. Web cable is considered jacketed cable by regulating agencies.

6.3 Verify the conductor size – typically AWG, MCM or mm^2.

6.4 Verify if the conductor material is copper; if not, determine the material and contact the factory for acceptability.

6.5 Verify the drop cable meets or exceeds the requirements of the Franklin Application (AIM) manual.

Notice:

- If the service entrance to pump panel or the pump panel to motor cable is not a copper material, contact the factory for the correct length derating factors.

7.0 MOTOR COOLING

7.1 Verify that the well water temperature does not exceed the maximum ambient temperature indicated on the nameplate of the motor.

7.2 Verify there is a minimum of 10 feet of clear water between the bottom of the motor and the bottom of the well.

7.3 Verify that all water entering the well is coming from below the lowest part of the motor.

7.4 Verify the system pumping rate will never deliver less flow than is required by the Franklin Application (AIM) manual to flow by-and-around the full length of the motor for cooling purposes.

7.5 Verify that 3-phase motors above 7.5 hp in a vertical potable water well should not exceed 100 starts in 24 hours and each start should include a minimum of 3 minutes ON and 10 minutes OFF.

Notice:

- If any water is entering the well above the lowest part of the motor, a flow sleeve is required.

8.0 MOTOR-PUMP INSTALLATION

8.1 Verify that the drop cable is supported to the drop pipe every 10 feet.

8.2 Verify at least one spring loaded (non-drilled) check valve is in the drop pipe.
Preferably, the first check valve should be located at the top of the first pipe joint above the pump discharge (~20 feet) if the pump does not have a check built in to its discharge.

8.3 Verify all pipe joints are as tight as practical.
The minimum torque should never be less than 10 foot-pounds times the motor nameplate hp rating.

8.4 Verify the rotation of the pump is correct.
It is preferable to do this by checking the flow and current in both directions on 3-phase motors.
This can be done by having the electrician swap any two leads.
This is considered "best practice" since pumps under some conditions can supply amp readings and a visual flow observation that can be extremely misleading.

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SUBMERSIBLE MOTORS INSTALLATION RECORD

RMA Number

KEY DEALER #

DISTRIBUTOR	INSTALLER	END USER
Name:	Name:	Name:
City:	City:	City:
State: Zip:	State: Zip:	State: Zip:

Well ID or GPS: _____ _____ _____ Water Temperature: _____ ☐ °F ☐ °C

Application/Water Use (e.g. potable water, irrigation, municipal, fountain, etc.): _____

Date Installed (mm/yy): _____ Date Failed (mm/yy):_____ Motor Position Shaft-Up: ☐ Yes ☐ No

Operating Cycle: ON Time Per Start _____ ☐ Hrs. ☐ Mins. Time OFF Between Stop & Restart _____ ☐ Hrs. ☐ Mins.

MOTOR

Model: _____ Serial Number: _____ Date Code (if updated): _____

MOTOR OVERLOAD

System Typical Operating Current: _____ Amps @ _____ Volts

Overload: ☐ FE SubMonitor Input Amps _____ D3 Attached ☐ Yes ☐ No Fault Settings Attached ☐ Yes ☐ No

☐ Other Manufacturer Model: _____ Dial Set at: _____ or Heater# _____

NEMA Class: ☐ 10 ☐ 20 ☐ 30 Ambient Compensated: ☐ Yes ☐ No

Power to Motor by: ☐ Full Volt Starter ☐ VFD ☐ Soft Starter VFD or Soft Starter Mfr. & Model: _____

PUMP

Manufacturer: _____

Model: _____

Stages: _____

Design Rating: _____ gpm @ _____ ft TDH

Horsepower Required by Pump End: _____

Actual Pump Delivery: _____ gpm @ _____ psi

What Controls When System Runs & Stops:

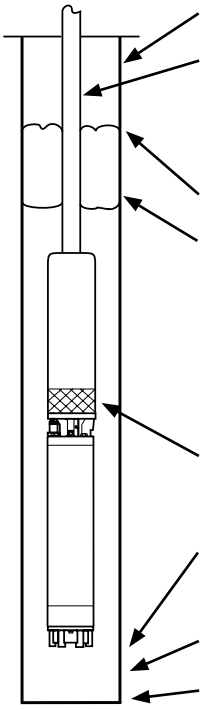
_____

(e.g. pressure, level, flow, manual on/off, timer, time clock etc.)

YOUR NAME / DATE

_____ / _____

WELL DATA (All measurements from well head down.)



Casing Diameter _____ in

Drop Pipe Diameter _____ in

Drop Pipe Material _____ PVC _____ Steel _____ Poly _____ Other

Number of Sticks of Drop Pipe _____

Static Water Level _____ ft

Drawdown (pumping) Water Level _____ ft

Spring Assist Check Valves:
(Measured from Well Head Down)

#1_____ #2_____ #3_____ #4_____ ft

☐ Solid ☐ Drilled Poppet ☐ Break-Off Plug

Pump Inlet Setting _____ ft

Flow Sleeve ☐ No ☐ Yes, Dia. _____ in

Case Ends _____ ft

☐ Well Screen ☐ Perforated Casing

#1 from ____to____ft & #2 from ____to____ft

Well Depth _____ ft

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Franklin Electric

Form 2207 – Page 2

SUBMERSIBLE MOTORS INSTALLATION RECORD

RMA Number

TRANSFORMERS

Number of Transformers: ☐ Two ☐ Three Transformers Supply Motor Only: ☐ Yes ☐ No ☐ Unsure

Transformer #1: _____ kVA Transformer #2: _____ kVA Transformer #3: _____ kVA

POWER CABLES & GROUND WIRE

1 **Service Entrance to Pump Control Panel:**

Length: _____ ft. & Gauge: _____ AWG/MCM

Material: ☐ Copper ☐ Aluminum Construction: ☐ Jacketed ☐ Individual Conductors ☐ Web ☐ Twisted

Temperature Rating of Cable: ☐ 60C ☐ 75C ☐ 90C ☐ 125C or Insulation Type: _____ (e.g. THHN)

2 **Pump Control Panel to Motor:**

Length: _____ ft. & Gauge: _____ AWG/MCM

Material: ☐ Copper ☐ Aluminum Construction: ☐ Jacketed ☐ Individual Conductors ☐ Web ☐ Twisted

Temperature Rating of Cable: ☐ 60C ☐ 75C ☐ 90C ☐ 125C or Insulation Type: _____ (e.g. THHN)

3 **Ground Wire Size:** From Control Panel to Motor: _____ AWG/MCM

Control Grounded to (mark all that apply):

☐ Well Head ☐ Metal Casing ☐ Motor ☐ Driven Rod ☐ Power Supply

INCOMING VOLTAGE

No Load L1-L2 _____ L2-L3 _____ L1-L3 _____

Full Load L1-L2 _____ L2-L3 _____ L1-L3 _____

RUNNING AMPS & CURRENT BALANCE

Full Load L1 _____ L2 _____ L3 _____

% Unbalance: _____

CONTROL PANEL

1 **Pump Panel Manufacturer/Fabricator:** _____

2 **Short Circuit Protection – Fuses or Circuit Breaker**

Option #1 – Fuse

Manufacturer: _____ Model: _____ Rating: _____ Amps

Type: ☐ Time-Delay ☐ Standard

Option #2 – Circuit Breaker

Manufacturer: _____ Model: _____ Rating: _____ Amps Setting: _____

3 **Starter – Full Voltage, Reduced Voltage, Soft-Starter or VFD (Variable Frequency Drive)**

Option #1 – Full Voltage

Manufacturer: _____ Model: _____ Size: _____ Contacts: ☐ NEMA ☐ IEC

Option #2 – Reduced Voltage

Manufacturer: _____ Model: _____ Ramp Time to Full Voltage: _____ sec.

Option #3 – Soft-Starter or VFD

Manufacturer: _____ Model: _____ Max. Continuous Amp Output Rating: _____

Min. Setting: _____ Hz & GPM: _____ Max. Setting: _____ Hz & GPM: _____

Start Ramp Time to 30 Hz: _____ sec. Stop Mode: ☐ Power Off Coast ☐ 30-0 Hz Ramp _____ sec.

Special Output Filter Purchased: ☐ Yes ☐ No

Output Filter Manufacturer: _____ Model: _____ % Reactance: _____

4 **Surge Arrestor:** ☐ No ☐ Yes, Manufacturer: _____ Model: _____

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Franklin Electric

Booster Install Record

SUBMERSIBLE MOTOR

RMA Number

Date _____/_____/_____ Filled In By _____

INSTALLATION

Owner/User _____ Telephone (_____) _____

Address _____ City _____ State _____ Zip _____

Installation Site, If Different _____

Contact _____ Telephone (_____) _____

System Application _____

_____

_____

System Manufactured By _____ Model _____ Serial No. _____

System Supplied By _____ City _____ State _____ Zip _____

Is this a "HERO" system (10.0 - 10.5 PH)? ☐ Yes ☐ No

MOTOR

Model No. _____ Serial No. _____ Date Code _____

Horsepower _____ Voltage _____ ☐ Single-Phase ☐ Three-Phase Diameter _____ in.

Slinger Removed? ☐ Yes ☐ No Check Valve Plug Removed? ☐ Yes ☐ No

Motor Fill Solution ☐ Standard ☐ DI Water Model No. _____ Serial No. _____ Date Code _____

PUMP

Manufacturer _____ Model _____ Serial No. _____

Stages _____ Diameter _____ Flow Rate Of _____ gpm At _____TDH

Booster Case Internal Diameter _____ Material _____

CONTROLS AND PROTECTIVE DEVICES

SubMonitor? ☐ Yes ☐ No If Yes, Warranty Registration No. _____

If Yes, Overload Set? ☐ Yes ☐ No _____ Set At _____

Underload Sets? ☐ Yes ☐ No _____ Set At _____

VFD or Reduced Voltage Starter? ☐ Yes ☐ No If Yes, Type _____

Mfr. _____ Setting _____ % Full Voltage In _____ sec

Pump Panel? ☐ Yes ☐ No If Yes, Mfr. _____ Size _____

Magnetic Starter/Contactor Mfr. _____ Model _____ Size _____

Heaters Mfr. _____ No. _____ If Adjustable Set At _____

Fuses Mfr. _____ Size _____ Type _____

Surge Arrestor Mfr. _____ Model _____

Controls Are Grounded to _____ with No. _____ Wire

Inlet Pressure Control ☐ Yes ☐ No If Yes, Mfr. _____ Model _____ Setting _____ psi Delay _____ sec

Inlet Flow Control ☐ Yes ☐ No If Yes, Mfr. _____ Model _____ Setting _____ gpm Delay _____ sec

Outlet Pressure Control ☐ Yes ☐ No If Yes, Mfr. _____ Model _____ Setting _____ psi Delay _____ sec

Outlet Flow Control ☐ Yes ☐ No If Yes, Mfr. _____ Model _____ Setting _____ gpm Delay _____ sec

Water Temperature Control ☐ Yes ☐ No If Yes, Mfr. _____ Model _____ Delay _____ sec

Set At _____ °F or _____ °C Located _____

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Franklin Electric

Booster Installation Record

SUBMERSIBLE MOTOR

INSULATION CHECK

Initial Megs: Motor & Lead Only	Black (T1/U1)_____	Yellow (T2/V1)_____	Red (T3/W1)_____
Installed Megs: Motor, Lead, & Cable	Black (T1/U1)_____	Yellow (T2/V1)_____	Red (T3/W1)_____

VOLTAGE TO MOTOR

Non-Operating:	B-Y (T1/U1 - T2/V1)_____	Y-R (T2/V1 - T3/W1)_____	R-B (T3/W1 - T1/U1)_____
At Rated Flow of _____gpm	B-Y (T1/U1 - T2/V1)_____	Y-R (T2/V1 - T3/W1)_____	R-B (T3/W1 - T1/U1)_____
At Open Flow _____gpm	B-Y (T1/U1 - T2/V1)_____	Y-R (T2/V1 - T3/W1)_____	R-B (T3/W1 - T1/U1)_____

AMPS TO MOTOR

At Rated Flow of _____gpm	Black (T1/U1)_____	Yellow (T2/V1)_____	Red (T3/W1)_____
At Open Flow _____gpm	Black (T1/U1)_____	Yellow (T2/V1)_____	Red (T3/W1)_____
At Shut-Off*	Black (T1/U1)_____	Yellow (T2/V1)_____	Red (T3/W1)_____

*Do **NOT** run at Shut-Off more than two (2) minutes.

Inlet Pressure _____psi Outlet Pressure _____psi Water Temperature _____ °F or _____ °C

If you have any questions or problems, call the Franklin Electric Toll-Free Hot Line: 1-800-348-2420

Comments: _____

_____

_____

_____

PLEASE SKETCH THE SYSTEM

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Franklin Electric

Three-Phase Motors

APPLICATION

SubMonitor Three-Phase Protection

Applications

SubMonitor is designed to protect 3-phase pumps/motors with service factor amp ratings (SFA) from 5 to 350 A (approx. 3 to 200 hp). Current, voltage, and motor temperature are monitored using all three legs and allows the user to set up the SubMonitor quickly and easily.

Protects Against

- Under/Overload
- Under/Overvoltage
- Current Unbalance
- Overheated Motor (if equipped with Subtrol Heat Sensor)
- False Start (Chattering)
- Phase Reversal

This product is lead free.

Power Factor Correction

In some installations, power supply limitations make it necessary or desirable to increase the power factor of a submersible motor. Table 32 lists the capacitive kVAR required to increase the power factor of large Franklin three-phase submersible motors to the approximate values shown at maximum input loading.

Capacitors must be connected on the line side of the overload relay, or overload protection will be lost.

Table 32 kVAR Required 60 Hz

MOTOR		KVAR REQUIRED FOR PF OF:		
HP	KW	0.90	0.95	1.00
5	3.7	1.2	2.1	4.0
7.5	5.5	1.7	3.1	6.0
10	7.5	1.5	3.3	7.0
15	11	2.2	4.7	10.0
20	15	1.7	5.0	12.0
25	18.5	2.1	6.2	15.0
30	22	2.5	7.4	18.0
40	30	4.5	11.0	24.0
50	37	7.1	15.0	32.0
60	45	8.4	18.0	38.0
75	55	6.3	18.0	43.0
100	75	11.0	27.0	60.0
125	93	17.0	36.0	77.0
150	110	20.0	42.0	90.0
175	130	9.6	36.0	93.0
200	150	16.0	46.0	110.0

Values listed are total required (not per phase).

Three-Phase Motors

APPLICATION

Three-Phase Starter Diagrams

Three-phase combination magnetic starters have two distinct circuits: a power circuit and a control circuit.

The power circuit consists of a circuit breaker or fused line switch, contacts, and overload heaters connecting incoming power lines L1, L2, L3 and the three-phase motor.

The control circuit consists of the magnetic coil, overload contacts, and a control device such as a pressure switch. When the control device contacts are closed, current flows through the magnetic contactor coil, the contacts close, and power is applied to the motor. Hand-Off-Auto switches, start timers, level controls, and other control devices may also be in series in the control circuit.

Line Voltage Control

This is the most common type of control encountered. Since the coil is connected directly across the power lines L1 and L2, the coil must match the line voltage.

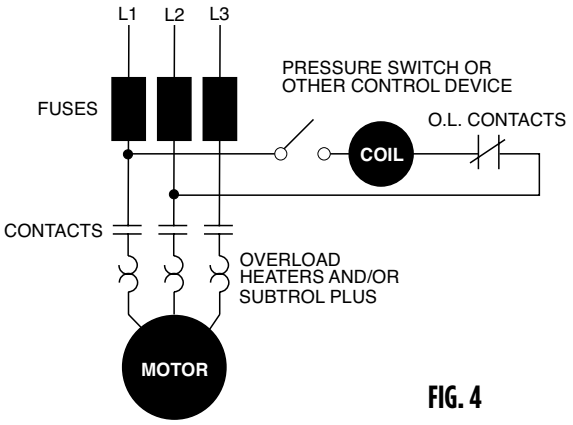


FIG. 4

Low Voltage Transformer Control

This control is used when it is desirable to operate push buttons or other control devices at some voltage lower than the motor voltage. The transformer primary must match the line voltage and the coil voltage must match the secondary voltage of the transformer.

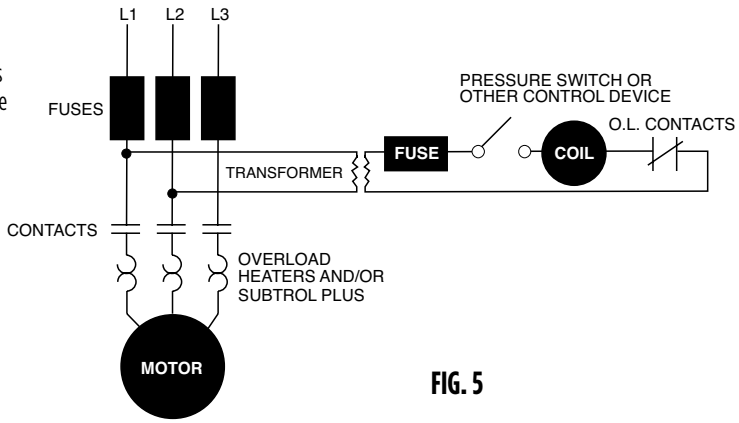


FIG. 5

External Voltage Controls

Control of a power circuit by a lower circuit voltage can also be obtained by connecting to a separate control voltage source. The coil rating must match the control voltage source, such as 115 or 24 volts.

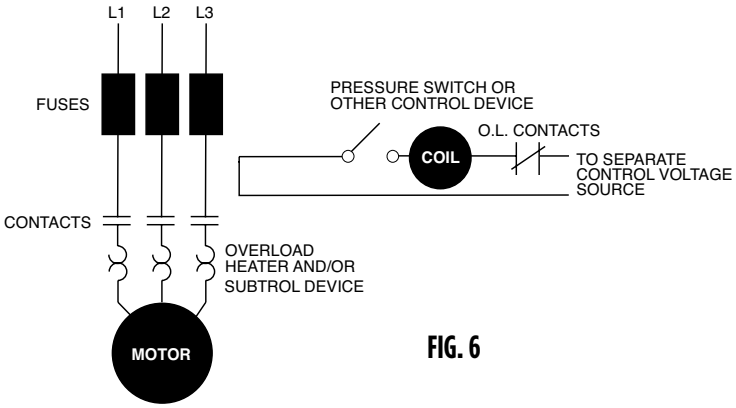


FIG. 6

Three-Phase Motors

APPLICATION

Three-Phase Power Unbalance

A full three-phase supply is recommended for all three-phase motors, consisting of three individual transformers or one three-phase transformer. So-called "open" Delta or Wye connections using only two transformers can be used, but are more likely to cause problems, such as poor performance, overload tripping or early motor failure due to current unbalance.

Transformer rating should be no smaller than listed in Table 4 for supply power to the motor alone.

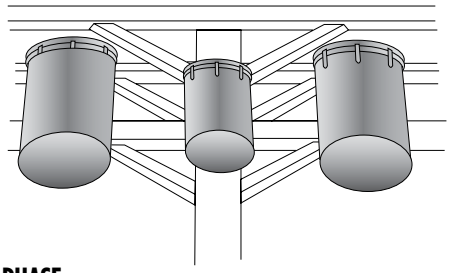


FIG. 7
FULL THREE-PHASE

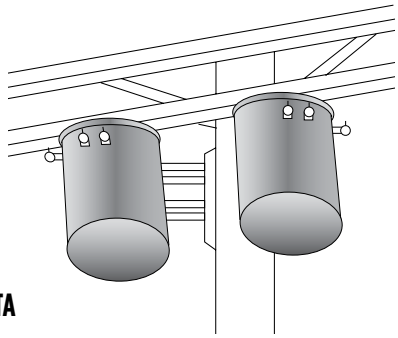


FIG. 8
OPEN DELTA

Checking and Correcting Rotation and Current Unbalance

1. Establish correct motor rotation by running the motor in both directions. Normal rotation is CCW viewing the shaft end. Rotation can be changed by interchanging any two of the three motor leads. The rotation that gives the most water flow is typically the correct rotation.
2. After correct rotation has been established, check the current in each of the three motor leads and calculate the current unbalance as explained in 3 below.

   If the current unbalance is 2% or less, leave the leads as connected.

   If the current unbalance is more than 2%, current readings should be checked on each leg using each of three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.
3. To calculate percent of current unbalance:
   - A. Add the three line amps values together
   - B. Divide the sum by three, yielding average current
   - C. Pick the amp value which is furthest from the average current (either high or low)
   - D. Determine the difference between this amp value(furthest from average) and the average
   - E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance
4. Current unbalance should not exceed 5% at max amp load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the "power side" of the system. If the reading farthest from average moves with the same motor lead, the primary source of unbalance is on the "motor side" of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

Phase designation of leads for CCW rotation viewing shaft end.

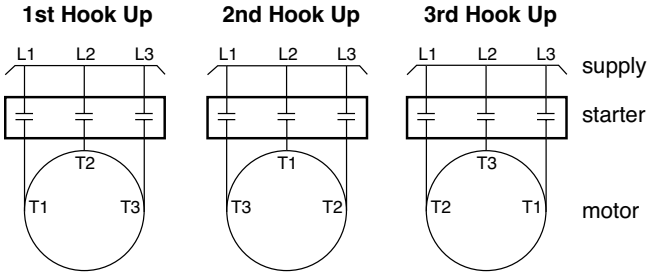
To reverse rotation, interchange any two leads.

Phase 1 or "A" - Black, T1, or U1

Phase 2 or "B" - Yellow, T2, or V1

Phase 3 or "C" - Red, T3, or W1

NOTICE: Phase 1, 2, and 3 may not be L1, L2, and L3.



EXAMPLE:

T1 = 51 amps	T3 = 50 amps	T2 = 50 amps T2 = 46
amps	T1 = 49 amps	T3 = 48 amps T3 = 53
+ amps	+ T2 = 51 amps	+ T1 = 52 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
$\frac{150}{3}$ = 50 amps	$\frac{150}{3}$ = 50 amps	$\frac{150}{3}$ = 50 amps
50 - 46 = 4 amps	50 - 49 = 1 amp	50 - 48 = 2 amps
$\frac{4}{50}$ = 0.08 or 8%	$\frac{1}{50}$ = 0.02 or 2%	$\frac{2}{50}$ = 0.04 or 4%

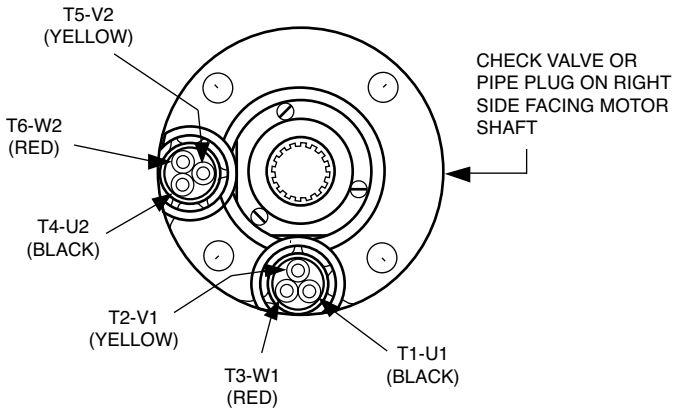
Three-Phase Motors

APPLICATION

Three-Phase Motor Lead Identification

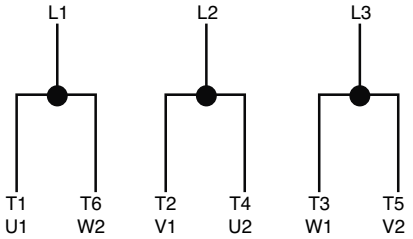
WARNING: When installing 6-lead motors extra care must be used to ensure lead identification at the surface. Leads must be marked and connected per diagram. Motor leads are not connected red to red, yellow to yellow, etc.

Line Connections — Six-Lead Motors

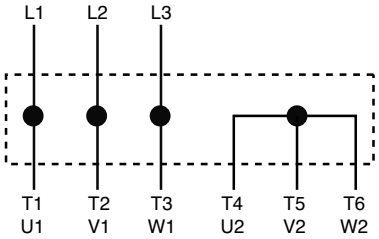


90° Lead Spacing

Connections for across-the-line starting, running, and any reduced voltage starting except WYE-DELTA type starters.



WYE-DELTA starters connect the motor as shown below during starting, then change to the running connection shown at the left.



Each motor lead is numbered with two markers, one near each end. To reverse rotation, interchange any two line connections.

Phase Converters

There are a number of different types of phase converters available. Each generates three-phase power from a single-phase power line.

In all phase converters, the voltage balance is critical to current balance. Although some phase converters may be well balanced at one point on the system-operating curve, submersible pumping systems often operate at differing points on the curve as water levels and operating pressures fluctuate. Other converters may be well balanced at varying loads, but their output may vary widely with fluctuations in the input voltage.

The following guidelines have been established for submersible installations to be warrantable when used with a phase converter.

1. Limit pump loading to rated horsepower. Do not load into motor service factor.
2. Maintain at least 3 ft/s flow past the motor. Use a flow sleeve when necessary.
3. Use time delay fuses or circuit breakers in pump panel. Standard fuses or circuit breakers do not provide secondary motor protection.
4. SubMonitor will not work with electronic solid state or electro mechanical phase converters.
5. Current unbalance must not exceed 10%.

Reduced Voltage Starters

All Franklin three-phase submersible motors are suitable for full-voltage starting. Under this condition the motor speed goes from zero to full speed within a half second or less. The motor current goes from zero to locked rotor amps, then drops to running amps at full speed. This may dim lights, cause momentary voltage dips to other electrical equipment, and shock power distribution transformers.

In some cases the power companies may require reduced-voltage starters to limit this voltage dip. There are also times when reduced-voltage starters may be desirable to reduce motor starting torque thus reducing the stress on shafts, couplings, and discharge piping. Reduced-voltage starters also slow the rapid acceleration of the water on start-up to help control upthrust and water hammer.

Reduced-voltage starters may not be required if the maximum recommended cable length is used. With maximum recommended cable length there is a 5% voltage drop in the cable at running amps, resulting in about 20% reduction in starting current and about 36% reduction in starting torque compared to having rated voltage at the motor. This may be enough reduction in starting current so that reduced-voltage starters are not required.

Three-Lead Motors: Autotransformer or solid-state reduced-voltage starters may be used for soft-starting standard three-phase motors.

When autotransformer starters are used, the motor should be supplied with at least 55% of rated voltage to ensure adequate starting torque. Most autotransformer starters have 65% and 80% taps. Setting the taps on these starters depends on the percentage of the maximum allowable cable length used in the system. If the cable length is less than 50% of the maximum allowable, either the 65% or the 80% taps may be used. When the cable length is more than 50% of allowable, the 80% tap should be used.

Six-Lead Motors: Wye-Delta starters are used with six-lead Wye-Delta motors. All Franklin 6" and 8" three-phase motors are available in six-lead Wye-Delta construction. Consult the factory for details and availability. Part winding starters are not compatible with Franklin Electric submersible motors and should not be used.

Wye-Delta starters of the open-transition type, which momentarily interrupt power during the starting cycle, are not recommended. Closed-transition starters have no interruption of power during the start cycle and can be used with satisfactory results.

Reduced-voltage starters have adjustable settings for acceleration ramp time, typically preset at 30 seconds. They must be adjusted so the motor is at full voltage within THREE SECONDS MAXIMUM to prevent excessive radial and thrust bearing wear.

If Subtrol-Plus or SubMonitor is used the acceleration time must be set to TWO SECONDS MAXIMUM due to the 3 second reaction time of the Subtrol-Plus or SubMonitor.

Solid-state starters AKA soft starts may not be compatible with Subtrol-Plus/ SubMonitor. However, in some cases a bypass contactor has been used. Consult the factory for details.

During shutdown, Franklin Electric's recommendation is for the power to be removed, allowing the pump/motor to coast down. Stopping the motor by ramping down the voltage is possible, but should be limited to three (3) seconds maximum.

Inline Booster Pump Systems

Franklin Electric offers three different types of motors for non-vertical applications.

1. The **Booster** motors are specifically designed for booster applications. They are the **"Best Choice" for sealed Reverse Osmosis applications.** These motors are the result of two years of focused development and bring additional value and durability to booster module systems. These motors are only available to OEMs or Distributors who have demonstrated capability in Booster Module systems design and operation and adhere to Franklin's Application Manual requirements.

2. The **Hi-Temp** motors have many of the internal design features of the Booster motor. It's additional length allows for higher temperature handling and the Sand Fighter sealing system provides greater abrasion resistance. One or both of these conditions are often experienced in open atmosphere applications such as lakes, ponds, etc.

3. The **Standard Vertical Water Well** (40-125 hp) motors can be adapted to non-vertical applications when applied per the below guidelines. However, they will be more sensitive to application variances than the other two designs.

All of the above motors must be applied per the guidelines listed below. In addition, for all applications where the motor is applied in a sealed system, a Submersible Motor Booster Installation Record (Form 3655) or its equivalent must be completed at start-up and received by Franklin Electric within 60 days. A sealed system is one where the motor and pump intake are mounted in a sleeve and the water feeding the pump intake is not open to the atmosphere.

Continued on next page

Inline Booster Pump Systems (Continued)

Design And Operational Requirements

1. **Non-Vertical Operation:** Vertical Shaft-up (0°) to Horizontal (90°) operation is acceptable as long as the pump transmits "down-thrust" to the motor within 3 seconds after start-up and continuously during operation. However, it is best practice to provide a positive slope whenever it is possible, even if it is only a few degrees.

2. **Motor, Sleeve, and Pump Support System:** The booster sleeve ID must be sized according to the motor cooling and pump NPSHR requirements. The support system must support the motor's weight, prevent motor rotation, and keep the motor and pump aligned. The support system must also allow for thermal axial expansion of the motor without creating binding forces.

3. **Motor Support Points:** A minimum of two support points are required on the motor. One in the motor/pump flange connection area and one in the bottom end of the motor area. The motor castings, not the shell area, are recommended as support points. If the support is a full length support and/or has bands in the shell area, they must not restrict heat transfer or deform the shell.

4. **Motor Support Material and Design:** The support system shall not create any areas of cavitation or other areas of reduced flow less than the minimum rate required by this manual. They should also be designed to minimize turbulence and vibration and provide stable alignment. The support materials and locations must not inhibit the heat transfer away from the motor.

5. **Motor and Pump Alignment:** The maximum allowable misalignment between the motor, pump, and pump discharge is 0.025 inch per 12 inches of length (2 mm per 1000 mm of length). This must be measured in both directions along the assembly using the motor/pump flange connection as the starting point. The booster sleeve and support system must be rigid enough to maintain this alignment during assembly, shipping, operation, and maintenance.

6. **Lubrication and Heat Resistance:** The best motor lubrication and heat resistance is obtained with the factory based propylene glycol fill solution. Only when an application MUST HAVE deionized (DI) water should the factory fill solution be replaced. When a deionized water fill is required, the motor must be derated as indicated on the below chart. The exchange of the motor fill solution to DI water must be done by an approved Franklin service shop or representative using a vacuum fill system per Franklin's Motor Service Manual instruction. The motor shell then must be permanently stamped with a D closely behind the Serial Number.

   The maximum pressure that can be applied to the motor internal components during the removal of the factory fill solution is 7 psi (0.5 bar.)

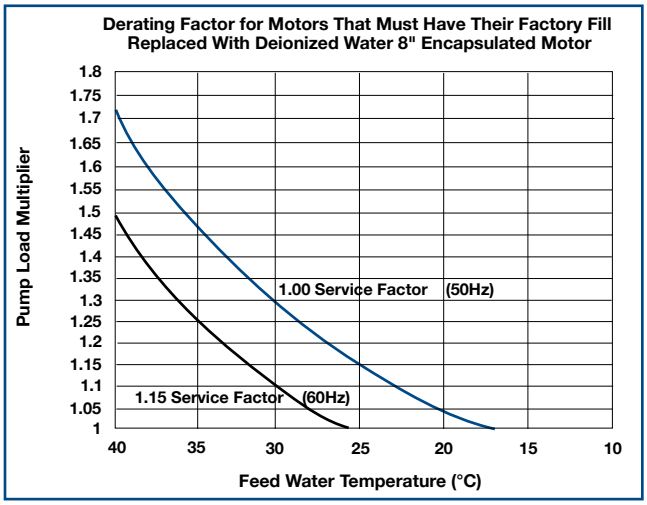


FIG. 9

First: Determine maximum Feed Water Temperature that will be experienced in this application. If the feed water exceeds the maximum ambient of the motor, both the DI water derating and a hot water application derating must be applied.

Second: Determine the Pump Load Multiplier from the appropriate Service Factor curve. (Typical 1.15 Service Factor is for 60 Hz ratings & 1.00 Service Factor for 50 Hz ratings).

Third: Multiply the Pump Load Requirement times the pump load multiplier number indicated on the vertical axis to determine the Minimum Motor Nameplate Rating.

Fourth: Select a motor with a nameplate equal or higher than the above calculated value.

7. **Motor Alterations - Sand Slinger & Check Valve Plug:** On 6" and 8" motors, the rubber sand slinger located on the shaft must be removed. If a pipe plug is covering the check valve, it must be removed. The special Booster motor already has these modifications.

8. **Frequency of Starts:** Fewer than 10 starts per 24-hour period are recommended. Allow at least 20 minutes between shutdown and start-up of the motor.

9. **Controls-Soft Starters and VFDs:** Reduced voltage starters and variable speed drives (inverter drives) may be used with Franklin three-phase submersible motors to reduce starting current, upthrust, and mechanical stress during start-up. The guidelines for their use with submersible motors are different than with normal air cooled motor applications. Refer to the Franklin Electric Application, Installation, and Maintenance (AIM) manual Reduced Voltage Starters section or Variable Speed Submersible Pump Operation, Inverter Drives sections for specific details including required filtering.

Continued on next page

Inline Booster Pump Systems (Continued)

10. **Motor Overload Protection:** Submersible motors require properly sized ambient compensated Class 10 quick-trip overloads per Franklin's AIM manual guidelines to protect the motor. Class 20 or higher overloads are NOT acceptable. Franklin's SubMonitor is strongly recommended for all large submersibles since it is capable of sensing motor heat without any additional wiring to the motor. Applications using Soft Starters with a SubMonitor require a start-up bypass - consult the factory for details. SubMonitor can not be used in applications using a VFD control.

11. **Motor Surge Protection:** Properly sized, grounded and dedicated motor surge arrestors must be installed in the supply line of the booster module as close to the motor as possible. This is required on all systems including those using soft-starters and variable speed drives (inverter drives).

12. **Wiring:** Franklin's lead assemblies are only sized for submerged operation in water to the motor nameplate maximum ambient temperature and may overheat and cause failure or serious injury if operated in air. Any wiring not submerged must meet applicable national and local wiring codes and Franklin Cable Chart Tables 16-21. (Notice: wire size, wire rating, and insulation temperature rating must be known when determining its suitability to operate in air or conduit. Typically, for a given size and rating, as the insulation temperature rating increases its ability to operate in air or conduit also increases.)

13. **Check Valves:** Spring-loaded check valves must be used on start-up to minimize motor upthrusting, water hammer, or in multiple booster (parallel) applications to prevent reverse flow.

14. **Pressure Relief Valves:** A pressure relief valve is required and must be selected to ensure that, as the pump approaches shut-off, it never reaches the point that the motor will not have adequate cooling flow past it.

15. **System Purge (Can Flooding):** An air bleeder valve must be installed on the booster sleeve so that flooding may be accomplished prior to booster start-up. Once flooding is complete, the booster should be started and brought up to operating pressure as quickly as possible to minimize the duration of an upthrust condition. At no time should air be allowed to gather in the booster sleeve because this will prevent proper cooling of the motor and permanently damage it.

16. **System Flush – Must Not Spin Pump:** Applications may utilize a low flow flushing operation. Flow through the booster sleeve must not spin the pump impellers and the motor shaft. If spinning takes place, the bearing system will be permanently damaged and the motor life shortened. Consult the booster pump manufacturer for maximum flow rate through the pump when the motor is not energized.

17. **Open Atmosphere Booster Pump Systems:** When an open booster is placed in a lake, tank, etc. that is open to atmospheric pressure, the water level must provide sufficient head pressure to allow the pump to operate above its NPSHR requirement at all times and all seasons. Adequate inlet pressure must be provided prior to booster start-up.

Table 38 Franklin Cable chart (See item 12 Wiring above)

CABLE TEMP. RATING (°C)	MOTOR NAMEPLATE RATED AMPS FULL LOAD	#10 AWG		#8 AWG		#6 AWG		#4 AWG		#2 AWG	
		IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT	IN AIR	IN CONDUIT
75	3-LEAD (DOL)	40A	28A	56A	40A	76A	52A	100A	68A	136A	92A
	6-LEAD (Y-Δ)	69A	48A	97A	69A	132A	90A	173A	118A	236A	159A
90	3-LEAD (DOL)	44A	32A	64A	44A	84A	60A	112A	76A	152A	104A
	6-LEAD (Y-Δ)	76A	55A	111A	76A	145A	104A	194A	132A	263A	180A
125	3-LEAD (DOL)	66A	46A	77A	53A	109A	75A	153A	105A	195A	134A
	6-LEAD (Y-Δ)	114A	80A	133A	91A	188A	130A	265A	181A	337A	232A

Based on 30 °C maximum ambient with cable length of 100 feet or less.

Continued on next page

Inline Booster Pump Systems (Continued)

Four Continuous Monitoring System Requirements for Sealed Booster Systems.

1. **Water Temperature:** Feed water on each booster must be continuously monitored and not allowed to exceed the motor nameplate maximum ambient temperature at any time. IF THE INLET TEMPERATURE EXCEEDS THE MOTOR NAMEPLATE MAXIMUM AMBIENT TEMPERATURE, THE SYSTEM MUST SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE. If feed water temperatures are expected to be above the allowable temperature, the motor must be derated. See Franklin's AIM manual Hot Water Applications section for derating guidelines. (The high temperature feed water derating is in addition to the exchange to DI water derating if the motor factory fill solution was exchanged to DI water.)

2. **Inlet Pressure:** The inlet pressure on each booster module must be continuously monitored. It must always be positive and higher than the NPSHR (Net Positive Suction Head Requirement) of the pump. A minimum of 20 PSIG (1.38 Bar) is required at all times, except for 10 seconds or less when the motor is starting and the system is coming up to pressure. Even during these 10 seconds the pressure must remain positive and be higher than the NPSHR (Net Positive Suction Head Requirement) of the pump.

   PSIG is the actual value displayed on a pressure gauge in the system piping. PSIG is the pressure above the atmospheric conditions. If at any time these pressure requirements are not being met, the motor must be de-energized immediately to prevent permanent damage to the motor. Once the motor is damaged, it is usually not immediately noticeable, but progresses and results in a premature motor failure weeks or months after the damage occurred.

   Motors that will be exposed to pressure in excess of 500 psi (34.47 Bar) must undergo special high pressure testing. Consult factory for details and availability.

3. **Discharge Flow:** The flow rate for each pump must not be allowed to drop below the motor minimum cooling flow requirement. IF THE MOTOR MINIMUM COOLING FLOW REQUIREMENT IS NOT BEING MET FOR MORE THAN 10 SECONDS, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.

4. **Discharge Pressure:** The discharge pressure must be monitored to ensure that a downthrust load toward the motor is present within 3 seconds after start-up and continuously during operation. IF THE MOTOR DISCHARGE PRESSURE IS NOT ADEQUATE TO MEET THIS REQUIREMENT, THE SYSTEM MUST BE SHUT DOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.

Three-Phase Motors

APPLICATION

Variable Frequency Drive Submersible Motor Requirements

Franklin Electric's three-phase, encapsulated submersible motors can be used with variable frequency drives (VFD) when applied within the guidelines below.

All three-phase, encapsulated submersible motors must have the VFD sized based on the motor's nameplate maximum amps, not horsepower. The continuous rated amps of the VFD must be equal to or greater than the motor's nameplate maximum amps or warranty will be void.

Franklin Electric's single-phase, 2- and 3-wire, encapsulated submersible motors can only be used with the appropriate Franklin constant pressure controller.

Franklin Electric's submersible motor Application, Installation, Maintenance (AIM) manual should be checked for the latest guidelines and can be found online at www.franklin-electric.com.

WARNING: There is a potential shock hazard from contact with and/or touching the insulated cables connected to the variable frequency drive output anytime the motor has energy applied.

Output Filter Requirement Test:

NOTICE: An incoming power supply or line-side filter for the drive does not replace the need for additional output filters.

An output filter is required if the answer is yes to one or both of the items below:

#1 - Does the peak voltage at the motor terminals exceed 1000-volts or is the rise time of the VFD's voltage less than 2 micro-seconds? Per NEMA MG 1-2011, the rise time is defined as the time between 10% and 90% of the steady-state voltage (i.e., DC bus voltage).

#2 - Is the motor nameplate voltage more than 379 Volts and is the cable from drive-to-motor more than 50 ft (15.2 m)?

NOTICE:
More than 99% of the drives applied on water well submersible motors will require the purchase of additional output filtering based on question #1.

Output filters can be expensive. However, when needed, it is required for the motor to be considered for warranty. Make sure this item is not overlooked when quoting a job.

PWM dV/dt value can be defined as: the rate at which voltage is changing with time or how fast the voltage is accelerating. This information can be supplied by the drive manufacturer or the manufacturer's drive specification sheet. The dV/dt value cannot be measured with typical field equipment, even when using a true-RMS voltage/amperage multi-meter.

Franklin Electric has a line of VFDs that are specifically designed for Franklin application systems. These VFDs are used in the MonoDrive and SubDrive constant pressure systems. Franklin drive systems have the required additional output filtering installed; however, the SubDrive HPX does not.

Types of Output Filters:

A resistor-inductor-capacitor (RLC) filter has both a high pass filter & a low pass filter section and are considered the best practice, but a high pass reactor filter is also acceptable.

Filters should be recommended by the drive manufacturer; for the correct recommendations provide them with answers to all five of the items below.

REQUIRED ITEMS FOR PROPER VFD FILTER SIZING:

(1) VFD model (2) Carrier frequency setting (3) Motor nameplate voltage (4) Motor nameplate max amps (5) Cable length from the drive output terminals to the motor

Input Current & Motor Overload Protection:

- Motor input current should be set at the system's typical operating current when running at nameplate rated voltage and frequency (Hz).
- Motor overload protection should be set to trip at 115% of the system's typical operating current.
- Motor overload protection must trip equal to or faster than NEMA Class 10 motor overload curve requirements.

Motor Maximum Load Limits:

- The system must never operate in excess of the motor nameplate maximum amps.
- On 50 Hz motors, nameplate amps are maximum amps as these motors have a 1.0 service factor.

Variable Frequency Drive Submersible Motor Requirements (Continued)

Motor Operating Hertz, Cooling Requirements, and Underload Settings:

- Standard practice for large VFD installations is to limit the operation to 60 Hz max. Operating at greater than 60 Hz requires special system design considerations.
- The motor must never operate below 30 Hz. This is the minimum speed required to provide correct bearing lubrication.
- The motor's operating speed must always operate so the minimum water flow requirements of 0.5 ft/sec for 6-inch & 8-inch motors and 0.25 ft/sec for 4-inch motors is supplied.
- The motor underload protection is normally set to trip at 80% of the system's typical operating current. However, the underload trip point must be selected so that minimum flow requirements are always met.

Starting and Stopping Ramp Settings:

- The motor must reach or pass the 30 Hz operating speed within 1 second of the motor being energized. If this does not occur, the motor bearings will be damaged and the motor life reduced.
- The best stopping method is to turn power off followed by a natural coast to stop.
- A controlled stop from 30 Hz to 0 Hz is allowed if the time does not exceed 1 second.

Drive Carrier Frequency:

- The carrier frequency is set in the field. The drive typically has a selectable range between 2k and 12k Hz. The higher the carrier wave frequency setting, the greater the voltage spikes; the lower the carrier wave frequency setting, the rougher/poorer the shape of the power curve.
- The carrier frequency should be set within the range of 4k to 5k Hz for encapsulated submersible motors.

Application Function Setting:

- If the VFD has a setting of centrifugal pump or propeller fan it should be used.
- Centrifugal pumps and fans have similar load characteristics.

VFD Frequency of Starts:

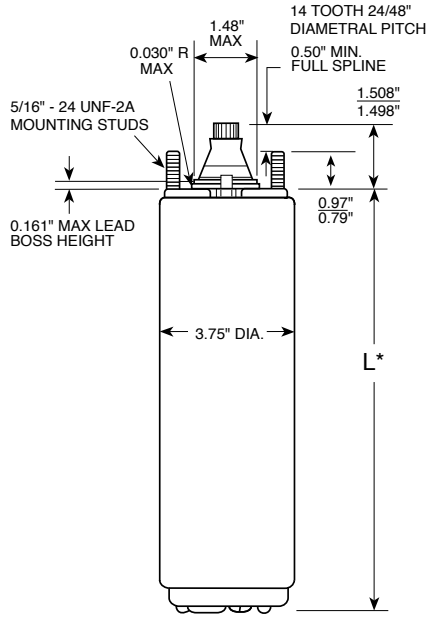
- Keeping the starts per day within the recommended numbers shown in the frequency of starts section of the AIM manual provides the best system life. However, since in-rush current is typically reduced when used with a properly configured VFD, large 3-phase submersible motors can be started more frequently. In all cases a minimum of 7 minutes must be allowed between a power off and the next restart attempt or consecutive restart attempts.

NEMA MG1 Above Ground Motor Standard Comments:

- Franklin Electric encapsulated submersible motors are not declared inverter duty motors by NEMA MG1 standards. The reason is NEMA MG1 standard part 31 does not include a section covering encapsulated winding designs.
- Franklin submersible motors can be used with VFDs without problems or warranty concerns providing Franklin's Application, Installation, Maintenance (AIM) manual guidelines are followed. See Franklin's on-line AIM manual for the latest guidelines.

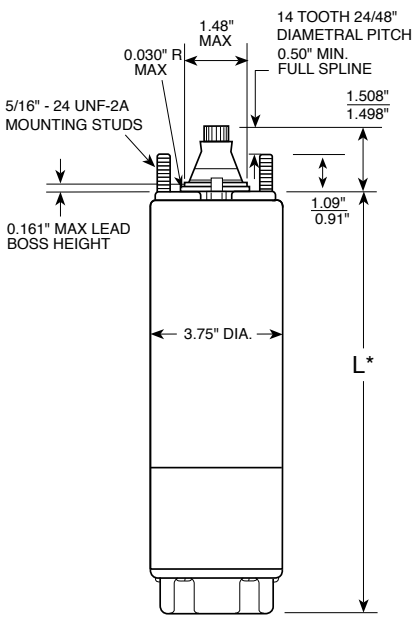
4″ Super Stainless — Dimensions

(Standard Water Well)



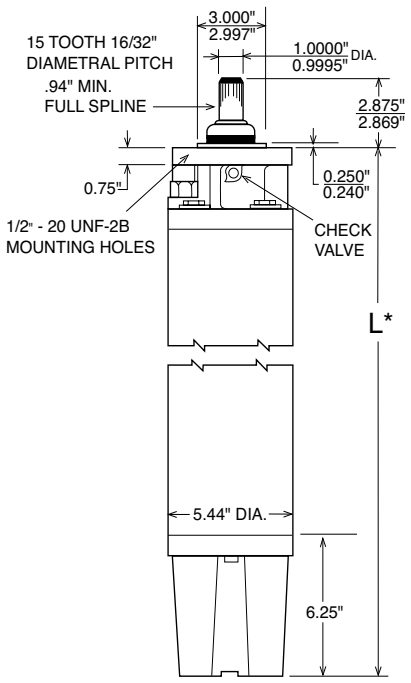
4″ High Thrust — Dimensions

(Standard Water Well)



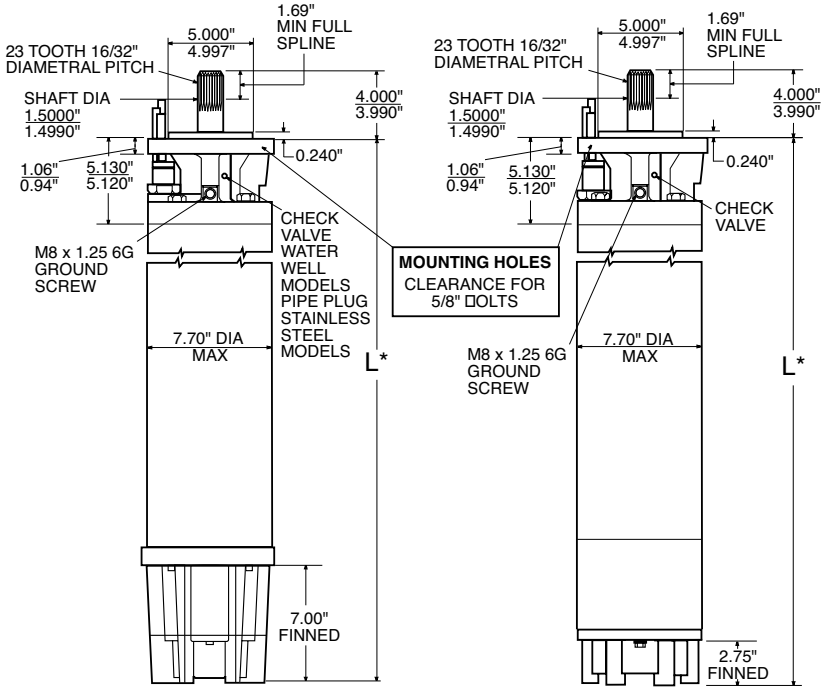
6″ — Dimensions

(Standard Water Well)



8″ — Dimensions

(Standard Water Well)



* Motor lengths and shipping weights are available on Franklin Electric's web site (www.franklin-electric.com) or by calling Franklin's Technical Service Hotline (800-348-2420).

Tightening Motor Lead Connector Jam Nut

4" Motors with Jam Nut:
15 to 20 ft-lb (20 to 27 Nm)

4" Motors with 2 Screw Clamp Plate:
35 to 45 in-lb (40 to 51 Nm)

6" Motors:
40 to 50 ft-lb (54 to 68 Nm)

8" Motors with 1-3/16" to 1-5/8" Jam Nut:
50 to 60 ft-lb (68 to 81 Nm)

8" Motors with 4 Screw Clamp Plate:
Apply increasing torque to the screws equally in a criss-cross pattern until 80 to 90 in-lb (9.0 to 10.2 Nm) is reached.

Jam nut tightening torques recommended for field assembly are shown. Rubber compression set within the first few hours after assembly may reduce the jam nut torque. This is a normal condition which does not indicate reduced seal effectiveness. Retightening is not required, but is permissible and recommended if original torque was questionable.

A motor lead assembly should not be reused. A new lead assembly should be used whenever one is removed from the motor, because rubber set and possible damage from removal may prevent proper resealing of the old lead.

All motors returned for warranty consideration must have the lead returned with the motor.

Pump to Motor Coupling

Assemble coupling with non-toxic FDA approved waterproof grease such as Mobile FM222, Texaco CYGNUS2661, or approved equivalent. This prevents abrasives from entering the spline area and prolongs spline life.

Pump to Motor Assembly

After assembling the motor to the pump, torque mounting fasteners to the following:

4" Pump and Motor: 10 lb-ft (14 Nm)

6" Pump and Motor: 50 lb-ft (68 Nm)

8" Pump and Motor: 120 lb-ft (163 Nm)

Shaft Height and Free End Play

Table 43

MOTOR	NORMAL SHAFT HEIGHT		DIMENSION SHAFT HEIGHT		FREE END PLAY	
					MIN.	MAX.
4"	1 1/2"	38.1 mm	1.508" / 1.498"	38.30 / 38.05 mm	0.010" 0.25 mm	0.045" 1.14 mm
6"	2 7/8"	73.0 mm	2.875" / 2.869"	73.02 / 72.88 mm	0.030" 0.76 mm	0.050" 1.27 mm
8" TYPE 1	4"	101.6 mm	4.000" / 3.990"	101.60 / 101.35 mm	0.008" 0.20 mm	0.032" 0.81 mm
8" TYPE 2.1	4"	101.6 mm	4.000" / 3.990"	101.60 / 101.35 mm	0.030" 0.76 mm	0.080" 2.03 mm

If the height, measured from the pump-mounting surface of the motor, is low and/or end play exceeds the limit, the motor thrust bearing is possibly damaged, and should be replaced.

Submersible Leads and Cables

A common question is why motor leads are smaller than specified in Franklin's cable charts.

The leads are considered a part of the motor and actually are a connection between the large supply wire and the motor winding. The motor leads are short and there is virtually no voltage drop across the lead.

In addition, the lead assemblies **operate under water**, while at least part of the supply cable must **operate in air.** Lead assemblies running under water operate cooler.

CAUTION: Lead assemblies on submersible motors are suitable only for use in water and may overheat and cause failure if operated in air.

System Troubleshooting

Motor Does Not Start

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. No power or incorrect voltage	Check voltage at line terminals. The voltage must be ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptacle. Check for tripped circuit breakers.	Replace with proper fuse or reset circuit breakers.
C. Defective pressure switch	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction	For detailed procedure, see pages 48-57.	Repair or replace.
E. Defective wiring	Check for loose or corroded connections or defective wiring.	Correct faulty wiring or connections.
F. Bound pump	Check for misalignment between pump and motor or a sand bound pump. Amp readings will be 3 to 6 times higher than normal until the overload trips.	Pull pump and correct problem. Run new installation until the water clears.
G. Defective cable or motor	For detailed procedure, see pages 46 & 47.	Repair or replace.

Motor Starts Too Often

A. Pressure switch	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve - stuck open	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank	Check air charge.	Clean or replace.
D. Leak in system	Check system for leaks.	Replace damaged pipes or repair leaks.

System Troubleshooting

Motor Runs Continuously

POSSIBLE CAUSE	CHECKING PROCEDURES	CORRECTIVE ACTION
A. Pressure switch	Check switch for welded contacts. Check switch adjustments.	Clean contacts, replace switch, or adjust setting.
B. Low water level in well	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be the fault.	Pull pump and replace worn parts.
E. Loose coupling or broken motor shaft	Check for loose coupling or damaged shaft.	Replace worn or damaged parts.
F. Pump screen blocked	Check for clogged intake screen.	Clean screen and reset pump depth.
G. Check valve stuck closed	Check operation of check valve.	Replace if defective.
H. Control box malfunction	See pages 48-57 for single-phase.	Repair or replace.

Motor Runs But Overload Protector Trips

A. Incorrect voltage	Using voltmeter, check the line terminals. Voltage must be within ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors	Direct sunlight or other heat source can raise control box temperature causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from source.
C. Defective control box	For detailed procedures, see pages 48-57.	Repair or replace.
D. Defective motor or cable	For detailed procedures, see pages 45 & 46.	Repair or replace.
E. Worn pump or motor	Check running current, see tables 13, 22, 24, 25, & 27.	Replace pump and/or motor.

Table 46 Preliminary Tests - All Sizes Single- and Three-Phase

TEST	PROCEDURE	WHAT IT MEANS
Insulation Resistance (Fig. 10)	1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter. 2. Use a megohmmeter set to 1000-volt (500-volt minimum). If using an ohmmeter, set to R X 100k. Zero the meter. 3. Connect one meter lead to any one of the motor leads and the other lead to the metal drop pipe. If the drop pipe is plastic, connect the meter lead to ground.	1. If the ohms value is normal (Table 47), the motor is not grounded and the cable insulation is not damaged. 2. If the ohms value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.
Winding Resistance (Fig 11.)	1. Open master breaker and disconnect all leads from control box or pressure switch (QD type control, remove lid) to avoid electric shock hazard and damage to the meter. 2. Use a multi-meter set to 20 ohms or an ohmmeter set to R X 1 for values under 10 ohms. Use next scale up for values over 10 ohms. Zero the meter. 3. On 3-wire motors measure the resistance of yellow to black (main winding) and yellow to red (start winding). On 2-wire motors: measure the resistance from line-to-line. Three-phase motors: measure the resistance line-to-line for all three combinations.	1. If all ohms values are normal (Tables 13, 22, 24, 25, & 27), the motor windings are neither shorted nor open, and the cable colors are correct 2. If any one value is less than normal, the motor is shorted. 3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection. 4. If some ohms values are greater than normal and some less on single-phase motors, the leads are mixed. See page 48 to verify cable colors.

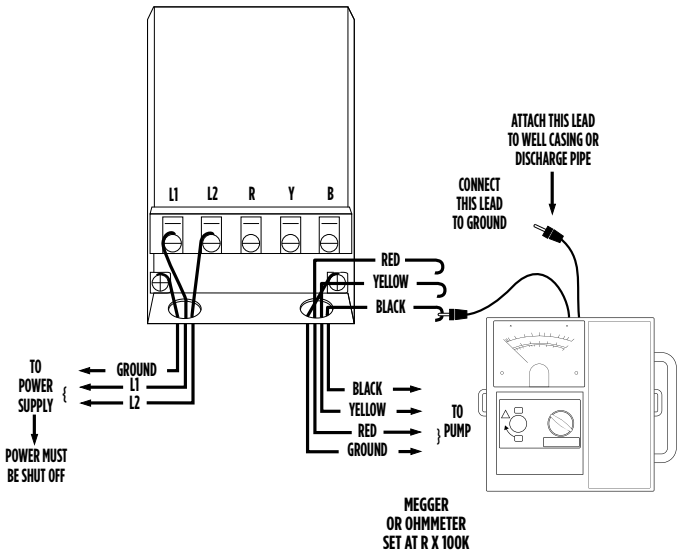


FIG. 10

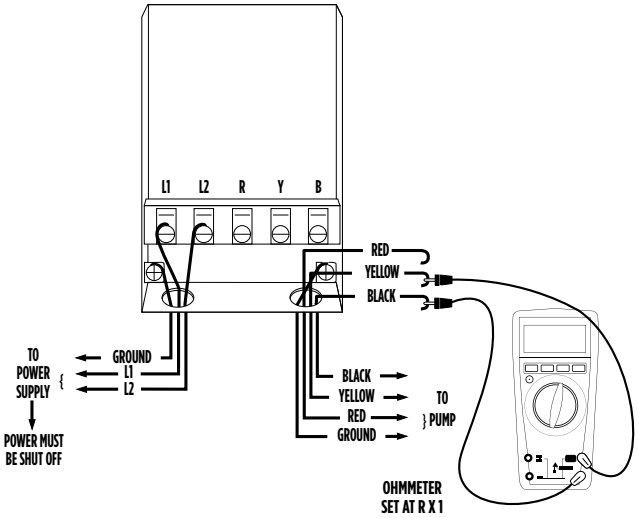


FIG. 11

Insulation Resistance Readings

Table 47 Normal ohm and Megohm Values Between All Leads and Ground

CONDITION OF MOTOR AND LEADS	MEGOHM VALUE	OHMS VALUE
A new motor (without drop cable)	200.0 (or more)	200,000,000 (or more)
A used motor which can be reinstalled in well	10.0 (or more)	10,000,000 (or more)
MOTOR IN WELL. READINGS ARE FOR DROP CABLE PLUS MOTOR.		
New motor	2.0 (or more)	2,000,000 (or more)
Motor in good condition	0.50 - 2.0	500,000 - 2,000,000
Insulation damage, locate and repair	Less than .50	Less than 500,000

Insulation resistance varies very little with rating. Motors of all hp, voltage, and phase rating have similar values of insulation resistance. The table above is based on readings taken with a megohm meter with a 500 VDC output. Readings may vary using a lower voltage ohmmeter; consult Franklin Electric if readings are in question.

Resistance of Drop Cable (ohms)

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher. To determine the actual resistance of the aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control to motor and back.

Winding Resistance Measuring

The winding resistance measured at the motor should fall within the values in Tables 13, 22, 24, 25, & 27. When measured through the drop cable, the resistance of the drop cable must be subtracted from the ohmmeter readings to get the winding resistance of the motor. See table below.

Table 47A DC Resistance in ohms per 100 ft of Wire (Two conductors) @ 50 °F

AWG OR MCM WIRE SIZE (COPPER)	14	12	10	8	6	4	3	2
OHMS	0.544	0.338	0.214	0.135	0.082	0.052	0.041	0.032

1	1/0	2/0	3/0	4/0	250	300	350	400	500	600	700
0.026	0.021	0.017	0.013	0.010	0.0088	0.0073	0.0063	0.0056	0.0044	0.0037	0.0032

Identification Of Cables When Color Code Is Unknown (Single-Phase 3-Wire Units)

If the colors on the individual drop cables cannot be found with an ohmmeter, measure:

Cable 1 to Cable 2
Cable 2 to Cable 3
Cable 3 to Cable 1

Find the highest resistance reading.

The lead not used in the highest reading is the yellow lead.

Use the yellow lead and each of the other two leads to get two readings:

Highest is the red lead.
Lowest is the black lead.

EXAMPLE:
The ohmmeter readings were:

Cable 1 to Cable 2 - 6 ohms
Cable 2 to Cable 3 - 2 ohms
Cable 3 to Cable 1 - 4 ohms

The lead not used in the highest reading (6 ohms) was

Cable 3—Yellow

From the yellow lead, the highest reading (4 ohms) was

To Cable 1—Red

From the yellow lead, the lowest reading (2 ohms) was

To Cable 2—Black

Single-Phase Control Boxes

Checking and Repairing Procedures (Power On)

WARNING: Power must be on for these tests. Do not touch any live parts.

A. VOLTAGE MEASUREMENTS

Step 1. Motor Off

1. Measure voltage at L1 and L2 of pressure switch or line contactor.
2. Voltage Reading: Should be ± 10% of motor rating.

Step 2. Motor Running

1. Measure voltage at load side of pressure switch or line contactor with pump running.
2. Voltage Reading: Should remain the same except for slight dip on starting. Excessive voltage drop can be caused by loose connections, bad contacts, ground faults, or inadequate power supply.
3. Relay chatter is caused by low voltage or ground faults.

B. CURRENT (AMP) MEASUREMENTS

1. Measure current on all motor leads.
2. Amp Reading: Current in red lead should momentarily be high, then drop within one second to values in Table 13. This verifies relay or solid state relay operation. Current in black and yellow leads should not exceed values in Table 13.
3. Relay or switch failures will cause red lead current to remain high and overload tripping.
4. Open run capacitor(s) will cause amps to be higher than normal in the black and yellow motor leads and lower than normal in the red motor lead.
5. A bound pump will cause locked rotor amps and overloading tripping.
6. Low amps may be caused by pump running at shut-off, worn pump, or stripped splines.
7. Failed start capacitor or open switch/relay are indicated if the red lead current is not momentarily high at starting.

CAUTION: The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.

Ohmmeter Tests

QD, Solid State Control Box (Power Off)

A. START CAPACITOR AND RUN CAPACITOR IF APPLICABLE (CRC)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then back to infinity.

B. Q.D. (BLUE) RELAY

Step 1. Triac Test

1. Meter setting: R x 1,000.
2. Connections: Cap and B terminal.
3. Correct meter reading: Infinity for all models.

Step 2. Coil Test

1. Meter Setting: R x 1.
2. Connections: L1 and B.
3. Correct meter reading: Zero ohms for all models.

C. POTENTIAL (VOLTAGE) RELAY

Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings:

   For 115 Volt Boxes:
   0.7-1.8 (700 to 1,800 ohms).

   For 230 Volt Boxes:
   4.5-7.0 (4,500 to 7,000 ohms).

Step 2. Contact Test

1. Meter setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero for all models.

Ohmmeter Tests

Integral Horsepower Control Box (Power Off)

A. OVERLOADS (Push Reset Buttons to make sure contacts are closed.)

1. Meter Setting: R x 1.
2. Connections: Overload terminals.
3. Correct meter reading: Less than 0.5 ohms.

B. CAPACITOR (Disconnect leads from one side of each capacitor before checking.)

1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then drift back to infinity, except for capacitors with resistors which will drift back to 15,000 ohms.

C. POTENTIAL (VOLTAGE) RELAY

Step 1. Coil Test

1. Meter setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings: 4.5-7.0 (4,500 to 7,000 ohms) for all models.

Step 2. Contact Test

1. Meter Setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading: Zero ohms for all models.

D. CONTACTOR

Step 1. Coil

1. Meter setting: R x 100
2. Connections: Coil terminals
3. Correct meter reading: 1.8-14.0 (180 to 1,400 ohms)

Step 2. Contacts

1. Meter Setting: R X 1
2. Connections: L1 & T1 or L2 & T2
3. Manually close contacts
4. Correct meter reading: Zero ohms

CAUTION: The tests in this manual for components such as capacitors, relays, and QD switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but may have lost some of its capacitance and may no longer be able to perform its function.

Table 50 QD Control Box Parts 60 Hz

HP	VOLTS	CONTROL BOX MODEL NUMBER	QD (BLUE) RELAY	START CAPACITOR	MFD	VOLTS	RUN CAPACITOR	MFD	VOLTS
1/3	115	280 102 4915	223 415 905	275 464 125	159-191	110			
	230	280 103 4915	223 415 901	275 464 126	43-53	220			
1/2	115	280 104 4915	223 415 906	275 464 201	250-300	125			
	230	280 105 4915	223 415 902	275 464 105	59-71	220			
	230	282 405 5015 (CRC)	223 415 912	275 464 126	43-53	220	156 362 101	15	370
3/4	230	280 107 4915	223 415 903	275 464 118	86-103	220			
	230	282 407 5015 (CRC)	223 415 913	275 464 105	59-71	220	156 362 102	23	370
1	230	280 108 4915	223 415 904	275 464 113	105-126	220			
	230	282 408 5015 (CRC)	223 415 914	275 464 118	86-103	220	156 362 102	23	370

Table 50A QD Capacitor Replacement Kits

CAPACITOR NUMBER	KIT
275 464 105	305 207 905
275 464 113	305 207 913
275 464 118	305 207 918
275 464 125	305 207 925
275 464 126	305 207 926
275 464 201	305 207 951
156 362 101	305 203 907
156 362 102	305 203 908

Table 50B Overload Kits 60 Hz

HP	VOLTS	KIT (1)
1/3	115	305 100 901
1/3	230	305 100 902
1/2	115	305 100 903
1/2	230	305 100 904
3/4	230	305 100 905
1	230	305 100 906

(1) For Control Boxes with model numbers that end with 4915.

Table 50C QD Relay Replacement Kits

QD RELAY NUMBER	KIT
223 415 901	305 101 901
223 415 902	305 101 902
223 415 903	305 101 903
223 415 904	305 101 904
223 415 905	305 101 905
223 415 906	305 101 906
223 415 912 (CRC)	305 105 901
223 415 913 (CRC)	305 105 902
223 415 914 (CRC)	305 105 903

FOOTNOTES:

(1) Control boxes supplied with QD Relays are designed to operate on 230-volt systems. For 208-volt systems or where line voltage is between 200 volts and 210 volts use the next larger cable size, or use a boost transformer to raise the voltage.

(2) Voltage relays kits for 115-volts (305 102 901) and 230-volts (305 102 902) will replace current, voltage or QD Relays, and solid state switches.

Table 51 Integral Horsepower Control Box Parts 60 Hz

MOTOR SIZE	MOTOR RATING HP	CONTROL BOX (1) MODEL NO.	CAPACITORS				OVERLOAD (2) PART NO.	RELAY (3) PART NO.	CONTACTOR (2) PART NO.
			PART NO. (2)	MFD.	VOLTS	QTY.			
4"	1 - 1.5 STANDARD	282 300 8110 (See Note 5)	275 464 113 S 155 328 102 R	105-126 10	220 370	1 1	275 411 107	155 031 102	
		282 300 8110 (See Note 5)	275 464 137 S 155 328 101 R	105-126 15	220 370	1 1	275 411 114 S 275 411 113 M	155 031 102	
		282 300 8610	275 464 113 S 155 328 101 R	105-126 15	220 370	1 1	None (See Note 4)	155 031 102	
4"	2 STANDARD	282 301 8110	275 464 137 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	
4"	2 DELUXE	282 301 8310	275 464 137 S 155 328 103 R	105-126 20	220 370	1 1	275 411 117 S 275 411 113 M	155 031 102	155 325 102 L
4"	3 STANDARD	282 302 8110	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	
4"	3 DELUXE	282 302 8310	275 463 123 S 155 327 109 R	208-250 45	220 370	1 1	275 411 118 S 275 411 115 M	155 031 102	155 325 102 L
4" & 6"	5 STANDARD	282 113 8110	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	
4" & 6"	5 DELUXE	282 113 9310	275 468 119 S 155 327 114 R	270-324 40	330 370	1 2	275 411 119 S 275 406 102 M	155 031 601	155 326 101 L
6"	7.5 STANDARD	282 201 9210	275 468 119 S 275 468 118 S 155 327 109 R	270-324 216-259 45	330 330 370	1 1 1	275 411 102 S 275 406 122 M	155 031 601	
6"	7.5 DELUXE	282 201 9310	275 468 119 S 275 468 118 S 155 327 109 R	270-324 216-259 45	330 330 370	1 1 1	275 411 102 S 275 406 121 M	155 031 601	155 326 102 L
6"	10 STANDARD	282 202 9210	275 468 119 S 275468 120 S 155 327 102 R	270-324 350-420 35	330 330 370	1 1 2	275 406 103 S 155 409 101 M	155 031 601	
6"	10 STANDARD	282 202 9230	275 463 120 S 275 468 118 S 275 468 119 S 155 327 102 R	130-154 216-259 270-324 35	330 330 330 370	1 1 1 2	275 406 103 S 155 409 101 M	155 031 601	
6"	10 DELUXE	282 202 9310	275 468 119 S 275468 120 S 155 327 102 R	270-324 350-420 35	330 330 370	1 1 2	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
6"	10 DELUXE	282 202 9330	275 463 120 S 275 468 118 S 275 468 119 S 155 327 102 R	130-154 216-259 270-324 35	330 330 330 370	1 1 1 2	275 406 103 S 155 409 101 M	155 031 601	155 326 102 L
6"	15 DELUXE	282 203 9310	275 468 120 S 155 327 109 R	350-420 45	330 370	2 3	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
6"	15 DELUXE	282 203 9330	275 463 122 S 275 468 119 S 155 327 109 R	161-193 270-324 45	330 330 370	1 2 3	275 406 103 S 155 409 102 M	155 031 601	155 429 101 L
6"	15 X-LARGE	282 203 9621	275 468 120 S 155 327 109 R	350-420 45	330 370	2 3	275 406 103 S 155 409 102 M	155 031 601 2 required	155 429 101 L

FOOTNOTES:

(1) Surge arrestors 150 814 902 are suitable for all control boxes.

(2) S = Start, M = Main, L = Line, R = Run
Deluxe = Control box with line contactor.

(3) For 208-volt systems or where line voltage is between 200 volts and 210 volts, a low voltage relay is required. On 3 hp and smaller control boxes use relay part 155 031 103 in place of 155 031 102 and use the next larger cable size than specified in the 230-volt table. On 5 hp and larger use relay 155 031 602 in place of 155 031 601 and next larger wire. Boost transformers per page 15 are an alternative to special relays and cable.

(4) Control box model 282 300 8610 is designed for use with motors having internal overload protectors. If used with a 1.5 hp motor manufactured prior to date code 06H18, Overload/ Capacitor Kit 305 388 901 is required.

(5) Control box model 282 300 8110 with date code 11C19 (March 2011) and newer contain 15 MFD run capacitor and both start and run overloads. This box is designed for use with any Franklin 1.5 hp motor.

Table 52 Integral hp Capacitor Replacement Kits

CAPACITOR NUMBER	KIT
275 463 120	305 206 920
275 463 122	305 206 922
275 463 123	305 206 923
275 464 113	305 207 913
275 464 137	305 207 937
275 468 118	305 208 918
275 468 119	305 208 919
275 468 120	305 208 920
155 327 101	305 203 901
155 327 102	305 203 902
155 327 109	305 203 909
155 327 114	305 203 914
155 328 101	305 204 901
155 328 102	305 204 902
155 328 103	305 204 903

Table 52A Integral hp Overload Replacement Kits

OVERLOAD NUMBER	KIT
275 406 102	305 214 902
275 406 103	305 214 903
275 406 121	305 214 921
275 406 122	305 214 922
275 411 102	305 215 902
275 411 107	305 215 907
275 411 108	305 215 908
275 411 113	305 215 913
275 411 114	305 215 914
275 411 115	305 215 915
275 411 117	305 215 917
275 411 118	305 215 918
275 411 119	305 215 919

Table 52B Integral hp Voltage Relay Replacement Kits

RELAY NUMBER	KIT
155 031 102	305 213 902
155 031 103	305 213 903
155 031 601	305 213 961
155 031 602	305 213 962

Table 52C Integral hp Contactor Replacement Kits

CONTACTOR	KIT
155 325 102	305 226 902
155 326 101	305 347 903
155 326 102	305 347 902
155 429 101	305 347 901

FOOTNOTES:

(1) The following kit number changes were made for number consistency purposes only. Parts in the kit did not change.

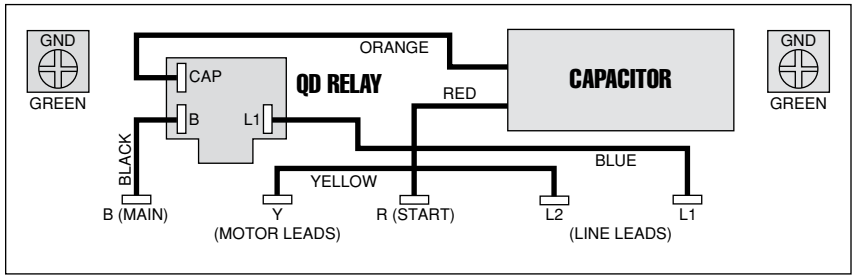
305 206 922 was 305 206 912

305 206 923 was 305 206 911

305 213 962 was 305 213 904

305 226 902 was 305 226 901

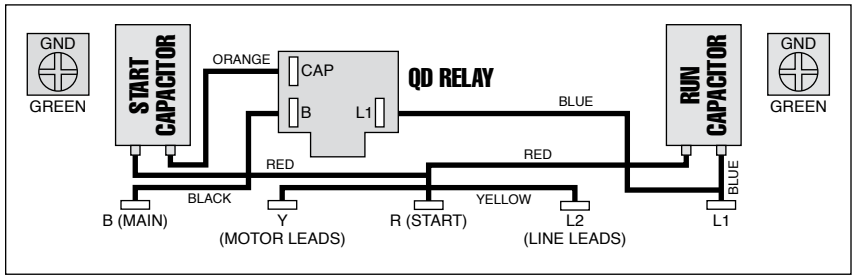
Control Box Wiring Diagrams



1/3 - 1 hp QD RELAY

280 10_ 4915

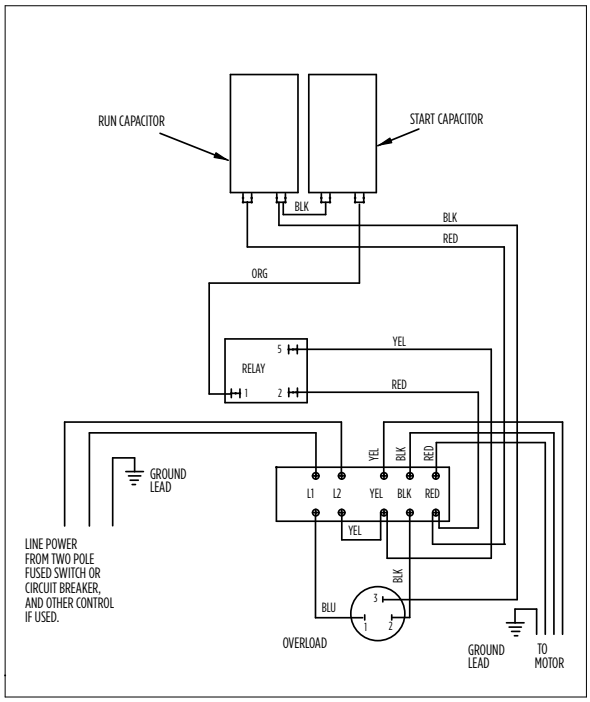
Sixth digit depends on hp



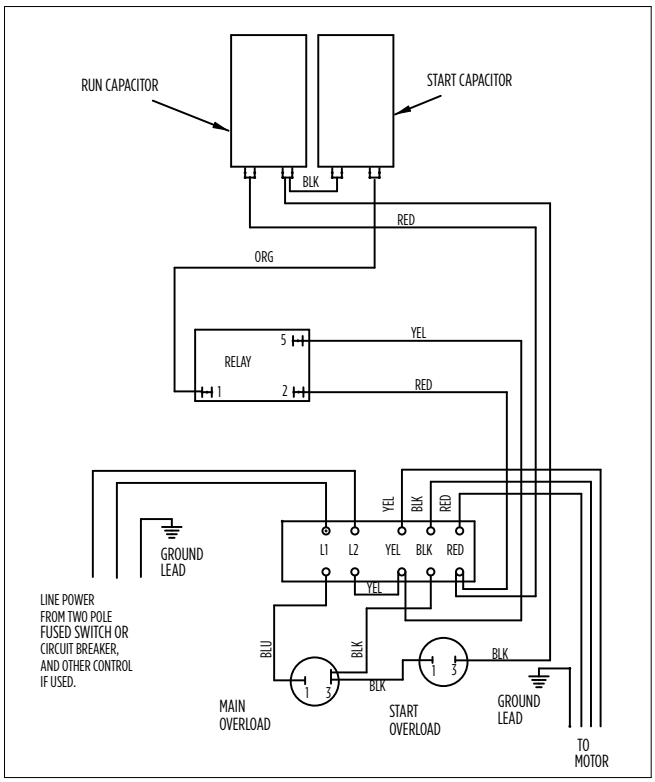
1/2 - 1 hp CRC QD RELAY

282 40_ 5015

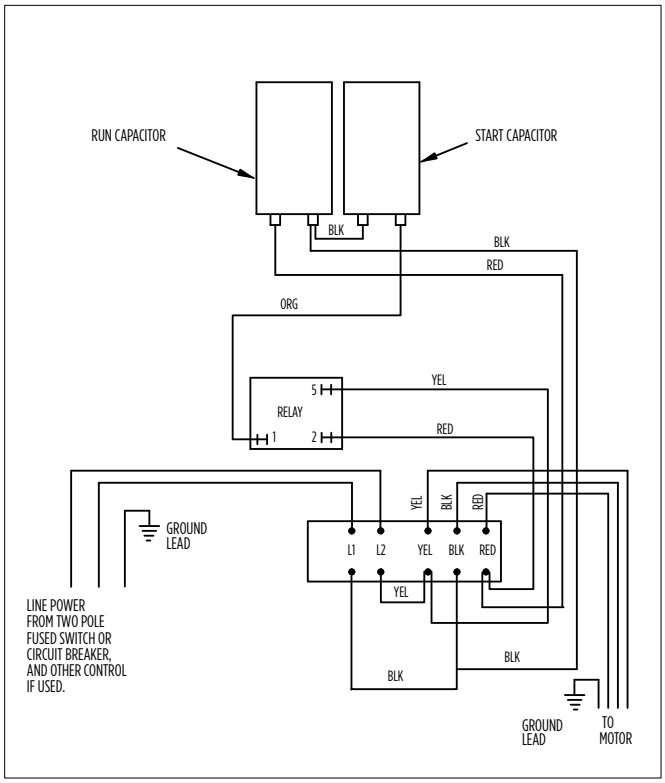
Sixth digit depends on hp



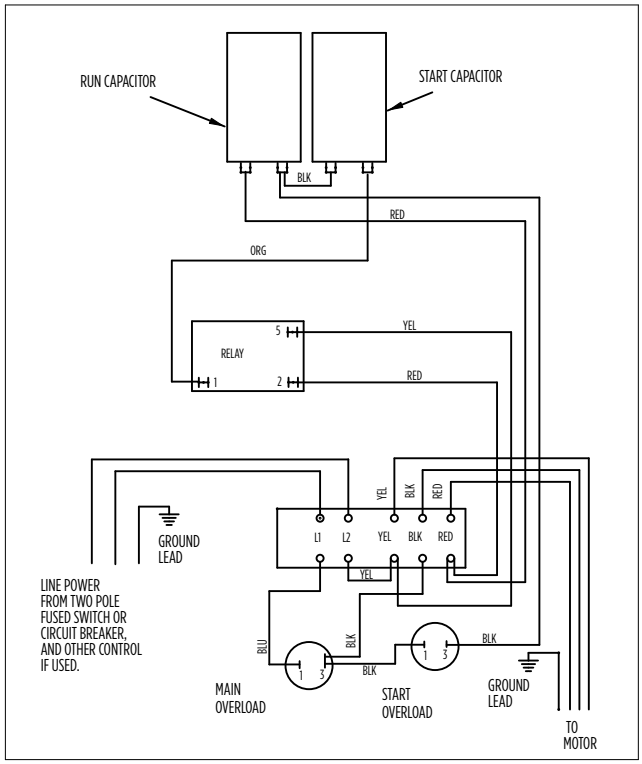
1 - 1.5 hp
282 300 8110
(Date Codes 11C19 & Older)



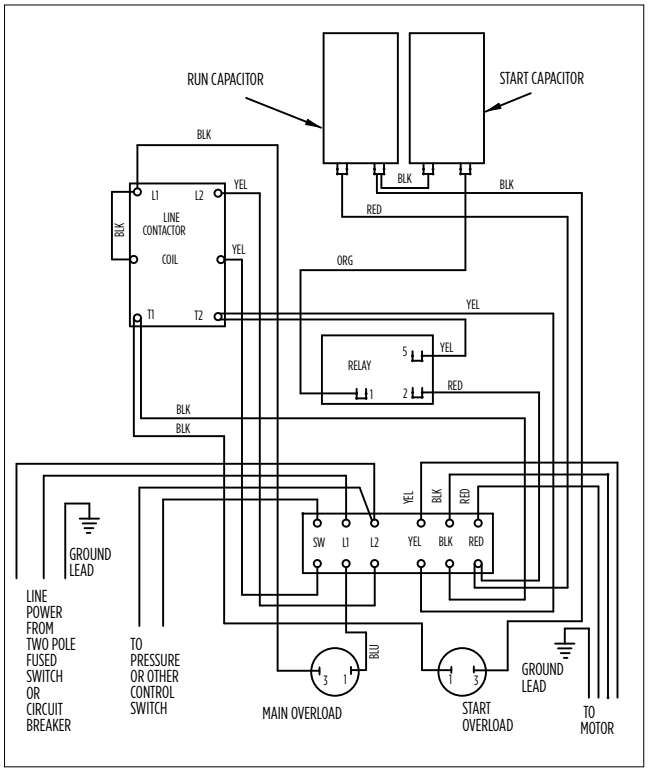
1 - 1.5 hp
282 300 8110
(Date Codes 11C19 & Newer)



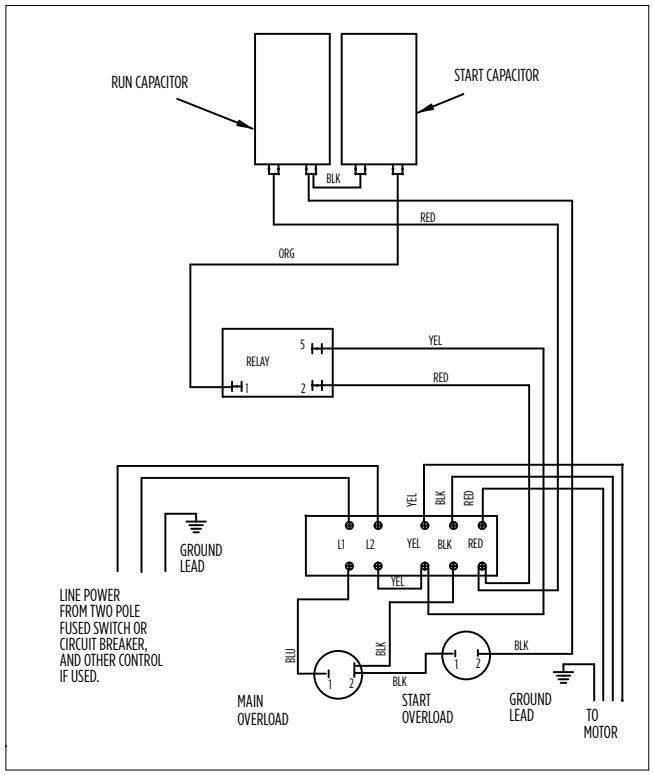
1 - 1.5 hp
282 300 8610



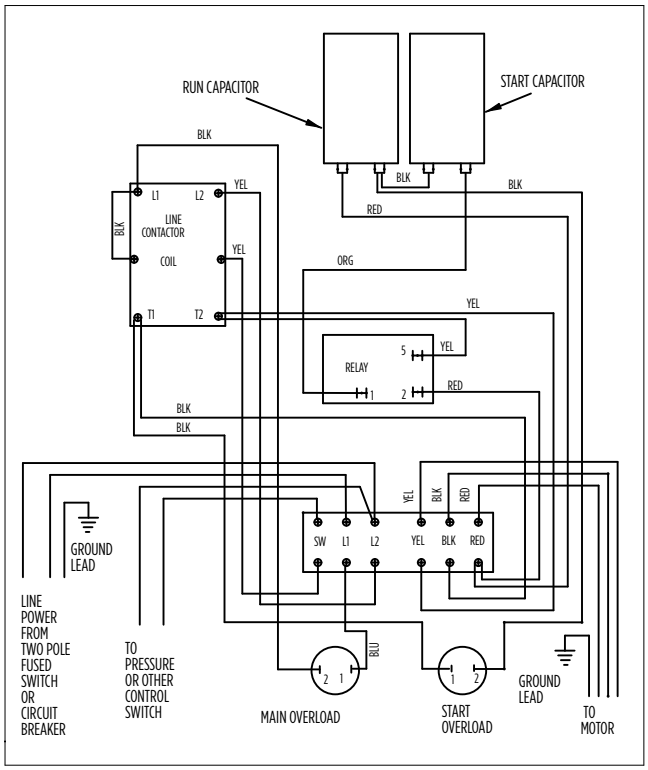
2 hp STANDARD
282 301 8110



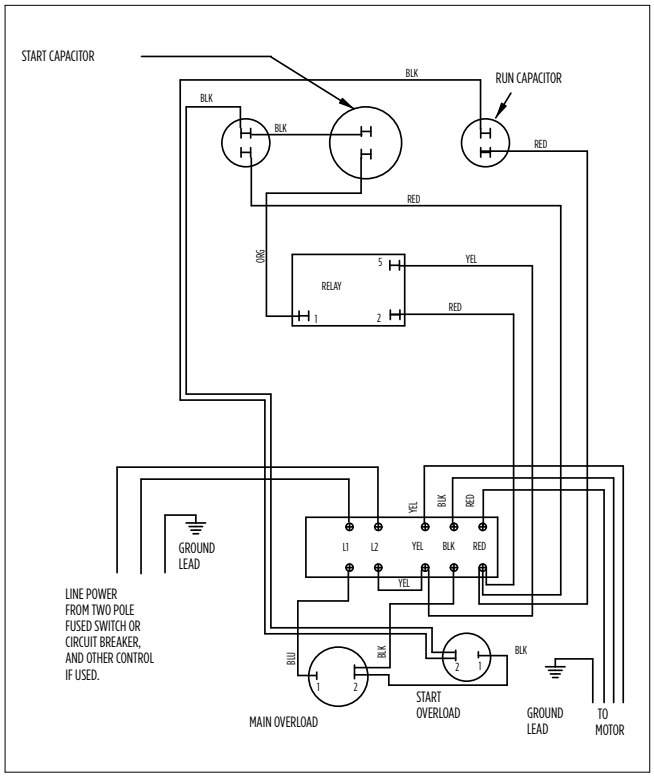
2 hp DELUXE
282 301 8310



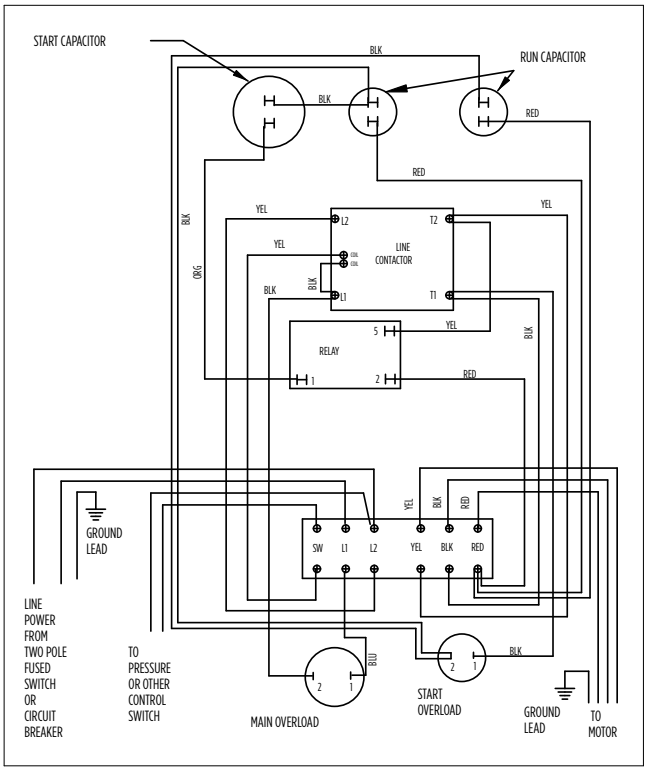
3 hp STANDARD
282 302 8110



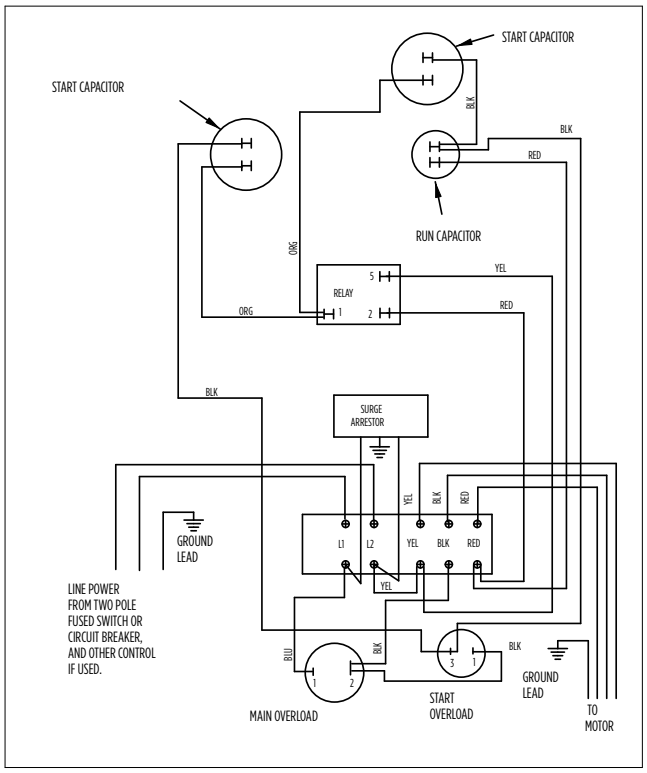
3 hp DELUXE
282 302 8310



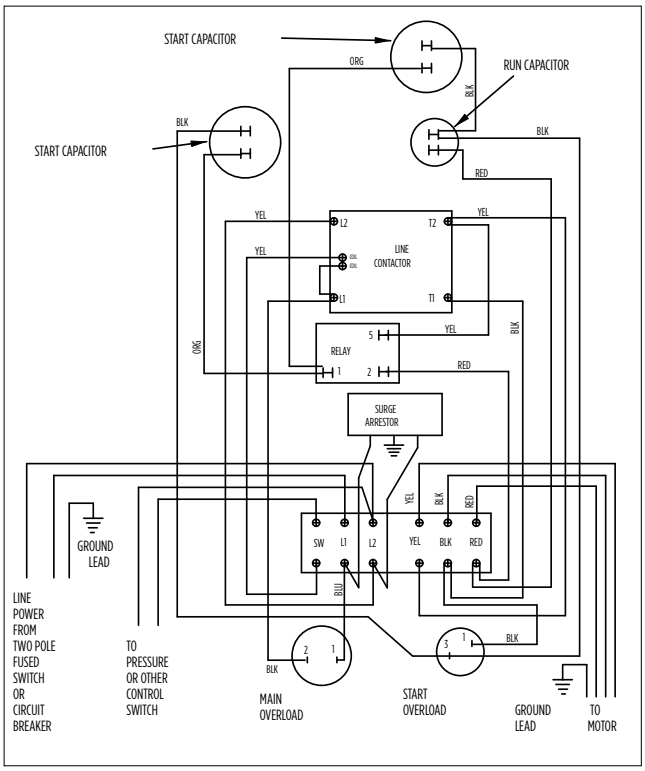
5 hp STANDARD
282 113 8110



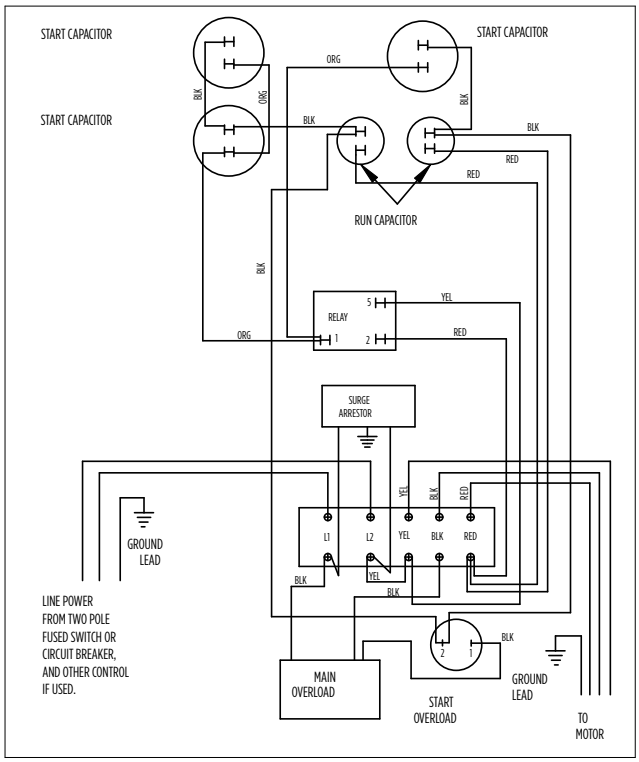
5 hp DELUXE
282 113 8310 or 282 113 9310



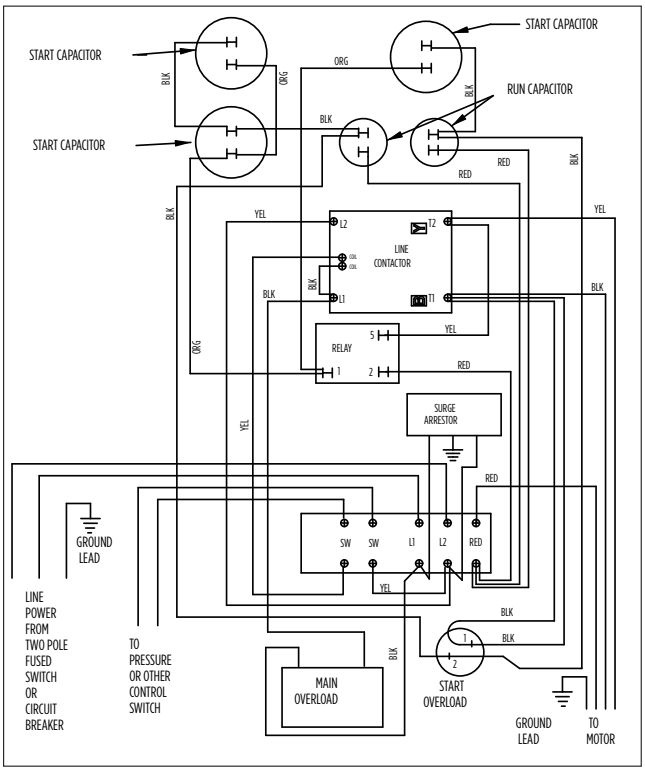
7.5 hp STANDARD
282 201 9210



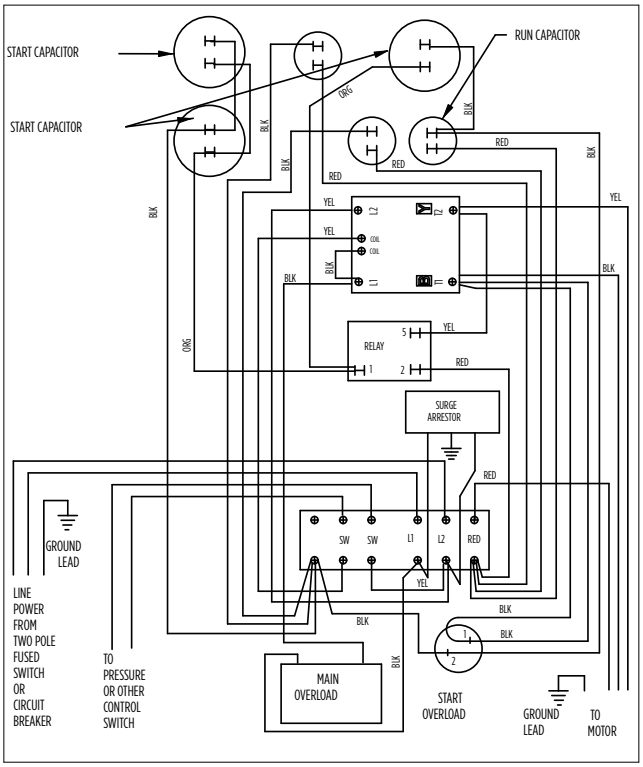
7.5 hp DELUXE
282 201 9310



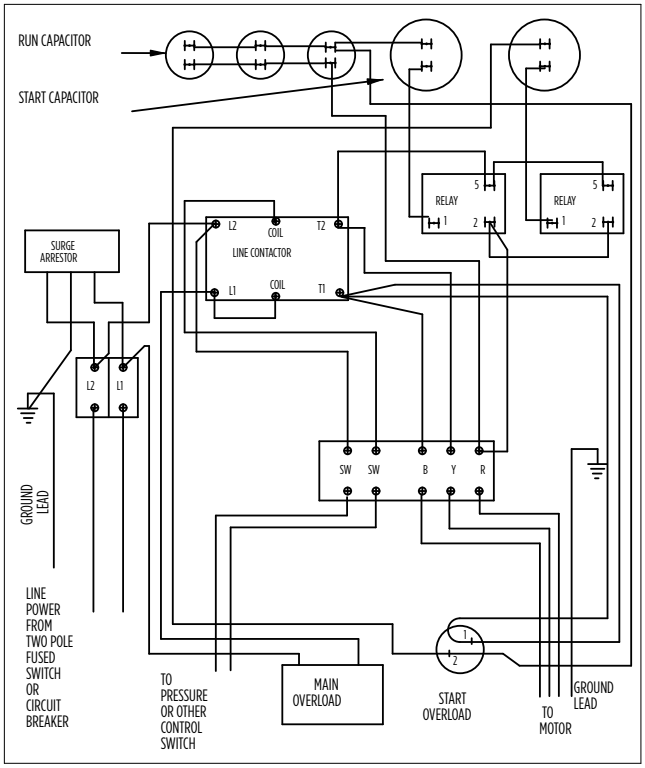
10 hp STANDARD
282 202 9210 or 282 202 9230



10 hp DELUXE
282 202 9230 or 282 202 9330



15 hp DELUXE
282 203 9310 or 282 203 9330



15 hp X-LARGE
282 203 9621

Electronic Products

APPLICATION

SubDrives & MonoDrives

The Franklin Electric SubDrive/MonoDrive controller is a variable-speed drive that delivers water at a constant pressure. MonoDrive and MonoDriveXT are designed to convert a conventional 3-wire 1/2 hp to 2 hp pump system to a variable speed constant pressure system by simply replaceing the 3-wire control box and pressure switch. The SubDrive 3-Phase models are designed for three-phase motors to provide constant pressure with three-phase performance using single-phase input power. The SubDrive2W is designed to convert a conventional 2-wire 1/2 hp, 3/4 hp and 1 hp pump system to a variable speed constant pressure system by simply replacing the pressure switch.

Applications

- Residential home
- Schools
- Restaurants
- Car washes
- Farms
- Landscape irrigation system

Protects Agianst

- Surge Protection
- Overheated Controller
- Locked pump
- Short Circuits
- Undervoltage
- Open Circuit
- Underload
- Broken pipe detection (NEMA 3R only excluding 2W)
- User-configuarable underload off time (NEMA 3R only excluding 2W)

WARNING: Serious or fatal electrical shock may result from failure to connect the motor, SubDrive/MonoDrive Controller, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires. To reduce the risk of electrical shock, disconnect power before working on or around the water system. Capacitors inside the SubDrive/MonoDrive Controller can still hold a lethal voltage even after power has been removed. Allow 10 minutes for dangerous internal voltage to discharge. Do not use motor in swimming areas.

Generator Sizing for SubDrive/MonoDrive

Basic generator sizing for the Franklin Electric SubDrive/MonoDrive system is 1.5 times maximum input Watts consumed by the drive, rounded up to the next normal sized generator.

Recommended minimum generator sizes:

MonoDrive

1/2 hp (0.37 kW) = 2000 Watts (2 kW)
3/4 hp (0.55 kW) = 3000 Watts (3 kW)
1 hp (0.75 kW) = 3500 Watts (3.5 kW)

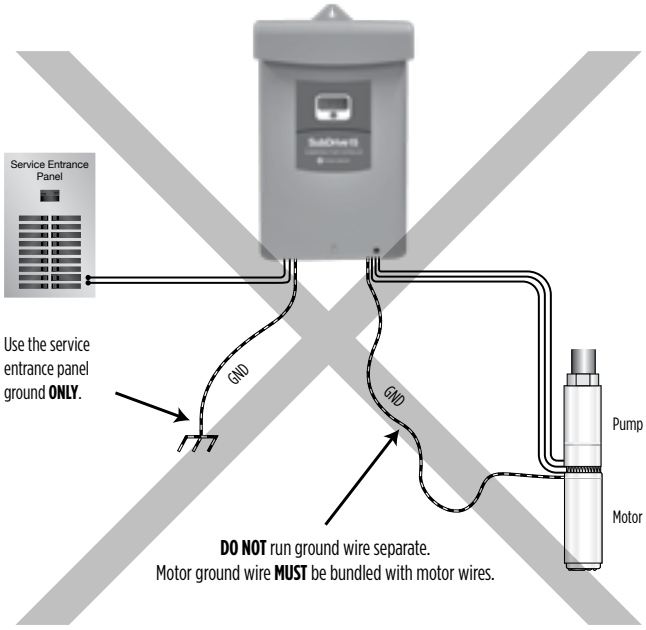
MonoDriveXT

1.5 hp (1.1kW) = 4000 Watts (4 kW)
2 hp (1.5 kW) = 5000 Watts (5 kW)

SubDrive15 = 3500 Watts (3.5 kW)
SubDrive20 = 5700 Watts (6 kW)
SubDrive30 = 7000 Watts (7 kW)
SubDrive2W = 6000 Watts (6 kW)

SubDrive75 = 3500 Watts (3.5 kW)
SubDrive100 = 5700 Watts (6 kW)
SubDrive150 = 7000 Watts (7 kW)
SubDrive300 = 11000 Watts (11 kW)
SubDrive2W = 6000 Watts (6 kW)

Note: Not to be used on a Ground Fault Circuit Interruptor (GFCI). If using an externally regulated generator, verify that the voltage and Hertz are appropriate to supply the drive.



Fuse/Circuit Breaker and Wire Sizing

The Listed fuse/Listed circuit breaker size and maximum allowable wire lengths for connection to the SubDrive/MonoDrive are given in the following tables:

Table 59: Circuit Breaker Sizing and Maximum Input Cable Lengths (in Feet)

Based on a 3% voltage drop

CONTROLLER MODEL	LISTED FUSE / LISTED CIRCUIT BREAKER AMPS	NOMINAL INPUT VOLTAGE	AWG COPPER WIRE SIZES, 167° F (75° C) INSULATION UNLESS OTHERWISE NOTED										
			14	12	10	8	6	4	3	2	1	1/0	2/0
MonoDrive	15	208	80	125	205	315	500	790	980	1290	1635	-	-
		230	95	150	250	385	615	970	1200	1580	2000	-	-
SubDrive15 / SubDrive75	15	208	70	110	185	280	450	710	880	1160	1465	-	-
		230	85	135	225	345	550	865	1075	1415	1795	-	-
SubDrive2W	20	230	-	125	205	315	505	795	985	1295	1645	-	-
MonoDriveXT	20	208	-	85	140	220	345	550	680	895	1135	-	-
		230	-	105	175	265	425	670	835	1095	1390	-	-
SubDrive20 / SubDrive100	25	208	-	-	115	180	285	450	555	730	925	-	-
	20	230	-	85	140	220	345	550	680	895	1130	-	-
SubDrive30 / SubDrive150	30	208	-	-	95	145	235	370	460	605	765	-	-
	25	230	-	-	115	180	285	455	560	740	935	-	-
SubDrive300	40	208	-	-	-	-	150	235	295	385	490	610	735
	40	230	-	-	-	115	185	290	360	470	600	745	895

XXXX Highlighted Numbers denote wire with 194° F (90° C) insulation only

Table 59A: Maximum Motor Cable Length (in feet)

CONTROLLER MODEL	FRANKLIN ELECTRIC MOTOR MODEL	HP	AWG COPPER WIRE SIZES, 140° F (60 °C) INSULATION					
			14	12	10	8	6	4
SubDrive15 / SubDrive75	234 514 xxxx	1.5 (1.1 kW)	420	670	1060	-	-	-
SubDrive20 / SubDrive100	234 315 xxxx	2.0 (1.5 kW)	320	510	810	1000	-	
SubDrive30 / SubDrive150	234 316 xxxx	3.0 (2.2 kW)	240	390	620	990	-	-
SubDrive300	234 317 xxxx	5.0 (3.7 kW)	-	230	370	590	920	-
SubDrive2W	244 505 xxxx	1/2 (.37 kW)	400	650	1000	-	-	-
	244 507 xxxx	3/4 (.55 kW)	300	480	760	1000	-	-
	244 508 xxxx	1.0 (.75 kW)	250	400	630	990	-	-
MonoDrive	214 505 xxxx	1/2 (.37 kW)	400	650	1020	-	-	-
	214 507 xxxx	3/4 (.55 kW)	300	480	760	1000	-	-
	214 508 xxxx	1.0 (.75 kW)	250	400	630	990	-	-
MonoDriveXT	214 508 xxxx	1.0 (0.75kW)	250	400	630	990	-	-
	224 300 xxxx	1.5 (1.1 kW)	190	310	480	770	1000	-
	224 301 xxxx	2.0 (1.5kW)	150	250	390	620	970	-

A 10-foot (3.05 m) section of cable is provided with the SubDrive/MonoDrive to connect the pressure sensor.

Notes:

- 1 ft = 0.305 m
- Maximum allowable wire lengths are measured between the controller and motor.
- Aluminum wires should not be used with the SubDrive/MonoDrive.
- All wiring to comply with the National Electrical Code and/or local codes.
- MonoDrive minimum breaker amps may be lower than AIM manual specifications for the motors listed due to the soft-starting characteristic of the MonoDrive controller.
- SubDrive minimum breaker amps may appear to exceed AIM manual specifications for the motors listed because SubDrive controllers are supplied from a single-phase service rather than three-phase.Amps (SFA). Motor overtemperature sensing is not provided by the drive.
- Motor Overload Portection: The drive electronics provide motor overload protection by preventing motor current from exceeding the maximum Service Factor Amps (SFA). Motor overtemperature sensing is not provided by the drive.

Pressure Tank

The SubDrive/MonoDrive needs only a small pressure tank to maintain constant pressure. (See Table X for recommended tank size.) For pumps rated 12 gpm (45.4 lpm) or more, a slightly larger tank is recommended for optimum pressure regulation. The SubDrive/MonoDrive can also use an existing tank with a much larger capacity.

Table 60: Minimum Pressure Tank Size (Total Capacity)

PUMP FLOW RATING	CONTROLLER MODEL	MINIMUM TANK SIZE
Less than 12 gpm (45.4 lpm)	SubDrive15, SubDrive 75 or MonoDrive	2 gallons (7.6 liters)
	SubDrive20 or SubDrive100	4 gallons (15.1 liters)
	SubDrive30, SubDrive150 or MonoDriveXT	4 gallons (15.1 liters)
	SubDrive300	8 gallons (30.3 liters)
12 gpm and higher (45.4 lpm)	SubDrive15, SubDrive 75 or MonoDrive	4 gallons (15.1 liters)
	SubDrive20 or SubDrive100	8 gallons (30.3 liters)
	SubDrive30, SubDrive150 or MonoDriveXT	8 gallons (30.3 liters)
	SubDrive300	20 gallons (75.7 liters)
All flows	SubDrive2W	20 gallons (75.7 liters)

Table 60A: Pressure Tank Pre-charge (PSI)

SYSTEM PRESSURE (AT PRESSURE SENSOR)	PRESSURE TANK SETTING (±2 PSI)
25	18
30	21
35	25
40	28
45	32
50 (Factory Set)	35
55	39
60	42
65	46
70	49
75	53
80	56

1 PSI = 0.068 bar
Note: Check tank pre-charge regularly to maintain optimum pressure regulation.

Table 60B: Minimum Pipe Diameter

MAXIMUM VELOCITY 8 FT/SEC. (2.4 M/S)	
MIN PIPE DIA	MAX GPM (LPM)
1/2"	4.9 (18.5)
3/4"	11.0 (41.6)
1"	19.6 (74.2)
1-1/4"	30.6 (115.8)
1-1/2"	44.1 (166.9)
2"	78.3 (296.4)
2-1/2"	176.3 (667.4)

Pumptec-Plus

Pumptec-Plus is a pump/motor protection device designed to work on any 230 V single-phase induction motor (PSC, CSCR, CSIR, and split phase) ranging in size from 1/2 to 5 horsepower. Pumptec-Plus uses a micro-computer to continuously monitor motor power and line voltage to provide protection against dry well, water logged tank, high and low voltage and mud or sand clogging.

Pumptec-Plus – Troubleshooting During Installation

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Unit Appears Dead (No Lights)	No Power to Unit	Check wiring. Power supply voltage should be applied to L1 and L2 terminals of the Pumptec-Plus. In some installations the pressure switch or other control devices is wired to the input of the Pumptec-Plus. Make sure this switch is closed.
Flashing Yellow Light	Unit Needs to Be Calibrated	Pumptec-Plus is calibrated at the factory so that it will overload on most pump systems when the unit is first installed. This overload condition is a reminder that the Pumptec-Plus unit requires calibration before use. See step 7 of the installation instructions.
	Miscalibrated	Pumptec-Plus should be calibrated on a full recovery well with the maximum water flow. Flow restrictors are not recommended.
Flashing Yellow Light During Calibration	2-Wire Motor	Step C of the calibration instructions indicate that a flashing green light condition will occur 2 to 3 seconds after taking the SNAPSHOT of the motor load. On some two-wire motors the yellow light will flash instead of the green light. Press and release the reset button. The green should start flashing.
Flashing Red and Yellow Lights	Power Interruption	During the installation of Pumptec-Plus power may be switched on and off several times. If power is cycled more than four times within a minute Pumptec-Plus will trip on rapid cycle. Press and release the reset button to restart the unit.
	Float Switch	A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on two-wire motors. Try to reduce water splashing or use a different switch.
Flashing Red Light	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
	Unloaded Generator	If you are using a generator the line voltage may become too high when the generator unloads. Pumptec-Plus will not allow the motor to turn on again until the line voltage returns to normal. Overvoltage trips will also occur if line frequency drops too far below 60 Hz.
Solid Red Light	Low Line Voltage	The line voltage is below 207 volts. Check line voltage.
	Loose Connections	Check for loose connections which may cause voltage drops.
	Loaded Generator	If you are using a generator the line voltage may become too low when the generator loads. Pumptec-Plus will trip on undervoltage if the generator voltage drops below 207 volts for more than 2.5 seconds. Undervoltage trips will also occur if the line frequency rises too far above 60 Hz.

Pumptec-Plus and Pumptec with 3-lights

Pumptec-Plus and Pumptec with 3 lights - Troubleshooting After Installation

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Solid Yellow Light	Dry Well	Wait for the automatic restart timer to time out. During the time out period, the well should recover and fill with water. If the automatic reset timer of the Pumptec-Plus is set to the manual position, push the reset button to reactivate the unit. If the reset timer is set to manual in the Pumptec, turn off power for 5 seconds to reset the unit.
	Blocked Intake	Clear or replace pump intake screen.
	Blocked Discharge	Remove blockage in plumbing.
	Check Valve Stuck	Replace check valve.
	Broken Shaft	Replace broken parts.
	Severe Rapid Cycling	Machine gun rapid cycling can cause an underload condition. See flashing red and yellow lights section below.
	Worn Pump	Replace worn pump parts and recalibrate.
Flashing Yellow Light	Stalled Motor	Repair or replace motor. Pump may be sand or mud locked.
	Float Switch	A bobbing float switch can cause two-wire motors to stall. Arrange plumbing to avoid splashing water. Replace float switch.
	Ground Fault	Check insulation resistance on motor and control box cable.
Solid Red Light	Low Line Voltage	The line voltage is below 207 volts. Pumptec and Pumptec-Plus will try to restart the motor approximately every two minutes until the line voltage is normal.
	Loose Connections	Check for excessive voltage drops in the system electrical connections (i.e. circuit breakers, fuse clips, pressure switch, and Pumptec-Plus L1 and L2 terminals). Repair connections.
Flashing Red Light	High Line Voltage	The line voltage is over 253 volts. Check line voltage. Report high line voltage to the power company.
Flashing Red and Yellow Lights	Rapid Cycle	The most common cause for the rapid cycle condition is a waterlogged tank. Check for a ruptured bladder in the water tank. Check the air volume control or snifter valve for proper operation. Check setting on the pressure switch and examine for defects.
	Leaky Well System	Replace damaged pipes or repair leaks.
	Stuck Check Valve	Failed valve will not hold pressure. Replace valve.
	Float Switch	A bobbing float switch may cause the unit to detect a rapid cycle condition on any motor or an overload condition on 2-wire motors. To reset a Pumptec, remove power for 5 seconds. To reset a Pumptec-Plus, press and release the reset button. To eliminate float switch bounce, try to reduce water splash or use a different switch.

QD Pumptec and Pumptec with 2-lights or no lights

QD Pumptec and the old 2-light version of Pumptec are load sensing devices that monitor the load on submersible pumps/motors. If the load drops below a preset level for a minimum of 4 seconds the QD Pumptec or the Pumptec will shut off the motor.

The QD Pumptec is designed and calibrated expressly for use on Franklin Electric 230 V 3-wire motors (1/3 to 1 hp.) The QD Pumptec must be installed in QD relay boxes.

The Pumptec is designed for use on Franklin Electric 2- and 3-wire motors (1/3 to 1.5 hp) 115 and 230 V. The Pumptec is not designed for jet pumps.

QD Pumptec & Pumptec – Troubleshooting

SYMPTOM	CHECKS OR SOLUTION
If the QD Pumptec or Pumptec trips in about 4 seconds with some water delivery.	A. Is the voltage less than 90% of nameplate rating? B. Are the pump and motor correctly matched? C. Is the **QD Pumptec** or **Pumptec** wired correctly? For the **Pumptec** check the wiring diagram and pay special attention to the positioning of the power lead (230 V or 115 V). Pre-2006 Pumptec used different wiring guidelines. D. For **QD Pumptec** is your system 230 V 60 Hz or 220 V 50 Hz?
If the QD Pumptec or Pumptec trips in about 4 seconds with no water delivery.	A. The pump may be airlocked. If there ia a check valve on top of the pump, put another section of pipe between the pump and the check valve. B. The pump may be out of water. C. Check the valve settings. The pump may be dead-heading. D. Pump or motor shaft may be broken. E. Motor overload may be tripped. Check the motor current (amperage).
If the QD Pumptec or Pumptec will not timeout and reset.	A. Check switch position on side of circuit board on **Pumptec**. **QD Pumptec** check timer position on top/front of unit. Make sure the switch is not between settings. B. If the reset time switch is set to manual reset (position 0), **QD Pumptec** and **Pumptec** will not reset (turn power off for 5 sec. then back on to reset).
If your pump/motor will not run at all.	A. Check voltage. B. Check wiring. C. Remove the **QD Pumptec** from the control box. Reconnect wires in box to original state. If motor does not run the problem is not **QD Pumptec**. Bypass **Pumptec** by connecting L2 and motor lead with jumper. Motor should run. If not, the problem is not **Pumptec**. D. On **Pumptec** only check that **Pumptec** is installed between the control switch and the motor.
If your QD Pumptec or Pumptec will not trip when the pump breaks suction.	A. Be sure you have a Franklin motor. B. Check wiring connections. On **Pumptec** is lead power (230 V or 115 V) connected to correct terminal? Is motor lead connected to correct terminal? C. Check for ground fault in the motor and excessive friction in the pump. D. The well may be "gulping" enough water to keep **QD Pumptec** or **Pumptec** from tripping. It may be necessary to adjust the **QD Pumptec** or the **Pumptec** for these extreme applications. Call the Franklin Electric Service Hotline at 800-348-2420 for information. E. On **Pumptec** applications does the control box have a run capacitor? If so, **Pumptec** will not trip. (Except for Franklin 1.5 hp motors).
If your QD Pumptec or Pumptec chatters when running.	A. Check for low voltage. B. Check for waterlogged tank. Rapid cycling for any reason can cause the **QD Pumptec** or the **Pumptec** relay to chatter. C. On **Pumptec** make sure the L2 and motor wires are installed correctly. If they are reversed, the unit can chatter.

SubDrive2W, 75, 100, 150, 300, MonoDrive, and MonoDrive XT

Should an application or system problem occur, built-in diagnostics will protect the system. The "FAULT" light or digital display on the front of the SubDrive/MonoDrive Controller will flash a given number of times or display a number indicating the nature of the fault. In some cases, the system will shut itself off until corrective action is taken. Fault codes and their corrective actions are listed below. See SubDrive/MonoDrive Installation Manual for installation data.

Diagnostic Fault Codes

NUMBER OF FLASHES OR DIGITAL DISPLAY	FAULT	POSSIBLE CAUSE	CORRECTIVE ACTION
1	MOTOR UNDERLOAD	- Overpumped well - Broken shaft or coupling - Blocked screen, worn pump - Air/gas locked pump - SubDrive not set properly for pump end	- Frequency near maximum with less than 65% of expected load, 42% if DIP #3 is "on" - System is drawing down to pump inlet (out of water) - High static, light loading pump - reset DIP switch #3 to "on" for less sensitivity if not out of water - Check pump rotation (SubDrive only) reconnect if necessary for proper rotation - Air/gas locked pump - if possible, set deeper in well to reduce - Verify DIP switches are set properly
2	UNDERVOLTAGE	- Low line voltage - Misconnected input leads - Dragging or failed cooling fan	- Line voltage low, less than approximately 150 VAC (normal operating range = 190 to 260 VAC) - Check incoming power connection and correct or tighten if necessary correct incoming voltage - check circuit breaker of fuses, contact power company - Disconnect fan. Re-apply system power. If 2-flash goes away, replace fan. If 2-flash continues, replace controller. Check fan with 9-volt battery.
3	LOCKED PUMP	- Motor and/or pump misalignment - Dragging motor and/or pump - Abrasives in pump - Low Insulation to Ground	- Line voltage low, less than approximately 150 VAC (normal operating range = 190 to 260 VAC) - Amperage above max amps at 10 Hz - Remove and repair or replace as required - Check line to ground with a megohmmeter - Are output leads to motor longer than 1000 feet?
4 (MonoDrive & MonoDriveXT only)	INCORRECTLY WIRED	- MonoDrive only - Wrong resistance values on main and start	- Wrong resistance on DC test at start - Check wiring, check motor size, and DIP switch setting, adjust or repair as needed
5	OPEN CIRCUIT	- Loose connection - Failed motor or drop cable - Wrong motor - Damaged controller	- Open reading on DC test at start - Check drop cable and motor resistance, tighten output connections, repair or replace as necesssary, use "dry" motor to check drive functions, if drive will not run and exhibits open circuit fault, replace drive - Check ratings - Replace controller
6	OVER CURRENT	- When fault is indicated immediately after power-up, over current is due to short circuit. Check for loose connections, defective cable, defective splice or grounded motor.	- Amperage exceeded 50 amps on DC test at start or max amps during running - Incorrect output wiring, phase to phase short, phase to ground short in wiring or motor - If fault is present after resetting and removing motor leads, replace drive
		- When fault is indicated while motor is running, over current due to loose debris trapped in pump	- Check pump
7	OVERHEATED DRIVE	- High ambient temperature - Direct sunlight - Obstruction of airflow	- Drive heat sink has exceeded max rated temperature, needs to drop below 85 °C to restart - Fan blocked or inoperable, ambient above 125 °F, direct sunlight, air flow blocked - Replace fan or relocate drive as necessary
8 (SubDrive300 only)	OVER PRESSURE	- Improper pre-charge - Valve closing too fast - Pressure setting too close to relief valve rating	- Reset the pre-charge pressure to 70% of sensor setting. Reduce pressure setting well below relief valve rating. Use next size larger pressure tank. - Verify valve operation is within manufacturer's specifications. - Reduce system pressure setting to a value less than pressure relief rating.
RAPID	INTERNAL FAULT	- A fault was found internal to drive	- Unit may require replacement. Contact your supplier.
9 (SubDrive2W only)	OVER RANGE (Values outside normal operating range)	- Wrong hp/voltage - Internal fault	- Verify motor hp and voltage - Unit may require replacement. Contact your supplier.

SubDrive15, 20, 30, MonoDrive, and MonoDriveXT (NEMA 3R)

Diagnostic Fault Codes

NUMBER OF FLASHES	FAULT	POSSIBLE CAUSE	CORRECTIVE ACTION
F1	MOTOR UNDERLOAD	- Overpumped well - Broken shaft or coupling - Blocked screen, worn pump - Air/gas locked pump - SubDrive not set properly for pump end - Underload Sensitivity setting incorrect	- Frequency near maximum with load less than configured underload sensitivity (Potentiometer or Wi-Fi) - System is drawing down to pump inlet (out of water) - High static, light loading pump - reset Potentiometer for less sensitivity if not out of water - Check pump rotation (SubDrive only) reconnect if necessary for proper rotation - Air/gas locked pump - if possible, set deeper in well to reduce - Verify DIP switches are set properly - Check Underload Sensitivity Setting (Potentiometer or Wi-Fi setting, whichever is applicable)
F2	UNDERVOLTAGE	- Low line voltage - Misconnected input leads - Loose connection at breaker or panel	- Line voltage low, less than approximately 150 VAC (normal operating range = 190 to 260 VAC) - Check incoming power connections and correct or tighten if necessary - Correct incoming voltage - check circuit breaker or fuses, contact power company
F3	OVERCURRENT / LOCKED PUMP	- Motor and/or pump misalignment - Dragging motor and/or pump - Motor and/or pump locked - Abrasives in pump - Excess motor cable length	- Amperage above SFL at 30 Hz - Remove and repair or replace as required - Reduce motor cable length. Adhere to Maximum Motor Cable Length table.
F4 (MonoDrive & MonoDriveXT only)	INCORRECTLY WIRED	- MonoDrive only - Wrong resistance values on main and start	- Wrong resistance on DC test at start - Check wiring, check motor size and DIP switch setting, adjust or repair as needed
F5	OPEN PHASE	- Loose connection - Defective motor or drop cable - Wrong motor	- Open reading on DC test at start. - Check drop cable and motor resistance, tighten output connections, repair or replace as necessary, use “dry” motor to check drive functions. If drive will not run and exhibits underload fault replace drive
F6	SHORT CIRCUIT	- When fault is indicated immediately after power-up, short circuit due to loose connection, defective cable, splice or motor	- Amperage exceeded 25 amps on DC test at start or SF amps during running - Incorrect output wiring, phase to phase short, phase to ground short in wiring or motor - If fault is present after resetting and removing motor leads, replace drive
F7	OVERHEATED DRIVE	- High ambient temperature - Direct sunlight - Obstruction of airflow	- Drive heat sink has exceeded max rated temperature, needs to drop below 194 °F (90 °C) to restart - Fan blocked or inoperable, ambient above 122 °F (50 °C), direct sunlight, air flow blocked - Replace fan or relocate drive as necessary - Remove debris from fan intake/exhaust - Remove and clean optional air screen kit (if installed)
F9	INTERNAL PCB FAULT	- A fault was found internal to drive	- Contact your Franklin Electric Service Personnel - Unit may require replacement. Contact your supplier.
F12	OVERVOLTAGE	- High line voltage - Internal voltage too high	- Line voltage high - Check incoming power connections and correct or tighten if necessary - If line voltage is stable and measured below 260 VAC and problem persists, contact your Franklin Electric Service Personnel

Power down, disconnect leads to the motor and power up the SubDrive:

- If the SubDrive does not give an “open phase” fault (F5), then there is a problem with the SubDrive.

- Connect the SubDrive to a dry motor. If the motor goes through DC test and gives “underload” fault (F1), the SubDrive is working properly.

SubDrive15, 20, 30, MonoDrive, and MonoDriveXT (NEMA 3R)

Diagnostic Fault Codes

NUMBER OF FLASHES	FAULT	POSSIBLE CAUSE	CORRECTIVE ACTION
F14	BROKEN PIPE	- Broken pipe or large leak is detected in the system - Drive runs at full power for 10 minutes without reaching pressure setpoint - Large water draw, such as a sprinkler system, does not allow system to reach pressure setpoint	- Check system for large leak or broken pipe - If the system contains a sprinkler system or is being used to fill a pool or cistern, disable the Broken Pipe Detection
F15 (SD15/20/30 only)	PHASE IMBALANCE	- Motor phase currents differ by 20% or more. - Motor is worn internally - Motor cable resistance is not equal - Incorrect motor type setting (single- or three-phase)	- Check resistance of motor cable and motor windings - Verify motor type matched drive settings (single- or three-phase)
F16	GROUND FAULT	- Motor output cable is damaged or exposed to water - Phase to ground short	- Check motor cable insulation resistance with megger (while not connected to drive). Replace motor cable if needed.
F17	INVERTER TEMPERATURE SENSOR FAULT	- Internal temperature sensor is malfunctioning	- Contact your Franklin Electric Service Personnel - If problem persists, unit may require replacement. Contact your supplier.
F18 (SD20/30/MDXT only)	PFC TEMPERATURE SENSOR FAULT	- Internal temperature sensor is malfunctioning	- Contact your Franklin Electric Service Personnel - If problem persists, unit may require replacement. Contact your supplier.
F19	COMMUNICATION FAULT	- Cable connection between Display/Wi-Fi Board and Main Control Board is loose or disconnected - Internal circuit failure	- Check cable connection between Display/Wi-Fi Board and Main Control Board. - If problem persists, unit may require replacement. Contact your supplier.
F22	DISPLAY/WI-FI BOARD EXPECTED FAULT	- Connection between Display/Wi-Fi Board and Main Control Board was not detected at drive start-up	- Check cable connection between Display/Wi-Fi Board and Main Control Board. - If problem persists, unit may require replacement. Contact your supplier.
F23	MAIN BOARD STARTUP FAULT	- A fault was found internal to drive	- Contact your Franklin Electric Service Personnel - Unit may require replacement. Contact your supplier.
F24	INVALID DIP SWITCH SETTING	- No DIP Switch set or more than one (1) DIP Switch set for Motor size - No DIP Switch set or more than one (1) DIP Switch set for Pump size - Invalid combination of DIP switches for drive type (SD or MD mode), Motor hp, and Pump hp.	- Check DIP switch settings

Power down, disconnect leads to the motor and power up the SubDrive:

- If the SubDrive does not give an “open phase” fault (F5), then there is a problem with the SubDrive.

- Connect the SubDrive to a dry motor. If the motor goes through DC test and gives “underload” fault (F1), the SubDrive is working properly.

SubDrive2W, 75, 100, 150, 300, MonoDrive, and MonoDrive XT

Troubleshooting

CONDITION	INDICATOR LIGHT	POSSIBLE CAUSE	CORRECTIVE ACTION
NO WATER	NONE	- No supply voltage present	- If correct voltage is present, replace drive
	SOLID GREEN	- Pressure sensor circuit	- Verify water pressure is below system set point - Jumper wires together at pressure sensor, if pump starts, replace sensor - If pump doesn't start, check sensor connection at printed circuit board (PCB), if loose, repair - If pump doesn't start, jumper sensor connection at PCB, if pump starts, replace wire - If pump doesn't start with sensor PCB connection jumpered, replace drive
	SOLID RED OR SOLID RED AND GREEN	- Power surge, bad component	- Power system down to clear fault, verify voltage, if repetitive, replace drive
	FLASHING RED	- Fault detected	- Proceed to fault code description and remedy
	FLASHING GREEN	- Drive and motor are operating - Loose switch or cable connection - Gulping water at pump inlet	- Frequency max, amps low, check for closed valve, or stuck check valve - Frequency max, amps high, check for hole in pipe - Frequency max, amps erratic, check pump operation, dragging impellers - This is not a drive problem - Check all connections - Disconnect power and allow well to recover for short time, then retry
PRESSURE FLUCTUATIONS (POOR REGULATION)	FLASHING GREEN	- Pressure sensor placement and setting - Pressure gauge placement - Pressure tank size and pre-charge - Leak in system - Air entrainment into pump intake (lack of submergence)	- Correct pressure and placement as necessary - Tank may be too small for system flow - This is not a drive problem - Disconnect power and check pressure gauge for pressure drop - Set deeper in the well or tank; install a flow sleeve with airtight seal around drop pipe and cable - If fluctuation is only on branches before sensor, flip DIP switch #4 to "on" (07C and newer)
RUN ON WON'T SHUT DOWN	FLASHING GREEN	- Pressure sensor placement and setting - Tank pre-charge pressure - Impeller damage - Leaky system - Sized improperly (pump can't build enough head)	- Check frequency at low flows, pressure setting may be too close to pump max head - Verify precharge at 70% if tank size is larger than minimum, increase precharge (up to 85%) - Verify that the system will build and hold pressure
RUNS BUT TRIPS	FLASHING RED	- Check fault code and see corrective action	- Proceed to fault code description and remedy on reverse side
LOW PRESSURE	FLASHING GREEN	- Pressure sensor setting, pump rotation, pump sizing	- Adjust pressure sensor, check pump rotation - Check frequency at max flow, check max pressure
HIGH PRESSURE	FLASHING GREEN	- Pressure sensor setting - Shorted sensor wire	- Adjust pressure sensor - Remove sensor wire at PCB, if drive continues to run, replace drive - Verify condition of sensor wire and repair or replace if necessary
AUDIBLE NOISE	FLASHING GREEN	- Fan, hydraulic, plumbing	- For excessive fan noise, replace fan - If fan noise is normal, drive will need to be relocated to a more remote area - If hydraulic, try raising or lowering depth of pump - Pressure tank location should be at entrance of water line into house
NO LIGHTS	NONE	- Ribbon cable detached from LED printed circuit board	- Reattach cable - if cable is attached, replace drive
RFI-EMI INTERFERENCE	FLASHING GREEN	- See interference troubleshooting procedure	

SubDrive15, 20, 30, MonoDrive, and MonoDriveXT (NEMA 3R)

Troubleshooting

CONDITION	INDICATOR LIGHT	POSSIBLE CAUSE	CORRECTIVE ACTION
NO WATER	NONE	- No supply voltage present - Display board cable disconnected or loose	- Verify cable connection between main control board and display board - If correct voltage is present, replace drive
	GREEN "---" ON DISPLAY	- Pressure sensor circuit	- Verify water pressure is below system set point - If Pressure Input Board break-away tab is removed, ensure auxiliary device is connected and closed circuit - If Pressure Input Board break-away tab is removed and no auxiliary device is being used, manually short-circuit "AUX IN" connections - Jumper wires together at pressure sensor; if pump starts, replace sensor - If pump doesn't start, check sensor connection at Pressure Input Board;. if loose, repair - If pump doesn't start, jumper sensor connection at Pressure Input Board. If pump starts, replace wire - If pump doesn't start with sensor Pressure Input Board connection jumpered, replace Pressure Input Board - If pump doesn't start with new Pressure Input Board, replace drive
	RED FAULT CODE ON DISPLAY	- Fault detected	- Proceed to fault code description and remedy
	GREEN MOTOR FREQUENCY ON DISPLAY	- Drive and motor are operating - Loose switch or cable connection - Incorrect motor or pump settings - Motor may be running backwards - Gulping water at pump inlet	- Verify Maximum Frequency setting. If this setting was reduced below maximum value, increase - Verify motor/pump ratings and match to motor/pump settings on drive (DIP switch or Wi-Fi) - Verify motor connections - Frequency max, amps low, check for closed valve, or stuck check valve - Frequency max, amps high, check for hole in pipe - Frequency max, amps erratic, check pump operation, dragging impellers - This is not a drive problem - Check all connections - Disconnect power and allow well to recover for short time, then retry
PRESSURE FLUCTUATIONS (POOR REGULATION)	GREEN MOTOR FREQUENCY ON DISPLAY	- Pressure sensor placement and setting - Pressure gauge placement - Pressure tank size and pre-charge - Leak in system - Air entrainment into pump intake (lack of submergence)	- Correct pressure and placement as necessary - Tank may be too small for system flow - This is not a drive problem - Disconnect power and check pressure gauge for pressure drop - Change tank size configuration - Set deeper in the well or tank; install a flow sleeve with airtight seal around drop pipe and cable - If fluctuation is only on branches before sensor, enable Steady Flow
RUN ON WON'T SHUT DOWN	GREEN MOTOR FREQUENCY ON DISPLAY	- Pressure sensor placement and setting - Tank pre-charge pressure - Impeller damage - Leaky system - Sized improperly (pump can't build enough head)	- Check frequency at low flows, pressure setting may be too close to pump max head - Verify precharge at 70% if tank size is larger than minimum, increase precharge (up to 85%) - Verify that the system will build and hold pressure - Enable bump and/or aggressive bump - Increase minimum frequency
RUNS BUT TRIPS	FLASHING RED	- Check fault code and see corrective action	- Proceed to fault code description and remedy on reverse side

SubDrive15, 20, 30, MonoDrive, and MonoDriveXT (NEMA 3R)

Troubleshooting

CONDITION	INDICATOR LIGHT	POSSIBLE CAUSE	CORRECTIVE ACTION
LOW PRESSURE	GREEN MOTOR FREQUENCY ON DISPLAY	- Pressure sensor setting, pump rotation, pump sizing - High temperature	- Adjust pressure sensor, check pump rotation - Check frequency at max flow, check max pressure - High ambient and/or drive temperature will cause drive to foldback power and run with reduced performance
HIGH PRESSURE	GREEN MOTOR FREQUENCY ON DISPLAY	- Pressure sensor setting - Shorted sensor wire	- Adjust pressure sensor - Remove sensor wire at Pressure Input Board, if drive stops running, wire may be shorted - Remove sensor wire at Pressure Input Board, if drive continues to run, replace Pressure Input Board - Remove sensor wire at new Pressure Input Board, if drive continues to run, replace drive - Verify condition of sensor wire and repair or replace if necessary
AUDIBLE NOISE	GREEN MOTOR FREQUENCY ON DISPLAY	- Fan, hydraulic, plumbing	- For excessive fan noise, replace fan - If fan noise is normal, drive will need to be relocated to a more remote area - If hydraulic, try raising or lowering depth of pump - Pressure tank location should be at entrance of water line into house
NO DISPLAY	NONE	- Display board cable disconnected or loose	- Verify cable connection between main control board and display board
CANNOT CONNECT TO DRIVE WI-FI	FE CONNECT LIGHT ON SOLID	- Attempting to connect to incorrect drive - Out of Wi-Fi range of drive	- Ensure the Wi-Fi SSID (hotspot name) you are connecting to matches the drive you wish to connect to - Wi-Fi range is 100 feet line-of-site, must be closer to drive if walls or floors are between you and the drive - Wi-Fi module not responding, cycle power to drive - Cycle Wi-Fi radio on mobile device, refresh Wi-Fi connection list
	FE CONNECT LIGHT OFF	- Wi-Fi timeout expired	- If more than fifteen (15) minutes since last power cycle, cycle power to drive - If more than one (1) hour since last disconnection from Wi-Fi, cycle power to drive
RFI-EMI INTERFERENCE	GREEN MOTOR FREQUENCY ON DISPLAY	- Poor grounding - Wire routing	- Adhere to grounding and wire routing recommendations - An additional external filter may be needed. See Accessories section for ordering information

SubMonitor

SubMonitor Troubleshooting

FAULT MESSAGE	PROBLEM/CONDITION	POSSIBLE CAUSE
SF Amps Set Too High	SF Amps setting above 359 Amps.	Motor SF Amps not entered.
Phase Reversal	Reversed incoming voltage phase sequence.	Incoming power problem.
Underload	Normal line current.	Wrong SF Max Amps setting.
	Low line current.	Over pumping well. Clogged pump intake. Closed valve. Loose pump impeller. Broken shaft or coupling. Phase loss.
Overload	Normal line current.	Wrong SF Max Amps setting.
	High line current.	High or low line voltage. Ground fault. Pump or motor dragging. Motor stalled or bound pump.
Overheat	Motor temperature sensor has detected excess motor temperature.	High or low line voltage. Motor is overloaded. Excessive current unbalance. Poor motor cooling. High water temperature. Excessive electrical noise (VFD in close proximity).
Unbalance	Current difference between any two legs exceeds programmed setting.	Phase loss. Unbalanced power supply. Open Delta transformer.
Overvoltage	Line voltage exceeds programmed setting.	Unstable power supply.
Undervoltage	Line voltage below programmed setting.	Poor connection in motor power circuit. Unstable or weak power supply.
False Starts	Power has been interrupted too many times in a 10 second period.	Chattering contacts. Loose connections in motor power circuit. Arcing contacts.

Electronic Products

APPLICATION

A	Amp or amperage
AWG	American Wire Gauge
BJT	Bipolar Junction Transistor
°C	Degree Celsius
CB	Control Box
CRC	Capacitor Run Control
DI	Deionized
DOL	Direct on Line
Dv/dt	Rise Time of the Voltage
EFF	Efficiency
°F	Degree Fahrenheit
FDA	Food & Drug Administration
FL	Full Load
ft	Foot
ft-lb	Foot Pound
ft/s	Feet per Second
GFCI	Ground Fault Circuit Interrupter
gpm	Gallon per Minute
HERO	High Efficiency Reverse Osmosis
hp	Horsepower
Hz	Hertz
ID	Inside Diameter
IGBT	Insulated Gate Bipolar Transistor
in	Inch
kVA	Kilovolt Amp
kVAR	Kilovolt Amp Rating
kW	Kilowatt (1000 watts)
L1, L2, L3	Line One, Line Two, Line Three
lb-ft	Pound Feet
L/min	Liter per Minute
mA	Milliamp
max	Maximum
MCM	Thousand Circular Mils
mm	Millimeter
MOV	Metal Oxide Varister
NEC	National Electrical Code
NEMA	National Electrical Manufacturer Association
Nm	Newton Meter
NPSH	Net Positive Suction Head
OD	Outside Diameter
OL	Overload
PF	Power Factor
psi	Pounds per Square Inch
PWM	Pulse Width Modulation
QD	Quick Disconnect
R	Resistance
RMA	Return Material Authorization
RMS	Root Mean Squared
rpm	Revolutions per Minute
SF	Service Factor
SFhp	Service Factor Horsepower
S/N	Serial Number
TDH	Total Dynamic Head
UNF	Fine Thread
V	Voltage
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VFD	Variable Frequency Drive
W	Watts
XFMR	Transformer
Y-D	Wye-Delta
Ω	ohms

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Heavy Duty Straight Centrifugal Pumps

- **Available in: 300 Series Investment Cast Stainless Steel, Cast Bronze and Cast Iron Construction with Stainless Steel Impeller**
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- **Viton® Mechanical Seal and O-Ring on Stainless Steel and Bronze Models**
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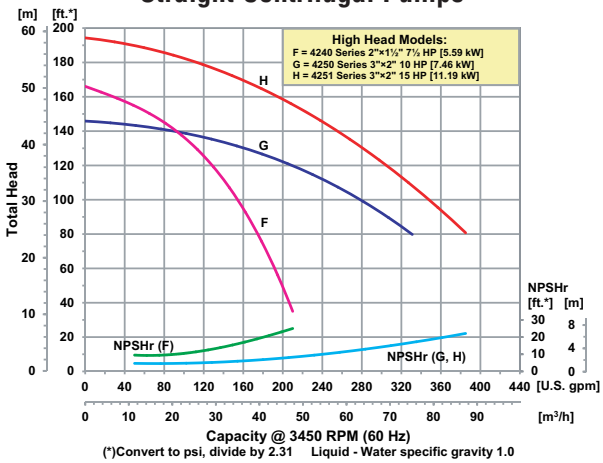
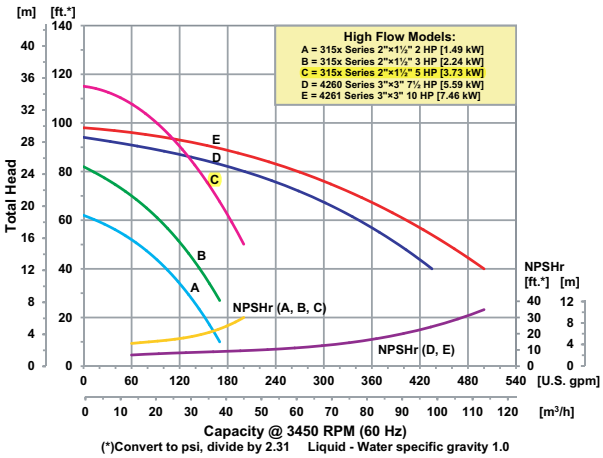
Performance of Heavy Duty Straight Centrifugal Pumps





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Heavy Duty Straight Centrifugal Pumps

Pump Dimensional & Specification Data

Model ‡	Curve	HP	PH	Frame	ENC	Voltage @ 60 Hz +	Full Load Amps	SUC*	DIS*	A**	B**	C**	D**	E	F**	G	J**	K	L**	W**	H	‡ Ship Wt. (Lbs.)
3156			1	56J		115/230	22/11			5.4 [13.8]	5.0 [12.7]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.4 [44.2]	10.6 [26.9]	9.6 [24.4]	78
3150	A	2	3	145JM	TEFC	230/460	6/3	2	1½	6.1 [15.5]	3.5 [8.9]	10.7 [27.1]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	2.7 [7.0]	1.3 [3.5]	19.2 [48.7]	11.4 [28.9]	9.6 [24.4]	84
3157			3	56J		230/460	6/3			5.4 [13.8]	3.6 [9.1]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	16.9 [42.9]	10.6 [26.9]	9.6 [24.4]	71
315A			1	56J		230	12			5.4 [13.8]	5.0 [12.7]	8.6 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.9 [45.4]	10.6 [26.9]	9.6 [24.4]	87
3151	B	3	3	182JM	TEFC	230/460	8/4	2	1½	7.1 [18.0]	6.6 [16.8]	10.9 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	20.0 [50.8]	12.8 [32.5]	9.6 [24.4]	137
315B			3	56J		230/460	8/4			5.4 [13.8]	3.6 [9.1]	8.5 [21.8]	3.5 [8.9]	2.5 [6.4]	4.0 [10.2]	4.3 [11.0]	2.4 [6.2]	1.3 [3.5]	17.4 [44.2]	10.6 [26.9]	9.6 [24.4]	75
315E	C	5	1	184JM	TEFC	230	16	2	1½	7.8 [19.9]	6.6 [16.8]	10.8 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	24.2 [61.4]	13.9 [35.3]	9.6 [24.4]	143
3152			3	184JM		230/460	17/9			7.1 [18.0]	6.6 [16.8]	10.8 [27.6]	4.5 [11.4]	2.5 [6.4]	4.0 [10.2]	4.4 [11.3]	3.7 [9.5]	0.3 [0.9]	21.7 [55.1]	12.8 [32.5]	9.6 [24.4]	145
4264	D	7½	1	213JM	TEFC	230	32	3	3	9.0 [22.9]	7.3 [18.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	27.0 [68.6]	16.2 [41.1]	12.0 [30.4]	205
4260			3	184JM		230/460	22/11			7.0 [18.0]	6.6 [16.8]	11.6 [29.5]	4.5 [11.4]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	3.7 [9.5]	1.0 [2.6]	22.5 [57.1]	14.3 [36.3]	12.0 [30.4]	172
4265	E	10	1	215JM	TEFC	230	40	3	3	9.0 [22.9]	6.2 [15.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	27.0 [68.5]	16.2 [41.1]	12.0 [30.4]	213
4261			3	215JM		230/460	26/13			8.1 [20.7]	7.3 [18.7]	12.3 [31.4]	5.2 [13.3]	2.7 [7.0]	4.5 [11.4]	4.7 [12.1]	4.2 [10.8]	0.2 [0.7]	26.0 [66.0]	15.0 [38.1]	12.0 [30.4]	204
4242	F	7½	1	213JM	TEFC	230	32	2	1½	9.0 [22.9]	7.3 [18.7]	11.3 [28.9]	5.2 [13.3]	2.4 [6.2]	3.8 [9.7]	4.4 [11.3]	4.2 [10.8]	N/A	26.0 [66.0]	14.6 [37.1]	11.1 [28.1]	196
4240			3	184JM		230/460	22/11			7.1 [18.0]	6.6 [16.8]	10.6 [27.0]	4.5 [11.4]	2.4 [6.2]	4.5 [11.4]	4.5 [11.4]	3.7 [9.5]	0.1 [0.3]	21.5 [54.6]	12.6 [32.0]	10.5 [30.6]	163
4253	G	10	1	215JM	TEFC	230	40	3	2	9.0 [22.9]	5.5 [14.2]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	26.1 [66.3]	15.9 [40.4]	10.6 [26.9]	217
4250			3	215JM		230/460	26/13			8.1 [20.7]	7.3 [18.7]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	25.2 [64.0]	14.7 [37.3]	10.6 [26.9]	208
4251	H	15	3	215JM	TEFC	230/460	47/24	3	2	8.1 [20.7]	7.3 [18.7]	11.5 [29.3]	5.2 [13.3]	2.7 [7.1]	4.7 [12.1]	5.0 [12.9]	4.2 [10.8]	0.3 [0.9]	25.2 [64.0]	14.7 [37.3]	10.6 [26.9]	218

(*) Standard NPT (Female) pipe thread.
(**) This dimension may vary due to motor manufacturer's specifications.
(+) 3-Phase motors can also operate on 50 Hz. (This will change full load amps, service factor and RPM)
NOTE: Dimensions are in inches (centimeters) and have a tolerance of ± 1/4".
NOTE: Electric supply for **ALL** motors must be within ±10% of nameplate voltage rating (e.g. 230V ±10%= 207 to 253).

NOTE: Check Price Book for Specific Pump Construction/Material Availability.
Maximum Solids Handling Capacity: 1/4" Diameter

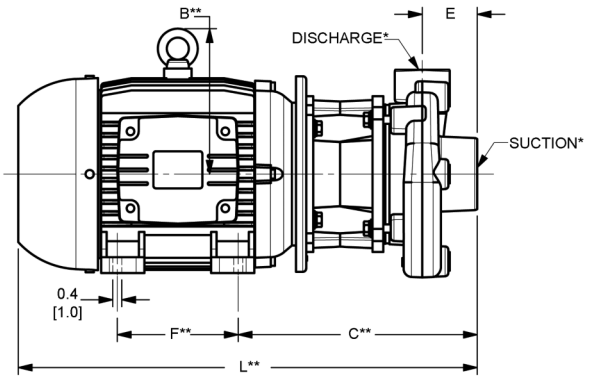
‡ When Ordering, Add the Correct (-9X) Suffix to Model Number Indicating Material Selection (Ex. 315A-95)

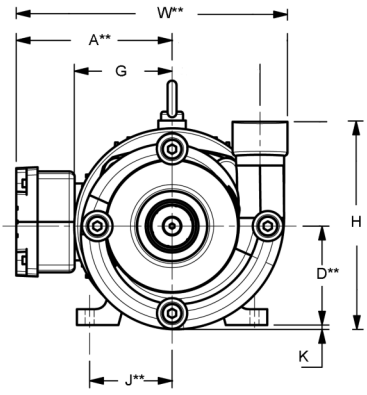
XCI (-95) Cast Iron Construction with Buna-N Seals

XB (-94) Cast Bronze Construction with Viton® Seals

XSS (-98) Cast Stainless Steel Construction with Viton® Seals

(All Models Come Standard with Stainless Steel Impeller)





Standard Features

- Stainless Steel, Bronze and Cast Bronze Construction
- Buna-N or Viton® Mechanical Seal and O-ring, Depending on Model
- Optional Silicon Carbide Mechanical Seals Available
- Stainless Steel Motor Shaft and Hardware
- NEMA TEFC Single and Three Phase Motors, Depending on Model
- Optional Mounting Base Available for 182/184/215 JM Frames
- Self-cleaning Stainless Steel Impeller
- Maximum Working Pressure 150 PSI
- Maximum Temperature
  - Viton® 200° F
  - Buna-N 180° F
- Optional Seal Wash Port and Hose Available on All Models
- Pedestal Version Models Available for Frame Models 145/182/184JM
- QSP – Quick Ship Pump for Many Models

Hazardous Duty/Xplosion Proof motors available from stock ranging from 1 to 10 HP; *CALL FOR QUOTATION & LEAD TIME!*

Manufacturer of AMT & IPT Pumps
400 Spring Street • Royersford, PA 19468 USA
www.amtpump.com • 888-amt-pump (268-7867)

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Please read and save this Repair Parts Manual. Read this manual and the General Operating Instructions carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. The Safety Instructions are contained in the General Operating Instructions. Failure to comply with the safety instructions accompanying this product could result in personal injury and/or property damage! Retain instructions for future reference. AMT reserves the right to discontinue any model or change specifications at any time without incurring any obligation.

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Periodic maintenance and inspection is required on all pumps to ensure proper operation. Unit must be clear of debris and sediment. Inspect for leaks and loose bolts. Failure to do so voids warranty.

Electric Motor-Driven Pumps

Refer to Specific Information and Repair Parts Manual for product specific information.

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SAFETY GUIDELINES

This manual contains information that is very important to know and understand. This information is provided for SAFETY and to PREVENT EQUIPMENT PROBLEMS. To help recognize this information, observe the following symbols:

⚠ DANGER

Danger indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠WARNING

Warning indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION

Caution Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

NOTE: ***Indicates important information that, if not followed, may cause damage to equipment.***

UNPACKING

When unpacking the unit, inspect carefully for any damage that may have occurred during transit. Check for loose, missing or damaged parts. (See pump exploded view and Repair Parts List.) **Do not attempt to assemble or operate pump if any parts are missing or damaged. Determine that all parts are properly installed.**

GENERAL SAFETY INFORMATION

1. Know the pump application, limitations, and potential hazards. Read all manuals included with this product carefully. Be thoroughly familiar with the pump and the proper use of the equipment.

⚠WARNING

Pump should only be used with liquids compatible with pump component materials.

⚠ DANGER

Do not use to pump flammable or explosive fluids such as gasoline, fuel oil, kerosene, etc. Do not use in flammable and/or explosive atmospheres.

When pumping hazardous or dangerous materials, use only in room or area designated for that purpose. For your protection, always wear proper clothing, eye protection, etc. in case of any malfunction. For proper handling techniques and cautions, contact your chemical supplier, insurance company and local agencies (fire dept., etc.). Failure to comply with this warning could result in personal injury and/or property damage.

2. Make certain that the power source (engine) conforms to the requirements of your equipment.
3. Provide adequate protection and guarding around moving parts.
4. Disconnect power before servicing. If the power disconnect is out of sight, lock in the open position and tag it to prevent unexpected application of power. Failure to do so could result in fatal electric shock!
5. Release all pressure within the system before servicing any component.
6. Drain all liquids from the system before servicing.
7. Secure the discharge line before starting the pump. An unsecured discharge line will whip, possibly causing personal injury and/or property damage.
8. Check hoses for weak or worn condition before each use, making certain that all connections are secure.
9. Periodically inspect pump and system components. Perform routine maintenance as required (See Maintenance section).
10. Provide a means of pressure relief for pumps whose discharge line can be shut-off or obstructed.
11. **Personal Safety:**
    a. Wear safety glasses at all times when working with pumps.
    b. Wear a face shield and proper apparel when pumping hazardous chemicals.
    c. Keep work area clean, uncluttered and properly lighted; replace all unused tools and equipment.
    d. Keep visitors at a safe distance from the work area.
    e. Make workshop childproof – with padlocks, master switches, and by removing starter keys.
12. This unit is not waterproof and is not intended to be used in showers, saunas or other potentially wet locations. The motor is designed to be used in a clean dry location with access to an adequate supply of cooling air. Ambient temperature around the motor should not exceed 104°F (40°C). For outdoor installations, motor must be protected by a cover that does not block airflow to and around the motor. This unit is not weatherproof nor is it able to be submersed in water.
13. When wiring an electrically driven pump, follow all electrical and safety codes, as well as the most recent United States National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).

⚠WARNING

Risk of Electric shock!

Electric Motor-Driven Pumps

14. **THREE-PHASE MOTORS:** These units are for permanent installation using a power supply with a ground. To reduce the risk of electric shock, electric motor must have one of the following:
    a. Adequately grounded to a metal raceway system.
    b. Use of a separate grounding wire connected to bare metal on the motor frame or to the grounding screw located inside motor terminal box.
    c. By other suitable means.

    Refer to the most recent National Electrical Code (NEC) Article 250 (Grounding) for additional information. ALL WIRING SHOULD BE DONE BY A QUALIFIED ELECTRICIAN.

    On three-phase power, voltages on all three lines should be balanced within 1%. Unbalanced voltages cause motor overheating and poor performance.

⚠WARNING

Risk of Electric Shock! Never connect the green (or green and yellow) wire to a live terminal!

15. **SINGLE PHASE MOTORS:** These units can be wired for either portability with flexible 3-wire cord, or permanent installation using a supply with a ground. To reduce the risk of electric shock, the motor must be securely and adequately grounded! This can be accomplished by either (1) inserting plug (portable) directly into a properly installed and grounded 3-prong grounding type receptacle (as shown in Figure A for 110-120 volt, or Figure B for 220-240 volt) (2) permanently wiring the unit with a grounded, metal raceway system (3) using a separate ground wire connected to the bare metal of the motor frame or (4) other suitable means. The green (or green and yellow) conductor in the cord is the grounding wire.

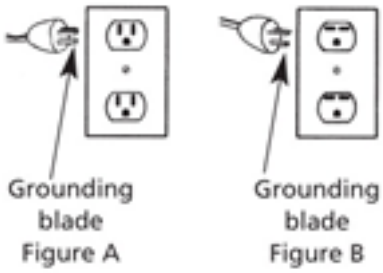

Figure 1 - Grounding Methods

    Where a 2-prong wall receptacle is encountered, it must be replaced with a properly grounded 3-prong receptacle installed in accordance with the National Electrical Code, local codes and ordinances. To ensure a proper ground, the grounding means must be tested by a qualified electrician.
16. Use only 3-wire extension cords that have 3-prong grounding type plugs and 3-pole receptacles that accept the equipment plug.
17. All wiring should be performed by a qualified electrician.
18. Protect electrical cord from sharp objects, hot surfaces, oil and chemicals. Avoid kinking the cord. Replace or repair damaged or worn cords immediately.
19. Keep fingers and foreign objects away from ventilation and other openings. Do not insert any objects into the motor.
20. Use wire of adequate size to minimize voltage drop at the motor.
21. Disconnect power before servicing a motor or its load. If the power disconnect is out of sight, lock it in the open position and tag it to prevent unexpected application of power.
22. Do not touch an operating motor. Modern motors are designed to operate at high temperatures.

⚠WARNING

Do not handle a pump or pump motor with wet hands, when standing on a wet or damp surface or in water.

⚠WARNING

Specific single phase pump motors are equipped with an automatic resetting thermal protector and may restart unexpectedly. Protector tripping is an indication of motor overloading as a result of operating the pump at low heads (low discharge restriction), excessively high or low voltage, inadequate wiring, incorrect motor connections or a defective motor or pump. A motor equiped with a automatic thermal protection will be inidicated on the motor nameplate

INSTALLATION

⚠WARNING

The pumps should not be used in flammable or explosive atmospheres. In order to safely use this product, familiarize yourself with this pump and also with the liquid (chemical, etc.) that is going to be pumped through the unit. This pump is not suitable for many liquids.

For installations where property damage might result from an inoperative or leaking pump due to power outages, discharge line blockage or any other reason, a backup system(s) should be used.
Failure to follow any warning can result in personal injury and/or property damage.

LOCATION

a. **Open Drip Proof Motor** - Clean dry locations with access to an adequate supply of cooling air.
b. **Totally Enclosed Motor** - Harsher environments where damp and dirty conditions may exist. Totally enclosed motors are not water proof.
c. Use only UL listed **Hazardous Location** motors for service in **Hazardous Locations** as defined in Article 500 of the NEC.
d. Temperature around the motor should not exceed 104°F (40°C). Minimum temperature is -20°F (29°C).
e. If the motor nameplate indicates “Air-Over, Cont. A.O.,” etc., the motor must be mounted in the air stream of an air moving device.

1. Locate pump as close to the fluid source as possible, thus making the suction line short and direct as possible.

⚠ CAUTION

The unit should be placed where the motor and electrical components are protected from the weather and extremes of heat, cold and humidity.

2. Attach piping suction line to suction inlet and piping discharge line to discharge outlet. Avoid using looped section of pipe or fittings, which might permit air to ensure airtight pipe connections.

IMPORTANT: If plastic or fabric hose is used for the suction piping, it should be of a reinforced type so as not to collapse under suction. The suction piping should be one size larger than the discharge piping.

Electric Motor-Driven Pumps

3. Support the piping independently of the pump to avoid universal or excessive stresses on the pump casing, which would cause impeller misalignment and possible pump failure.
4. Install both a union and a gate valve (not furnished) on the discharge side of the pump for service convenience.

⚠ CAUTION

Do not use a globe or other restricting type of valve at the discharge. Globe valves seriously restrict the capacity of the pump; however, restricting the discharge of a centrifugal pump will not overload the drive motor.

5. **SELF-PRIMING PUMPS:** It is recommended that a foot valve be used on the suction line to assure quick priming and that a suitable suction strainer be attached to the suction line so that large pieces of foreign material are not drawn into the pump.
    a. Locate pump as close to the fluid source as possible making the suction line as short and direct as possible.

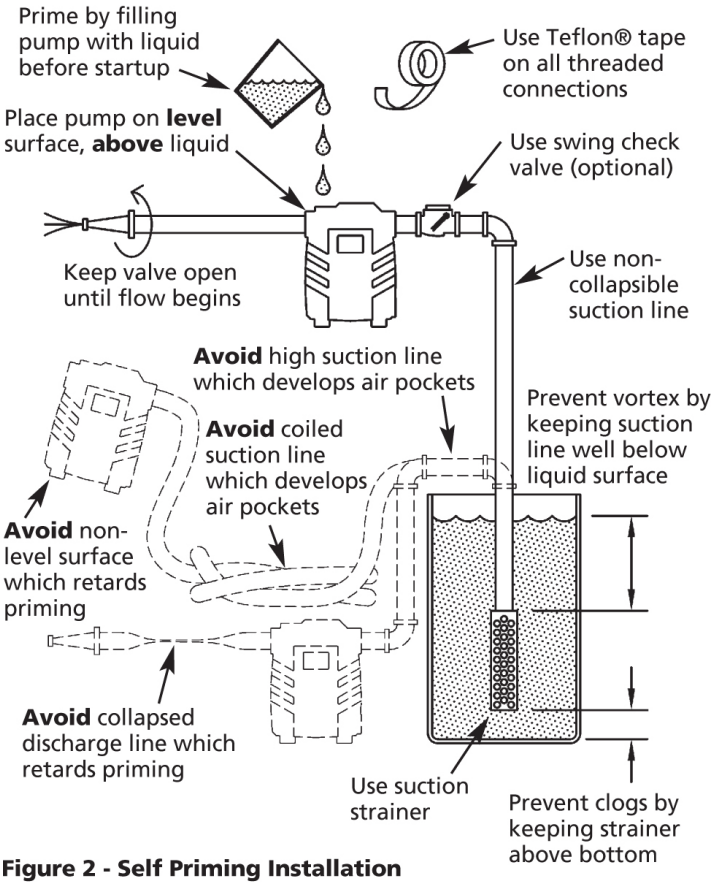

Figure 2 - Self Priming Installation

    b. The suction line should be positioned such that there is a continual upward slope from the fluid source to the pump. Avoid using loops or sections of pipe or fittings which might permit air to become trapped.
    c. Suction piping should be the same size as the discharge piping.

6. **WIRING:** For proper electrical connections, refer to the diagram located on the nameplate or inside the terminal of the motor. Make sure the connections are correct for the voltage being supplied to the motor. Connections should be made with flexible conduit to minimize vibration transmission.

    Whenever possible, the pump should be powered from a separate branch circuit of adequate capacity to keep voltage drop to a minimum during starting and running.

    Select the voltage to be used, either
    a. Single phase - 115V or 230V
    b. Three phase - 230V or 460V

    Check motor wiring to verify which voltage the motor is currently wired for. If the wiring must be changed to conform to a specific voltage requirement, then the motor should be wired according to recommendations of wiring diagrams located on motor nameplate or wiring compartment cover. Make sure unit is properly grounded. A motor to be used with single phase power cannot be used with three phase power and vice versa. If unsure about the above information or the wiring diagrams, consult an electrician familiar with motor wiring.

⚠WARNING

A wrong connection can burn out the pump motor, cause an electrical short or produce an electrical shock. Failure to follow the above warning can result in property damage and/or personal injury. Always wire the motor with a three-wire system, ensuring that a ground wire runs to a good electrical ground such as a grounded water system or conduit. Also, ensure that a good electrical ground is provided at the supply end of the line. Connections should be made with flexible conduit to minimize vibration transmission.

7. Do not operate pump dry. Mechanical seal damage will result.
8. Install any auxiliary components (e.g. pressure switch, time).

OPERATION

SELF-PRIMING PUMPS

It is necessary to prime the pump before initial startup. Prime the pump by filling the casing with liquid through the top fill plug, the discharge port, or by installing a pipe tee at the discharge of the pump. (When installing a tee, use the horizontal leg of the tee as the pump discharge and place a pipe plug in the vertical leg. This procedure will help facilitate priming later.)

NON-PRIMING PUMPS

1. The casing and suction piping must be filled with liquid before the unit can begin pumping. In order to completely fill casing with liquid, entrapped air in casing must be vented. This is accomplished by momentarily loosening or removing the top drain plug located on the casing.

⚠ CAUTION

Do not run pump dry as permanent damage to the mechanical seal will result.

2. Activate the unit.

IMPORTANT: Proper Rotation- Power supply should be applied momentarily to the pump at first and the direction of rotation checked. When viewing the front of the pump, the motor shaft (impeller) should be rotating counterclockwise. If it is not, disconnect power and re-check wiring to motor. (See “Installation” section.) To change rotation on three phase models, interchange any two incoming line (power) leads. Other models, consult driver information that came with driver.

NOTE: Never shut off discharge or restrict suction flow while the pump is operating. It may take up to 5 minutes for a **SELF-PRIMING** pump to prime if

Electric Motor-Driven Pumps

long horizontal/ vertical lines are used. If pump has not picked up prime in 2 minutes, re-prime piping and casing after letting unit cool down for 5 minutes. Re-check all suction connections making sure pipe compound has sealed all connections. Initial priming may take 2 to 3 tries to prime successfully.

⚠ CAUTION

The proper Impeller (motor) rotation is CCW (counter clockwise) facing the front of the pump. Wrong rotation will give low performance, low head and could damage unit and/or injure personnel.

3. On initial start-up (after 15 minutes running time), check power consumption to be sure motor is not overloaded.
4. If motor is overloaded, install a valve on discharge to increase back pressure. Close the valve until pump motor is below full nameplate or within Service Factor (SF) amps.

MAINTENANCE

⚠WARNING

Make certain that the unit is disconnected from the power source before attempting to service or remove any components!

NOTE: Always flush pump thoroughly after use or if unit is not going to be used for any prolonged length of time to prevent crystallization and/or damage to seal and pump.

ROUTINE

1. Pump should be drained when subjected to freezing temperatures. A drain plug is provided on the pump casing.
2. Clean the suction line strainer at regular intervals.
3. Properly selected and installed electric motors are capable of operating for years with minimal maintenance. Periodically clean dirt accumulations from open-type motors, especially in and around vent openings, preferably by vacuuming (avoids imbedding dirt in windings).
4. Periodically check to see if electrical connections are tight.
5. Pump should be checked daily, weekly, monthly, etc. for proper operation. If anything has changed since unit was new, unit should be removed and repaired or replaced. Only qualified electricians or service personnel should attempt to repair this unit. Improper repair and/or assembly can cause an electrical shock hazard.

TROUBLESHOOTING CHART

Problem	Possible Cause(s)	Corrective Action
Motor will not start or run	1 Improperly wired.	1 Check wiring diagram on motor.
	2 Blown fuse or open circuit breaker.	2 Replace fuse or close circuit breaker after reason for overload has been determined and corrected.
	3 Loose or broken wiring.	3 Tighten connections, replace broken wiring.
	4 Stone or foreign object lodged in impeller.	4 Disassemble pump and remove foreign object.
	5 Motor shorted out.	5 Replace.
	6 Thermal overload has opened circuit.	6 Allow unit to cool. Restart after reason for overload has been determined.
	7 Voltage too low at motor terminals due to line drop.	7 Consult local power company. Increase wire size. Check for poor connections.
Motor runs slowly; will not get up to speed	1 Motor wired improperly.	1 Check and recheck wiring diagram on motor. Make internal wiring changes in wiring compartment.
	2 Capacitor burned out (single phase units only).	2 Replace capacitor.
	3 Voltage too low at motor terminals.	3 Increase wire size. Check for poor connections. Check for voltage unbalance (3 phase).
Motor overheats while running under load	1 Dirt blocking ventilation openings.	1 Clean Motor.
	2 Unbalanced supply voltage.	2 Check for faulty connections. Voltage on all three lines should be balanced within 1%. Excessive single phase loads.
	3 Faulty connection.	3 Clean, tighten, or replace.
	4 High or low voltage.	4 Check voltage at motor, should not be more than 10% above or below rated.
Pump will not prime	1 No priming water in casing.	1 Fill pump casing.
	2 Mechanical seal is leaking.	2 Replace (See Maintenance).
	3 Leak in suction line.	3 Use threaded sealant on piping, tighten, repair or replace.
	4 Discharge line is closed and priming air has nowhere to go.	4 Open.
	5 Suction line (or valve) is closed.	5 Open.
	6 Pipe union was used on suction side instead of discharge.	6 Remove union from suction side. Replace with single section of pipe.
	7 Pump is worn.	7 Replace worn parts.

TROUBLESHOOTING CHART (continued)

Problem	Possible Cause(s)	Corrective Action
Little or no discharge	1 Casing not filled with water.	1 Fill pump casing with liquid.
	2 Total head too high.	2 Shorten suction lift and/or discharge head.
	3 Suction head too high.	3 Lower suction head, install foot valve and prime.
	4 Impeller plugged.	4 Disassemble pump and clean impeller.
	5 Rotation incorrect.	5 Correct (See wiring diagram on motor)
	6 Hole or air leak in suction line.	6 Repair or replace suction line.
	7 Foot valve was too small.	7 Match foot valve to piping or install one size larger foot valve.
	8 Impeller damaged.	8 Replace.
	9 Foot valve or suction line not submerged deep enough in water.	9 Submerge lower in water.
	10 Suction piping too small.	10 Increase to pump inlet size or one size larger.
	11 Discharge piping too small.	11 Match to discharge outlet size on pump.
	12 Motor wired incorrectly.	12 Check wiring diagram.
	13 Casing gasket leaking.	13 Replace.
	14 Suction or discharge line valve closed.	14 Open.
	15 Single phase, new installation. Motor wired for 230V, etc. but supply is 115V, etc.	15 Check voltage of incoming power supply. Rewire as necessary.
	16 Mechanical seal is leaking.	16 Replace (See Maintenance).
Loss of suction	1 Air leak in suction line.	1 Use threaded sealant on piping, tighten, repair or replace.
	2 Suction lift too high.	2 Lower suction lift, install foot valve and prime.
	3 Clogged foot valve or strainer.	3 Clean.
Pump vibrates and/or makes excessive noise	1 Mounting plate or foundation not rigid enough.	1 Reinforce.
	2 Foreign material in pump.	2 Disassemble pump and clean.
	3 Impeller damaged.	3 Replace.
	4 Worn motor bearings.	4 Replace.
	5 Suction lift too high.	5 Decrease suction lift.
	6 Cavitation present.	6 Check suction line for proper size and be sure valve is open. Remove excessive lops in suction line. Install gate valve on discharge side of pump and reduce flow as necessary to match suction conditions available.
Pump leaks at shaft	1 Damaged or worn mechanical seal.	1 Replace (See Maintenance).
	2 Corrosion due to character of liquid pumped.	2 Discontinue pumping liquid and consult factory.
	3 Abrasive material in liquid causing an accumulation around the rotating assembly which results in faces opening up and allowing grit between them.	3 Pump not designed for abrasives. Discontinue use
	4 Liquid not compatible with seal.	4 Consult factory. Operational seal may be available.
	5 Temperature too high.	5 Lower liquid temperature below temperature rating of pump, See Specifications.
Pinholes in casting, drips around seal area	1 Cavitation caused by insufficient inlet pressure or suction head (NPSH).	1 Increase inlet pressure by adding a higher liquid level of fluid to source, increasing inlet pressure, or remove piping restrictions(valves, lops, etc.) in suction line.

AMT Pump Company
(herein "AMT")
400 Spring Street
Royersford, PA 19468
Phone: (610) 948-3800
Fax: (610) 948-5300
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General Information

SALES POLICY: AMT products are sold through our established Distributors. We do not sell direct to the consumer or organization not entitled to trade recognition. Therefore, possession of our catalogs and/or price list(s) does not infer an offer to sell.

MINIMUM ORDER: We appreciate your order, however, all orders are subject to a minimum $35.00 net invoice charge (excluding freight). This applies to all pump and parts purchase orders.

PRICES: Prices are subject to change without notice. All orders accepted are subject to prices in effect at time of shipment.

PAYMENT TERMS: Terms, upon establishment of credit, are Net 30 days. Past due accounts may be subject to a service charge of 1.5% per month. Domestic or assignable letter of credit is required for all export trade.

PAST DUE ACCOUNTS: AMT reserves the right to withhold open account shipments on any past due account. Invoices are considered past due after thirty (30) days. In the interest of sound business, all orders are subject to approval of the Credit Department.

SHIPPING INSTRUCTIONS: All shipments will be made F.O.B. the factory. Where instructions for shipment do not appear on the order, the shipment will be made according to our best judgment. Full risk of loss (including transportation delays and losses) shall pass to the customer upon delivery of the products to the carrier at the F.O.B. point. When loss or delay occurs, primary responsibility for tracing rests with the customer. When there is LOSS or APPARENT VISIBLE DAMAGE to a shipment, when tendered for delivery, *DO NOT* give the carrier a clear receipt. Note such damage on the carrier's delivery receipt and *HAVE THE DRIVER SIGN THE RECEIPT.*

PRODUCT REVISIONS: AMT reserves the right to discontinue, change or improve its products or any portions thereof without being obligated to provide such a change or improvement for units sold and/or shipped prior to such a change or improvement.

LEAD TIME: Products designated "Quick Ship Product", also referred to as "QSP" will normally be shipped within 24 hours of receipt of a non-cancellable purchase order. Only limited quantities of "QSP" pumps are available.

STANDARD LEAD TIME: Lead time is two weeks for all non "QSP" product. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control.

VIP SHIPMENT: Select AMT and IPT branded pumps are available for next day shipment for non-QSP (Quick Ship Products) items and subjected to a specific model surcharge per unit noted in the respective price book. Requires calling for availability, confirmation and a non-cancellable purchase order or credit card payment prior to shipment. The expedited shipping charges are an additional cost added separately from the VIP charges per item. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control. QSP quantities are limited as determined by AMT.

ALL purchase orders must be submitted via hard copy sent to AMT customer service department by fax, EDI or e-mail.

RETURN GOODS POLICY: Goods shall not be returned without a return goods authorization number (RGA) issued by AMT customer service. The RGA number must be listed on the packing list. Only current model and part numbers with a valid date code may be returned (within one year from date of purchase). **A 20% restocking and packaging charge will apply to all returns. All shipping charges must be pre-paid. No exceptions.**

ORDER CHANGES BY CUSTOMER: Orders in process may not be changed except with written consent and may be subject to special charges.

12 Month Limited Warranty

EXTENT AND DURATION OF LIMITED WARRANTY

Coverage: AMT Pump Company (herein "AMT") or IPT Pumps by Gorman-Rupp (herein "IPT") or Gorman-Rupp Industries Division of the The Gorman-Rupp Company, Patterson, or the Gorman-Rupp Company (herein referred to as "G-R Unit) each individually warrants that its products and parts shall be free from defects in material and workmanship for twelve (12) months from the date of purchase by the original end user when installation is made and maintenance is performed in accordance with G-R Unit's recommendations. Wear and tear resulting from use and items normally consumed in use are not covered.

EXCEPTIONS

(A) This Limited Warranty shall not apply to mechanical seals in AMT or IPT pumps and the following products and parts: engines, motors, trade accessories and all other products, components, parts and materials not manufactured by the G-R Units. These items may, however, be covered by the warranties of their respective manufacturers. (B) This warranty does not extend to or apply to any unit which has been repaired or altered at any place other than by a G-R Unit, or by persons not expressly approved by a G-R Unit to make repairs or alterations, nor to any unit the serial number, model number or identification of which has been removed, defaced or altered. (C) This warranty does not extend to any product manufactured by a G-R Unit, which has been subjected to mis-use, neglect, accident, improper installation, or use in violation of instructions furnished by a G-R Unit. (D) Pump Kits: This warranty does not extend to any product sold by a G-R Unit unassembled as a Pump Kit. Pump Kits are warranted against defects in material and workmanship for 60 days from the date of shipment from a G-R Unit. Any Pump Kit parts deemed defective by a G-R Unit will be replaced free of charge within 60 days of shipment. Pump Kits are not returnable for credit.

LIMITATIONS

THE G-R UNITS' SOLE AND EXCLUSIVE WARRANTY WITH RESPECT TO THEIR PRODUCTS AND PARTS IS THIS LIMITED WARRANTY. THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND/OR IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDY AND DAMAGES

The sole and exclusive remedy for breach of this Warranty by a G-R Unit and the entire extent of its liability for such breach or for damages arising from the use of the products and parts covered under this Limited Warranty, shall be as follows:

1. **Repair or Replacement:** If inspection shows that any G-R Unit product or part covered under this Limited Warranty is defective in materials or workmanship, the G-R Unit shall repair or replace the defective or non-conforming product or part without charge, whichever the G-R Unit chooses. You must have properly maintained and used the product or part claimed to be defective in accordance with the maintenance schedule or manual, which comes with the product. No allowance will be made for labor, installation, removal, transportation or other charges incurred by you in connection with such repair or replacement.
2. To obtain the above remedy:
    A. Immediately notify the G-R Unit upon discovery of the claimed defect in materials or workmanship and provide the serial number or date code of the product and/or part(s) or provide the G-R Unit with the invoice or bill of sale referencing the product by no later than the expiration date of the warranty period.
    B. The G-R Unit will advise whether inspection will be necessary and how whether repair or replacement will be made. If inspection by the G-R Unit is necessary, the pump or defective part must be sent freight pre-paid to the G-R Unit. Return shipment will be F.O.B. the G-R Unit's plant.
    C. **Return Goods Authorization Requirement:** No product will be accepted for return or replacement without the prior written authorization of the G-R Unit. Upon such authorization, and in accordance with instructions from the G-R Unit, the product will be returned to the G-R Unit, shipping charges prepaid by the Buyer.

3. **Damages:** The G-R Unit's liability for damages for breach of this Limited Warranty shall not exceed the amount of the purchase price of the product or part(s) in respect to which Such damages are claimed. **IN NO EVENT SHALL THE G-R UNITS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES FOR BREACH OF THIS LIMITED WARRANTY.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This Limited Warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

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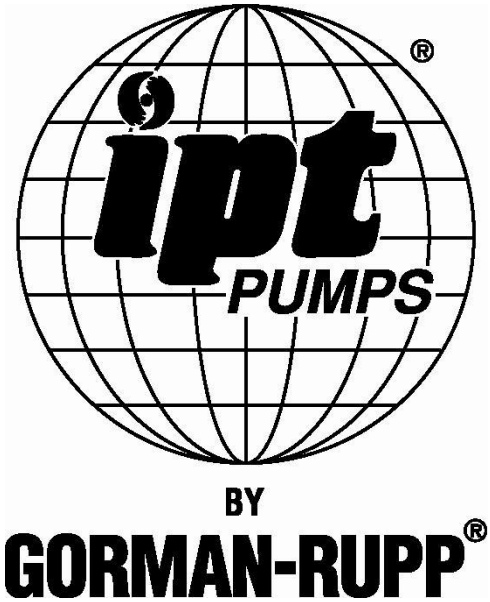

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Periodic maintenance and inspection is required on all pumps to ensure proper operation. Unit must be clear of debris and sediment. Inspect for leaks and loose bolts. Failure to do so voids warranty.

CENTRIFUGAL PUMPS

Refer to pump manual 1808-634-00 for General Operating and Safety Instructions.

AMT® A Gorman-Rupp Company

DESCRIPTION

These non self-priming centrifugal pumps are intended for liquid transfer, heating and cooling circulation, booster service and other industrial applications where no suction lift is required.

All models feature a semi-open clog resistant impeller and a pull-from-the-rear design for easy servicing. A dual volute casing is used on all models except 4240. A mechanical seal (comprised of carbon, ceramic and stainless steel components) isolates motor shaft from liquid being pumped. Discharge port on pump casing can be rotated in 90° increments with vent and drain plugs for all positions. Buna seals handle liquids from 40° to 180° F (4° to 82° C).Viton® seals handle liquids from 40º to 200º F(4º to 90º C) Maximum ambient temperature 104° F (40° C). Casing working pressure to 100 psi (689 kPa). These are manual units, no controls are supplied. For use with nonflammable, non-abrasive liquids compatible with pump component materials.

INSTALLATION

Flooded Suction: Net Positive Suction Head Required (NPSHR). Curve with NPSHR available at www.amtpump.com.

1. Problems will arise in operation of this pump unless the recommended NPSHR is supplied to the pump (See “Troubleshooting”chart in 1808-634- 00 manual).
2. Salt Water Usage: Because of crystallization and erosive material on the shaft seal (Ref. Nos. 9, 10), we recommend installation of seal-wash hose (Ref. No. 21). Using a wrench, remove the pipe plug (Ref. No. 20) from adapter (Ref. No. 18) and pipe plug (Ref. No. 15) from casing (Ref. No. 14) (remove pipe plug on the 3 o’clock position). Install optional seal wash hose.

NOTE: Applicable only with pumps having (A220-90) seal wash and hose installed or by ordering casing (Ref. #18) with optional seal wash and hose installation (A220-90).

MAINTENANCE

⚠ WARNING

Make certain that unit is disconnected from power source before attempting to service or remove any component.

REMOVAL OF OLD SEAL

Refer to Figure 1 for seal location.

IMPORTANT: Always replace both seal seat (Ref. No. 9) and seal head (Ref. No. 10) to ensure proper mating of components! Also, impeller seal (Ref. No. 16) (where applicable) should be replaced any time impeller fastener (Ref. No. 13) has been removed.

1. Remove fasteners (Ref. No. 6) that connect adapter (Ref. No. 3) to casing (Ref. No. 14).
2. Remove casing and 0-ring (Ref. No. 8).

⚠ CAUTION

Care should be taken not to pinch or “shave” o-ring between adapter and casing.

3. Using a wrench, remove impeller fastener, impeller seal (where applicable) and impeller (Ref. No. 12).

IMPORTANT: Care should be taken to ensure that the same number of shim washers (Ref. No. 11) are replaced behind impeller as were removed. These shim washers are located directly behind impeller. These washers as well as impeller key (Ref. No. 19) (where applicable) become loose as impeller is removed.

4. Seal head and shaft sleeve (Ref. No. 17) (where applicable) can now be pulled from shaft.
5. Pry seal seat from adapter.
6. Push seal head from shaft sleeve (where applicable).

INSTALLATION OF NEW SEAL

⚠ CAUTION

The precision lapped faces on shaft seal are easily damaged. Handle your replacement seal carefully.

1. Thoroughly clean all surfaces of seal seat cavity.
2. Using a clean cloth, wipe shaft and shaft sleeve (where applicable) and make certain that they are perfectly clean.
3. Wet rubber portion of new seal seat with a light coating of soapy water. While wearing clean gloves or using a clean light rag, press seal seat squarely into adapter recess. Avoid scratching white ceramic surface. If seat will not position properly, place a cardboard washer over polished surface and use a piece of pipe to press in firmly, but gently
4. Dispose of cardboard washer. Check again to see that polished surface is free of dirt and all other foreign particles and that it has not been scratched or damaged.
5. Wet inside rubber portion of new seal head with a light coating of soapy water. Slide head onto shaft/shaft sleeve.

Centrifugal Pumps

Slide shaft sleeve with seal head onto motor shaft (where applicable). Seal head and seal seat will meet. Reinstall any shims that have been removed (See “Shim Adjustment” section).

IMPORTANT: Before installing new shaft sleeve, apply a bead of non-hardening, pliable sealant (such as Permatex® Form-A-Gasket® No. 2) to motor shaft shoulder.

6. Replace impeller key (where applicable) and impeller. Replace impeller seal (where applicable) before screwing impeller fastener in place.
7. Reassemble pump.
8. A short “run-in” period may be necessary to provide completely leak free seal operation.

SHIM ADJUSTMENT

When installing a replacement impeller (Ref. No. 12) or motor (Ref. No. 1), it may be necessary to adjust the number of shims (Ref. No. 11) to ensure proper running clearance between impeller and casing (Ref. No. 14).

Proceed as follows:

NOTE: A proper running clearance is less than 0.010”.

1. For impeller replacement, add one 0.010” shim in addition to those removed originally.
2. For motor replacement, add two 0.010” shims in addition to shims removed during disassembly.
3. Reassemble pump as described in steps 6 and 7. (See “Installation of New Seal” section).

IMPORTANT: Ensure that casing is snugly in place and check shaft to make sure it is turning freely (rotate impeller by impeller fastener, Ref. No. 13 with a wrench). If it turns freely, check to ensure that adapter (Ref. No. 3) and casing are fitted metal-to-metal where they meet on outside. If they are not metal-to-metal, tighten fasteners (Ref. No. 6) and recheck shaft for free turning. Tighten carefully, turning shaft while tightening so that motor bearings are not damaged in the event that too many shims were installed. If shaft seizes before fasteners are completely tight, disassemble pump and remove one shim and repeat reassembly.

Centrifugal Pumps

For Repair Parts contact dealer where pump was purchased.

Please provide following information:
-Model Number
-Serial Number (if any)

Part description and number as shown in parts list

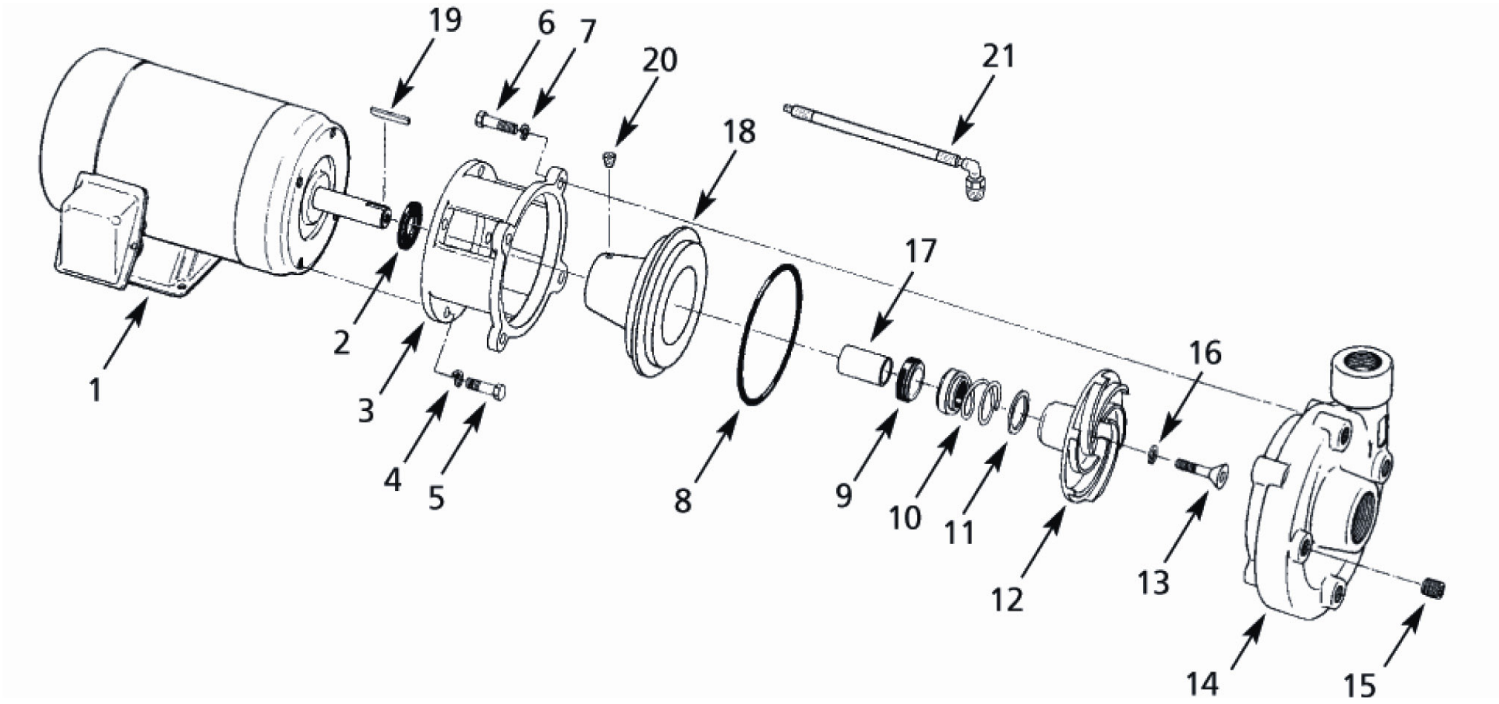


Figure 1 - Repair Parts Illustrations

Repair Parts List

Ref. No.	Description	Part Number for Models: 3158 3159 3156 3157 2HP	315C 315D 315A 315B 3HP	3150 2HP	3151 3HP	315E 3152 5HP	Qty.
1	Motor - 1 Phase ODP	1626-024-00	1626-026-00	-	-	-	1
	Motor - 3 Phase ODP	1626-025-00	1626-027-00	-	-	-	
	Motor - 1 Phase TEFC	1626-305-00	1626-306-00	-	-	1626-078-00	
	Motor - 3 Phase TEFC	1626-311-00	1626-312-00	1626-350-00	1626-351-00	1626-352-00	
2	Slinger Washer	N/A	N/A	1470-093-00	1470-093-00	1470-093-00	1
3	Adapter - Cast Iron	4890-030-01	4890-030-01	3150-033-09	3150-033-09	3150-033-09	1
	Adapter - Bronze	4890-032-01	4890-032-01	3150-033-09	3150-033-09	3150-033-09	
	Adapter - Stainless Steel	4890-031-98	4890-031-98	3150-033-09	3150-033-09	3150-033-09	
4	Washer	*	*	*	*	*	4
5	Fastener	*	*	*	*	*	4
6	Fastener	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
7	Washer	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
8	O-Ring	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	1
9,10	Shaft Seal Assembly	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	1
11	Impeller Shim Kit	1806-044-90	1806-044-90	1664-000-90	1664-000-90	1664-000-90	1
12	Impeller	3156-010-01	3156-010-02	3150-013-09	3151-013-09	3152-013-09	1
13	Impeller Fastener	1784-001-00	1784-001-00	1759-003-00	1759-003-00	1759-003-00	1
14	Casing - Cast Iron	3156-001-95	3156-001-95	3150-001-95	3150-001-95	3150-001-95	1
	Casing - Bronze	3156-001-94	3156-001-94	3150-004-94	3150-004-94	3150-004-94	
	Casing - Stainless Steel (includes Ref. Nos. 6, 7 14 and 15)	3156-001-98	3156-001-98	3150-003-98	3150-003-98	3150-003-98	
15	Pipe Plug	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
16	O-Ring	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	4
17	Shaft Sleeve	-	-	1555-140-02	1555-140-02	1555-140-02	1
18	Casing Cover - Cast Iron	-	-	3150-025-09	3150-025-09	3150-025-09	1
	Casing Cover- Bronze	-	-	3150-023-09	3150-023-09	3150-023-09	
	Casing Cover - Stainless Steel	-	-	3150-023-09	3150-023-09	3150-023-09	
19	Impeller Key	-	-	1471-030-00	1471-030-00	1471-030-00	1
20	Pipe Plug (optional for seal wash)	*	*	*	*	*	1
21	Hose (optional for pumps w/ seal wash)	4261-170-00	4261-170-00	4261-170-00	4261-170-00	4261-170-00	1
KIT	Seal Kit - Buna N (standard Cast Iron)	3156-300-94	3156-300-94	3150-300-94	3150-300-94	3150-300-94	1
	Seal Kit - Buna N & Sil. Carb. (optional)	3156-300-93	3156-300-93	3150-300-93	3150-300-93	3150-300-93	1
	Seal Kit - Viton (standard Bronze & SS)	3156-300-91	3156-300-91	3150-300-91	3150-300-91	3150-300-91	1
	Seal Kit - Viton & Sil. Carb. (optional)	3156-300-92	3156-300-92	3150-300-92	3150-300-92	3150-300-92	1
	Seal Kit - EPR-EPDM (optional) (includes Ref. Nos. 8, 9 10 and 16)	-	-	3150-300-96	3150-300-96	3150-300-96	1

(*) Standard hardware item, available locally.

Repair Parts List

		Part Number for Models:					
		4264		4265			
Ref.		4260	4240	4261	4250	4251	
No.	Description	7.5HP	7.5HP	10HP	10HP	15HP	Qty.
1	Motor - 1 Phase TEFC	1626-079-00	-	1626-080-00	-	-	1
	Motor - 3 Phase TEFC	1626-353-00	1626-353-00	1626-354-00	1626-354-00	1626-355-00	
2	Slinger Washer	1470-093-00	1470-093-00	1470-093-00	1470-093-00	1470-093-00	1
3	Adapter	3150-033-09	4252-033-01	3150-033-09	4252-033-01	4252-033-01	1
4	Washer	*	*	*	*	*	4
5	Fastener	*	*	*	*	*	4
6	Fastener	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
7	Washer	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
8	O-Ring	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	1
9,10	Shaft Seal Assembly	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	1
11	Impeller Shim Kit	1664-000-90	1664-000-90	1664-000-90	1664-000-90	1664-000-90	1
12	Impeller	4260-013-01	4240-013-01	4261-013-01	4250-013-01	4251-013-01	1
13	Impeller Fastener	1761-002-00	1759-003-00	1761-002-00	1759-003-00	1757-005-00	1
14	Casing - Cast Iron	4260-001-95	4240-001-95	4260-001-95	4250-001-95	4250-001-95	1
	Casing - Bronze	N/A	4240-004-94	N/A	4250-004-94	4250-004-94	
	Casing - Stainless Steel (includes Ref. Nos. 6, 7 14 and 15)	4260-003-98	4240-003-98	4260-003-98	4250-003-98	4250-003-98	
15	Pipe Plug	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	Incl. w/ Ref 14	4
16	O-Ring	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	Incl. w/ Ref KIT	4
17	Shaft Sleeve	1555-140-02	1555-140-02	1555-140-02	1555-140-02	1555-140-02	1
18	Casing Cover - Cast Iron	3150-025-09	4240-025-01	3150-025-09	4240-025-01	4240-025-01	1
	Casing Cover- Bronze	N/A	4240-024-01	N/A	4240-024-01	4240-024-01	
	Casing Cover - Stainless Steel	3150-023-09	4240-023-01	3150-023-09	4240-023-01	4240-023-01	
19	Impeller Key	1471-030-00	1471-030-00	1471-030-00	1471-030-00	1471-030-00	1
20	Pipe Plug (optional for seal wash)	*	*	*	*	*	1
21	Hose (optional for pumps w/ seal wash)	4261-170-00	4261-170-00	4261-170-00	4261-170-00	4261-170-00	1
KIT	Seal Kit - Buna N (standard Cast Iron)	3150-300-94	4240-300-94	3150-300-94	4240-300-94	4240-300-94	1
	Seal Kit - Buna N & Sil. Carb. (optional)	3150-300-93	4240-300-93	3150-300-93	4240-300-93	4240-300-93	1
	Seal Kit - Viton (standard Bronze & SS)	3150-300-91	4240-300-91	3150-300-91	4240-300-91	4240-300-91	1
	Seal Kit - Viton & Sil. Carb. (optional)	3150-300-92	4240-300-92	3150-300-92	4240-300-92	4240-300-92	1
	Seal Kit - EPR-EPDM (optional) (includes Ref. Nos. 8, 9 10 and 16)	3150-300-96	-	3150-300-96	-	-	1

(*) Standard hardware item, available locally.

NOTES:

AMT Pump Company
(herein "AMT")
400 Spring Street
Royersford, PA 19468
Phone: (610) 948-3800
Fax: (610) 948-5300
www.amtpump.com

General Information

SALES POLICY: AMT products are sold through our established Distributors. We do not sell direct to the consumer or organization not entitled to trade recognition. Therefore, possession of our catalogs and/or price list(s) does not infer an offer to sell.

MINIMUM ORDER: We appreciate your order, however, all orders are subject to a minimum $35.00 net invoice charge (excluding freight). This applies to all pump and parts purchase orders.

PRICES: Prices are subject to change without notice. All orders accepted are subject to prices in effect at time of shipment.

PAYMENT TERMS: Terms, upon establishment of credit, are Net 30 days. Past due accounts may be subject to a service charge of 1.5% per month. Domestic or assignable letter of credit is required for all export trade.

PAST DUE ACCOUNTS: AMT reserves the right to withhold open account shipments on any past due account. Invoices are considered past due after thirty (30) days. In the interest of sound business, all orders are subject to approval of the Credit Department.

SHIPPING INSTRUCTIONS: All shipments will be made F.O.B. the factory. Where instructions for shipment do not appear on the order, the shipment will be made according to our best judgment. Full risk of loss (including transportation delays and losses) shall pass to the customer upon delivery of the products to the carrier at the F.O.B. point. When loss or delay occurs, primary responsibility for tracing rests with the customer. When there is LOSS or APPARENT VISIBLE DAMAGE to a shipment, when tendered for delivery, *DO NOT* give the carrier a clear receipt. Note such damage on the carrier's delivery receipt and *HAVE THE DRIVER SIGN THE RECEIPT.*

PRODUCT REVISIONS: AMT reserves the right to discontinue, change or improve its products or any portions thereof without being obligated to provide such a change or improvement for units sold and/or shipped prior to such a change or improvement.

LEAD TIME: Products designated "Quick Ship Product", also referred to as "QSP" will normally be shipped within 24 hours of receipt of a non-cancellable purchase order. Only limited quantities of "QSP" pumps are available.

STANDARD LEAD TIME: Lead time is two weeks for all non "QSP" product. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control.

VIP SHIPMENT: Select AMT and IPT branded pumps are available for next day shipment for non-QSP (Quick Ship Products) items and subjected to a specific model surcharge per unit noted in the respective price book. Requires calling for availability, confirmation and a non-cancellable purchase order or credit card payment prior to shipment. The expedited shipping charges are an additional cost added separately from the VIP charges per item. AMT reserves the right to revise lead times as required due to availability of materials and all other causes beyond our control. QSP quantities are limited as determined by AMT.

ALL purchase orders must be submitted via hard copy sent to AMT customer service department by fax, EDI or e-mail.

RETURN GOODS POLICY: Goods shall not be returned without a return goods authorization number (RGA) issued by AMT customer service. The RGA number must be listed on the packing list. Only current model and part numbers with a valid date code may be returned (within one year from date of purchase). **A 20% restocking and packaging charge will apply to all returns. All shipping charges must be pre-paid. No exceptions.**

ORDER CHANGES BY CUSTOMER: Orders in process may not be changed except with written consent and may be subject to special charges.

12 Month Limited Warranty

EXTENT AND DURATION OF LIMITED WARRANTY

Coverage: AMT Pump Company (herein "AMT") or IPT Pumps by Gorman-Rupp (herein "IPT") or Gorman-Rupp Industries Division of the The Gorman-Rupp Company, Patterson, or the Gorman-Rupp Company (herein referred to as "G-R Unit) each individually warrants that its products and parts shall be free from defects in material and workmanship for twelve (12) months from the date of purchase by the original end user when installation is made and maintenance is performed in accordance with G-R Unit's recommendations. Wear and tear resulting from use and items normally consumed in use are not covered.

EXCEPTIONS

(A) This Limited Warranty shall not apply to mechanical seals in AMT or IPT pumps and the following products and parts: engines, motors, trade accessories and all other products, components, parts and materials not manufactured by the G-R Units. These items may, however, be covered by the warranties of their respective manufacturers. (B) This warranty does not extend to or apply to any unit which has been repaired or altered at any place other than by a G-R Unit, or by persons not expressly approved by a G-R Unit to make repairs or alterations, nor to any unit the serial number, model number or identification of which has been removed, defaced or altered. (C) This warranty does not extend to any product manufactured by a G-R Unit, which has been subjected to mis-use, neglect, accident, improper installation, or use in violation of instructions furnished by a G-R Unit. (D) Pump Kits: This warranty does not extend to any product sold by a G-R Unit unassembled as a Pump Kit. Pump Kits are warranted against defects in material and workmanship for 60 days from the date of shipment from a G-R Unit. Any Pump Kit parts deemed defective by a G-R Unit will be replaced free of charge within 60 days of shipment. Pump Kits are not returnable for credit.

LIMITATIONS

THE G-R UNITS' SOLE AND EXCLUSIVE WARRANTY WITH RESPECT TO THEIR PRODUCTS AND PARTS IS THIS LIMITED WARRANTY. THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND/OR IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDY AND DAMAGES

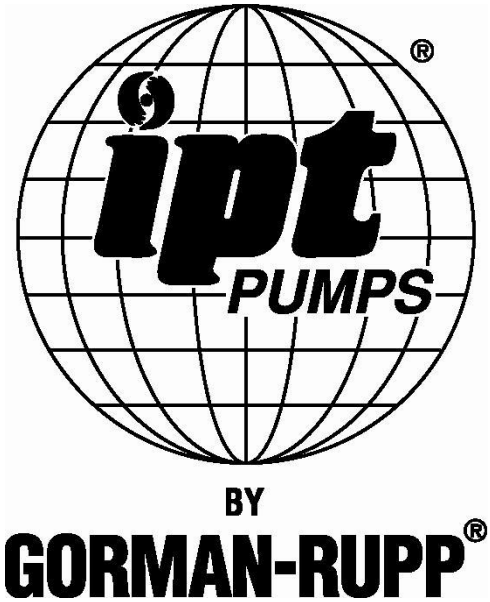
The sole and exclusive remedy for breach of this Warranty by a G-R Unit and the entire extent of its liability for such breach or for damages arising from the use of the products and parts covered under this Limited Warranty, shall be as follows:

1. **Repair or Replacement:** If inspection shows that any G-R Unit product or part covered under this Limited Warranty is defective in materials or workmanship, the G-R Unit shall repair or replace the defective or non-conforming product or part without charge, whichever the G-R Unit chooses. You must have properly maintained and used the product or part claimed to be defective in accordance with the maintenance schedule or manual, which comes with the product. No allowance will be made for labor, installation, removal, transportation or other charges incurred by you in connection with such repair or replacement.
2. To obtain the above remedy:
    A. Immediately notify the G-R Unit upon discovery of the claimed defect in materials or workmanship and provide the serial number or date code of the product and/or part(s) or provide the G-R Unit with the invoice or bill of sale referencing the product by no later than the expiration date of the warranty period.
    B. The G-R Unit will advise whether inspection will be necessary and how whether repair or replacement will be made. If inspection by the G-R Unit is necessary, the pump or defective part must be sent freight pre-paid to the G-R Unit. Return shipment will be F.O.B. the G-R Unit's plant.
    C. **Return Goods Authorization Requirement:** No product will be accepted for return or replacement without the prior written authorization of the G-R Unit. Upon such authorization, and in accordance with instructions from the G-R Unit, the product will be returned to the G-R Unit, shipping charges prepaid by the Buyer.

3. **Damages:** The G-R Unit's liability for damages for breach of this Limited Warranty shall not exceed the amount of the purchase price of the product or part(s) in respect to which Such damages are claimed. **IN NO EVENT SHALL THE G-R UNITS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES FOR BREACH OF THIS LIMITED WARRANTY.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This Limited Warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

A Gorman-Rupp Company



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Product Details

Specifications

Dimensions: H 10.63 in, W 8.27 in, D 6.3 in

Dimensions

Product Depth (in.)	6.3 in
Product Height (in.)	10.63 in
Product Width (in.)	8.27 in
Switch-Off Height (in.)	3.94
Switch-On Height (in.)	11.81

Details

Amperage (amps)	15
Cord Length (ft.)	8.25

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Discharge Flow @ 0 ft. (gallons/hour)	2580
Discharge Flow @ 0 ft. (gallons/min)	43
Discharge Flow @ 10 ft. (gallons/hour)	2160
Discharge Flow @ 10 ft. (gallons/min)	36
Discharge Flow @ 15 ft. (gallons/min)	33
Features	Bottom/End Suction, Non-Clogging, Self-Priming, Solids Handling, Submersible, Thermal Overload Protection
Housing Material	Aluminum
Impeller Material	Plastic
Maximum Horsepower (hp)	1/3
Maximum Pressure (psi)	9.96
Maximum Working Temperature (F)	100
Minimum Sump Basin Diameter	18 or More
Minimum working temperature (F)	35
Outlet Diameter Connection (in.)	1-1/2 FPT
Pack Size	1
Power Type Required	AC
Product Weight (lb.)	8.49 lb
Pump Switch Type	Tethered
Returnable	90-Day
Vertical Lift (ft.)	23
Voltage	115v

Warranty / Certifications

Certifications and Listings	CSA Certified
Manufacturer Warranty	1 year

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31 Questions

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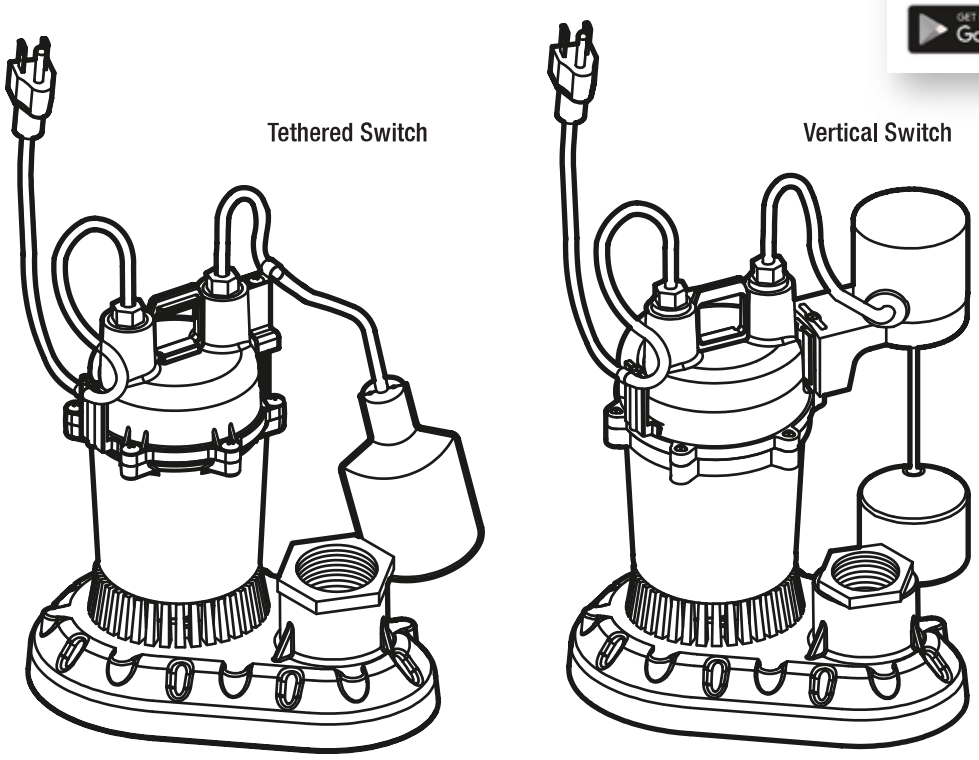

Questions, problems, missing parts? Before returning to the store,
call Everbilt Customer Service
8 a.m. - 7 p.m., EST, Monday - Friday, 9 a.m. - 6 p.m., EST, Saturday

1-844-883-1872

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THANK YOU

We appreciate the trust and confidence you have placed in Everbilt through the purchase of this sump pump. We strive to continually create quality products designed to enhance your home. Visit us online to see our full line of products available for your home improvement needs. Thank you for choosing Everbilt!

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Troubleshooting 10

Safety Information

- ☐ Do not splice the electrical power cord.
- ☐ Do not allow the electrical cord to become submerged.
- ☐ Do not use extension cords. They are a fire hazard and can reduce voltage sufficiently to prevent pumping and/or damage the motor.
- ☐ Do not handle or service the pump while it is connected to a power supply.
- ☐ DO NOT remove the grounding prong from the plug or modify the plug to protect against electrical shock. The power cord is a three-wire conductor and includes a 3-prong grounded plug. Plug the pump into a 3-wire, grounded, grounding type receptacle. Connect the pump according to electrical codes that apply.

DANGER: Do not pump flammable or explosive liquids such as oil, gasoline, kerosene, ethanol, etc. Do not use in the presence of flammable or explosive vapors. Using this pump with or near flammable liquids can cause an explosion or fire, resulting in property damage, serious personal injury, and/or death.

DANGER: ALWAYS disconnect the power to the pump before servicing.

DANGER: Do not touch the motor housing during operation. The motor is designed to operate at high temperatures. Do not disassemble the motor housing.

DANGER: Do not handle the pump or pump motor with wet hands or when standing on a wet or damp surface, or in water before disconnecting the power.

WARNING: Release all pressure and drain all water from the system before servicing any component.

WARNING: Secure the discharge line before starting the pump. An unsecured discharge line will whip, possibly causing personal injury, and/or property damage.

WARNING: Extension cords may not deliver sufficient voltage to the pump motor. Extension cords present a life threatening safety hazard if the insulation becomes damaged or the connection ends fall into water. The use of an extension cord to power this pump is not permitted.

WARNING: Wear safety goggles at all times when working with pumps.

WARNING: This unit is designed only for use on 115 volts (single phase), 60 Hz, and is equipped with an approved 3-conductor cord and 3-prong grounded plug. Do not remove the ground pin under any circumstances. The 3-prong plug must be directly inserted into a properly installed and grounded 3-prong, grounding-type receptacle. Do not use this pump with a 2-prong wall outlet. Replace the 2-prong outlet with a properly grounded 3-prong receptacle (a GFCI outlet) installed in accordance with the National Electrical Code and local codes and ordinances. All wiring should be performed by a qualified electrician.

WARNING: Protect the electrical cord from sharp objects, hot surfaces, oil, and chemicals. Avoid kinking the cord. Do not use damaged or worn cords.

WARNING: Failure to comply with the instruction and designed operation of this unit may void the warranty. ATTEMPTING TO USE A DAMAGED PUMP can result in property damage, serious personal injury, and/or death.

WARNING: Ensure that the electrical circuit to the pump is protected by a 15 Amp fuse or circuit breaker.

CAUTION: Do not lift the pump by the power cord.

CAUTION: Know the pump and its applications, limitations, and potential hazards.

Safety Information (continued)

CAUTION: Secure the pump to a solid base. This will aid in keeping the pump in a vertical orientation. This is critical in keeping the pump operating at maximum efficiency. It will also help prevent the pump from clogging resulting in premature failure.

CAUTION: Periodically inspect the pump and system components to ensure the pump suction screen is free of mud, sand, and debris. Disconnect the pump from the power supply before inspecting.

CAUTION: Follow all local electrical and safety codes, along with the National Electrical Code (NEC). In addition, all Occupational Safety and Health Administration (OSHA) guidelines must be followed.

IMPORTANT: Ensure the electrical power source is adequate for the requirements of the pump.

IMPORTANT: This pump is made of high-strength, corrosion-resistant materials. It will provide trouble-free service for a long time when properly installed, maintained, and used. However, inadequate electrical power to the pump, dirt, or debris may cause the pump to fail. Please carefully read the manual and follow the instructions regarding common pump problems and remedies.

IMPORTANT: The motor of this pump has a thermal protector that will trip if the motor becomes too hot. The protector will reset itself once the motor cools down and an acceptable temperature has been reached. The pump may start unexpectedly if it is plugged in.

Warranty

The manufacturer warrants the products to be free from defects in materials and workmanship for a period of one year from date of purchase. This warranty applies only to the original consumer purchaser and only to products used in normal use and service. If within one year this product is found upon examination by the manufacturer to be defective in materials or workmanship, the manufacturer's only obligation, and your exclusive remedy, is the repair or replacement of the product at the manufacturer's discretion, provided that the product has not been damaged through misuse, abuse, accident, modifications, alterations, neglect or mishandling. Your original receipt of purchase is required to determine warranty eligibility.

The purchaser must pay all labor and shipping charges necessary to replace the product covered by this warranty.

This Limited Warranty does not cover products which have been damaged as a result of an accident, misuse, abuse, negligence, alteration, improper installation or maintenance, or failure to operate in accordance with the instructions supplied with the products, or operational failures caused by corrosion, rust, or other foreign materials in the system.

Requests for service under this warranty shall be made by returning the defective product to the manufacturer as soon as possible after the discovery of any alleged defect. The manufacturer will subsequently take corrective action as promptly as reasonably possible.

The manufacturer does not warrant and especially disclaims any warranty, whether express or implied, of fitness for a particular purpose, other than the warranty contained herein. This is the exclusive remedy and any liability for any and all indirect or consequential damages or expenses whatsoever is excluded.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

Contact the Customer Service Team at 1-844-883-1872 or visit www.HomeDepot.com.

Pre-Installation

PLANNING INSTALLATION

This submersible sump pump is designed for home sump applications. Use this pump only for pumping water. This unit is not designed as a waterfall or fountain pump, or for applications involving salt water or brine. Use with waterfalls, fountains, salt water or brine will void warranty. Do not use where water recirculates. This pump is not designed for use as a swimming pool drainer.

INSTALLATION REQUIREMENTS

NOTICE: Install the pump on a hard, level surface (cement, asphalt, etc.). Never place the pump directly on earth, clay, or gravel surfaces.

- □ Use a rigid plastic pipe for the discharge. Do not use ordinary pipe joint compound. Pipe joint compound can attack plastics.

CAUTION: Risk of flooding. Can cause personal injury and/or property damage. If a flexible discharge hose is used, make sure the pump is secured in the sump to prevent movement. Failure to secure the pump may allow pump movement, switch interference and prevent the pump from starting or stopping.

- □ To reduce motor noise and vibrations, a short length of rubber hose (1-7/8 in. (47.6 mm) I.D., e.g. radiator hose) can be connected into the discharge line near the pump using suitable clamps.
- □ If the check valve is not equipped with an air bleed hole to prevent air locking the pump, drill a 1/8 in. (3.2 mm) hole in the discharge pipe just above where the discharge pipe screws into the pump discharge. Be sure the hole is below the waterline and the check valve to prevent air locks.
- □ If the pump discharge line is exposed to outside subfreezing atmosphere, a portion of line exposed must be installed so any water remaining in the pipe will drain to the outfall by gravity. Failure to do this can cause water trapped in the discharge to freeze which could result in damage to the pump.
- □ The shaft seal depends on water for lubrication. Do not operate the pump unless it is submerged in water as the seal may be damaged if allowed to run dry.
- □ Do not change the preset tether switch length.

ELECTRICAL REQUIREMENTS

- □ For automatic operation, plug the pump into a GFCI wall outlet. Connect the pump to an individual branch circuit with no other outlets or equipment in the circuit.
- □ Size fuses or circuit breakers according to this chart:

HP	Voltage	Individual Branch Circuit Required (Amps)
1/2	115	15

PERFORMANCE CHART

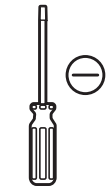
SKU	HP	Amp	GPM of Water @ Total Feet of Lift					Max. Lift
			0 ft.	5 ft.	10 ft.	15 ft.	20 ft.	
1004 118 355 1004 118 361	1/4	6.0	40	37	33	28	--	20 ft.
1004 118 371 1004 118 379	1/3	6.0	43	40	36	32	13	23 ft.
1004 118 292 1004 118 395	1/2	6.0	47	43	40	35	18	25 ft.

Pre-Installation (continued)

SPECIFICATIONS

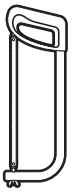
Power supply	115 V, 60 Hz, 15 Amp circuit	
Liquid tempereature range	32° – 95°F (0° – 35°C)	
Discharge size	1-1/2 in. FNPT or 1-1/4 in. FNPT (with adaptor)	
Sump basin	Min. 14 in. (356 mm) diameter, 18 in. (457 mm) depth for tethered switch Min. 10 in. (254 mm) diameter, 14 in. (356 mm) depth for vertical switch	
Water level on/off	**1004 118 361 1004 118 379 1004 118 395**	**ON: 13.8 - 15.7 in (350 - 400 mm), OFF: 5.9 - 7.0 in (150 - 200 mm)**
	1004 118 355 1004 118 371 1004 118 292	**ON: 6.3 - 6.7 in (160 - 170 mm), OFF: 2.3 - 3.15 in (60 - 80 mm)**

TOOLS REQUIRED

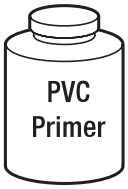

Flathead screwdriver

Phillips screwdriver

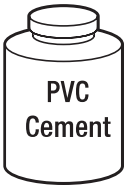
Wrench


Hacksaw

Thread tape

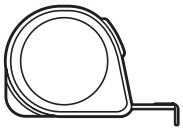


PVC primer



PVC cement

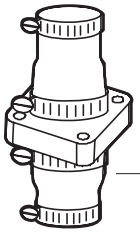
Safety goggles

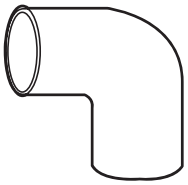

Tape measure

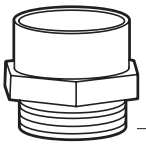
MATERIALS REQUIRED (NOT INCLUDED)

NOTE: Hardware not shown to actual size.

AA


BB


CC

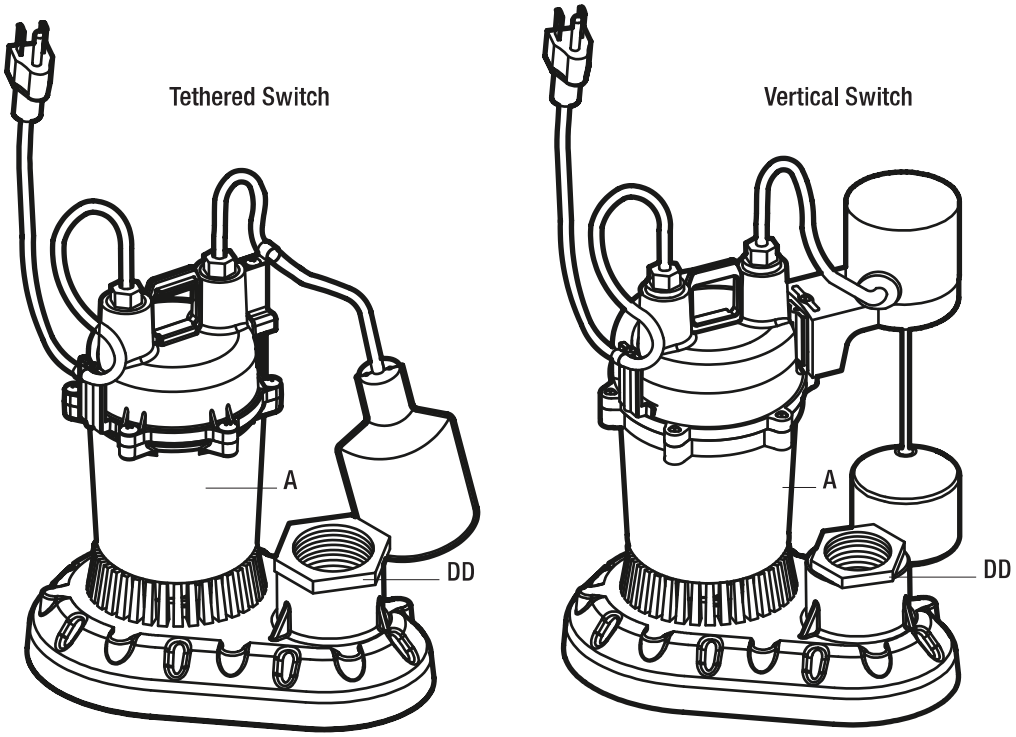

DD

Part	Description	Quantity
AA	1 -1/4 in. or 1-1/2 in. discharge pipe	1
BB	1 -1/4 in. or 1-1/2 in. check valve	1

Part	Description	Quantity
CC	1 -1/4 in. or 1-1/2 in. 90° elbow	1
DD	Pipe adapter	1

Pre-Installation (continued)

PACKAGE CONTENTS

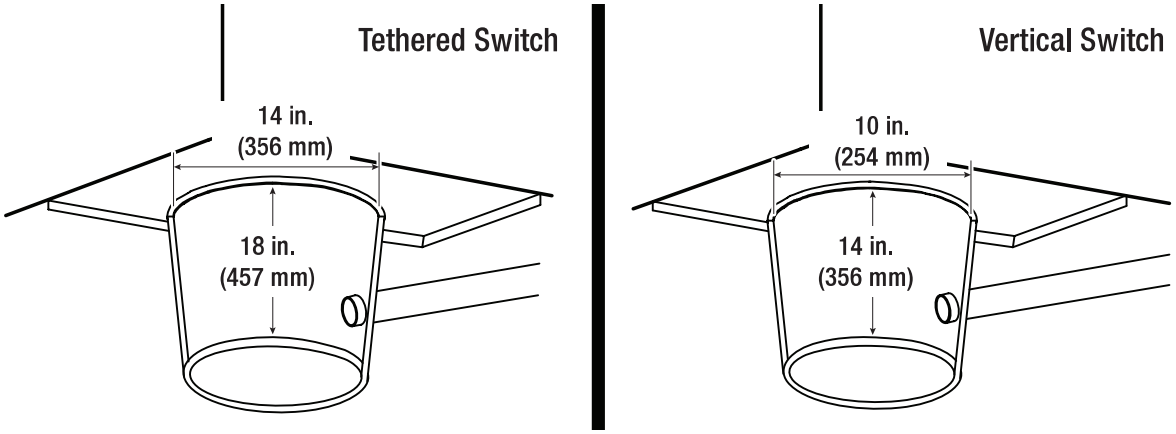


Part	Description
A	Pump
DD	Adapter (1-1/2 in. MNPT X 1-1/4 in. FNPT)

Installation

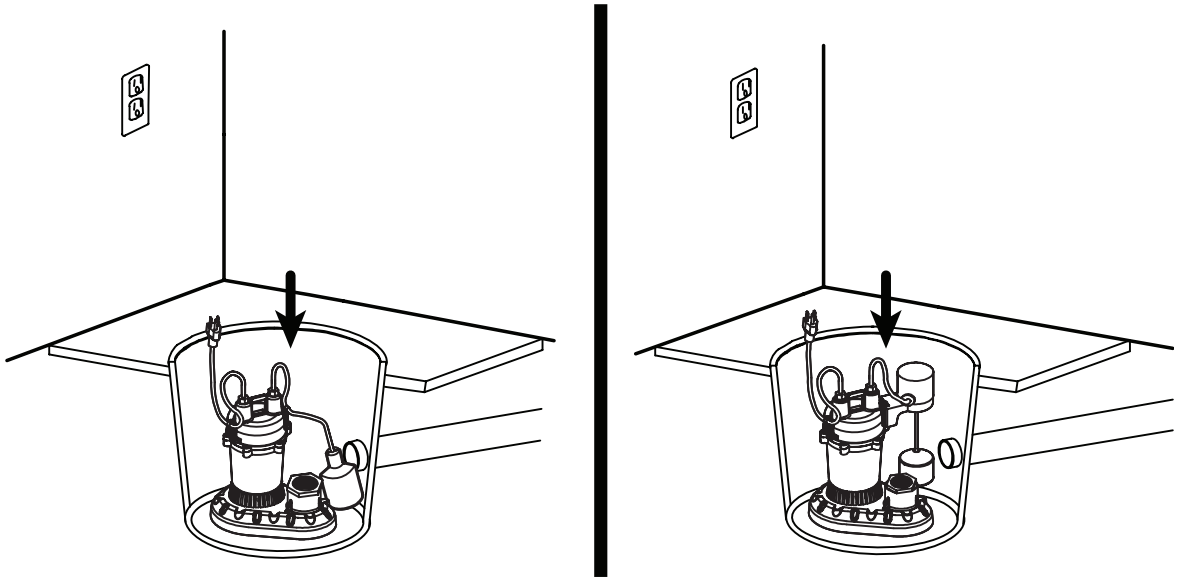
1 Preparing a pump basin

- ☐ The sump pump must be installed in a sump basin with a minimum diameter of 10 in. (254 mm) for vertical switch models and 14 in. (356 mm) for tethered float switch models.
- ☐ The sump basin must have a minimum depth of 14 in. (356 mm) for vertical switch models and 18 in. (457 mm) for tethered float switch models.
- ☐ The sump basin can be constructed of tile, concrete, steel, or plastic. Check local codes for approved materials and for proper installation.



2 Placing the pump in a basin

- ☐ Place the pump on a hard surface inside the sump basin. Do not install the pump on clay, earth, or sand surfaces.
- ☐ Clear the sump basin of debris which could clog the pump. Keep the inlet screen clear.

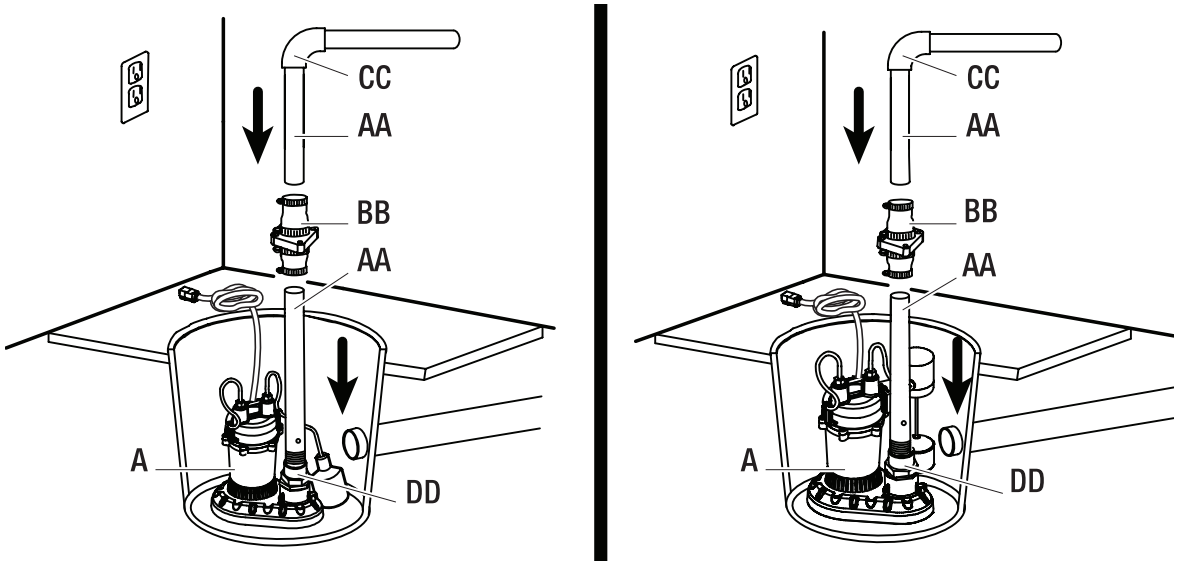


Please contact 1-844-883-1872 for further assistance.

Installation (continued)

3 Installing the discharge plumbing

- □ Attach a pipe adapter (DD) to the discharge pipe (AA). Wrap the threads with PTFE pipe thread sealant tape.
- □ Screw the discharge pipe (AA) onto the pump (A) hand-tight, plus 1-1/2 turns.
- □ Install an in-line check valve (BB) or an in-pump check valve.

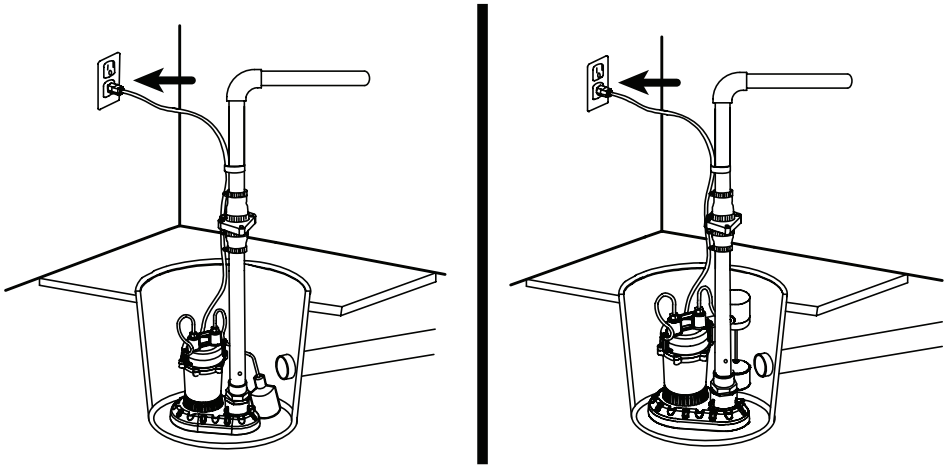


Operation

1 Connecting power

- □ Plug the power cord into a 115 V GFCI power outlet.

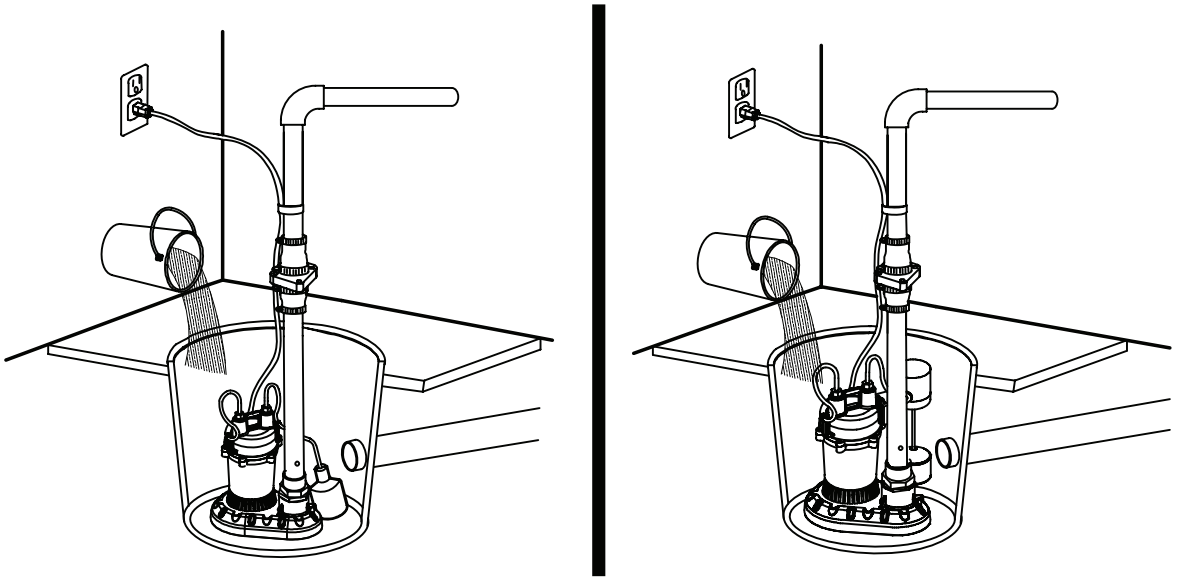
WARNING: Do not handle this pump or plug in or unplug this pump with wet hands or while standing in water, unless you are certain all power has been turned off to the pump. Remember, the pump should be connected only to a properly grounded, GFCI outlet.



2 Operating the pump

- □ After connecting power to the pump, test the pump by filling the sump basin with water and observing pump operation through one complete cycle.
- □ The motor is equipped with an automatically-resetting thermal overload protector. If the motor gets too hot, the overload protector will shut off the pump before it is damaged. When the motor has cooled sufficiently, the overload protector will reset, and the motor will restart.
- □ The pump will not remove all water. If operating a pump manually, and suddenly no water comes out of the discharge hose, shut off the unit immediately. The water level is probably very low and the unit has broken prime.

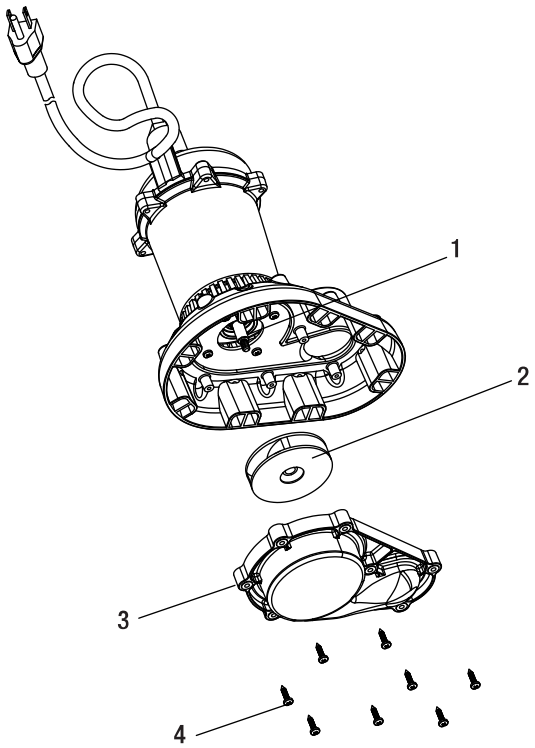
NOTICE: If the overload protector stops the pump repeatedly, disconnect the power from the pump and check to find the problem. Low voltage, a long extension cord, clogged impeller, screen blocked by debris, or water that is too hot can cause motor overheating.



Care and Cleaning

WARNING: Before removing the pump from the basin for service, always disconnect electrical power to the pump and control switch. Do not lift the pump by the power cord.

- □ Unscrew the bolts (4) and remove the volute (3) .
- □ If necessary use a flathead screwdriver to hold the shaft (1), then turn the impeller (2) counterclockwise to release the impeller (2).
- □ Remove debris from around the shaft (1) and the impeller (2). (Impeller is shown removed for clarity. Do not remove impeller.)
- □ Reassemble the pump.



Troubleshooting

Problem	Probable Cause	Solution
The pump fails to operate.	There is no power.	□ Reset the GFCI switch □ Reset the circuit breaker □ Make sure the pump is plugged in □ Clean the plug prongs
	The impeller is blocked.	Remove the debris around the impeller.
	The float switch failed.	Replace the float switch.
	The motor failed.	Replace the pump.
The pump operates, but pumps little or no water.	The screen is blocked.	Clean the screen.
	Debris is caught in the impeller or discharge.	Remove the debris.
	The impeller is broken.	Replace the impeller.
The pump starts and stops too often.	There is a backflow of water from the piping or the check valve is leaking.	Install or replace the check valve.
	The float switch is stuck.	Clean float switch.
	The float switch failed.	Replace the float switch.
The pump will not shut off.	The float switch is tangled.	Reposition the pump and make sure the switch moves freely.
	The float switch failed.	Replace the float switch.

EVERBILT™

Questions, problems, missing parts? Before returning to the store,
call Everbilt Customer Service
8 a.m. - 7 p.m., EST, Monday-Friday, 9 a.m. - 6 p.m., EST, Saturday

1-844-883-1872

HOMEDEPOT.COM

Retain this manual for future use.

EVERBILT™

Artículo n.° 1004 118 361 1004 118 355
1004 118 379 1004 118 371
1004 118 395 1004 118 292
Modelo n.° HDPS25W HDPS25V
HDPS33W HDPS33V
HDPS50W HDPS50V

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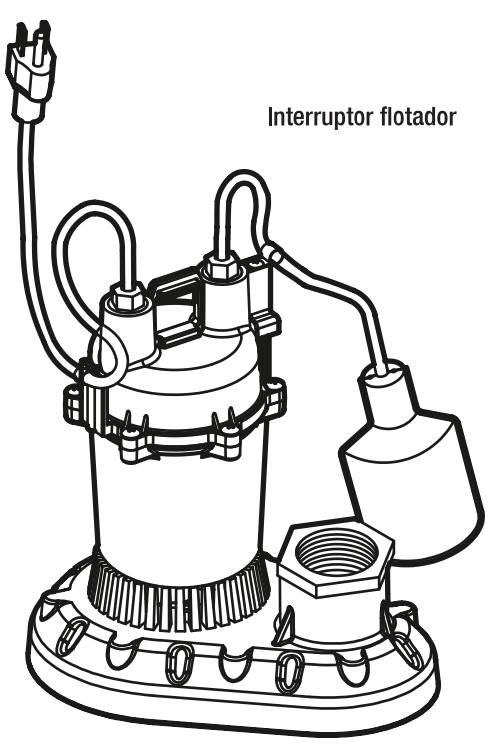
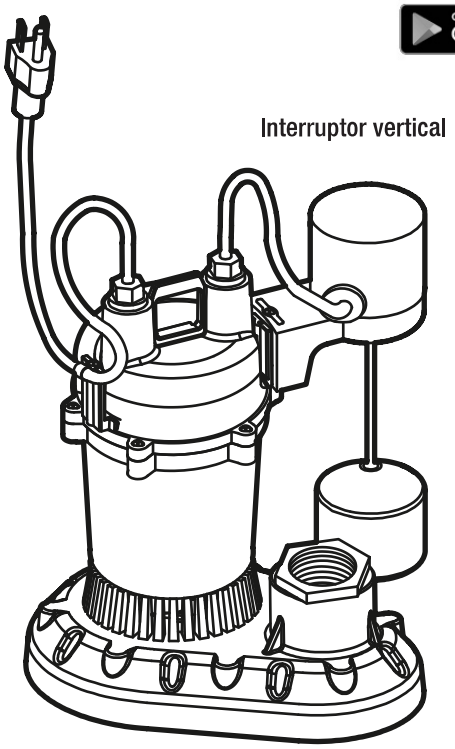
BOMBA DE SUMIDERO SUMERGIBLE



Interruptor flotador



Interruptor vertical

¿Tiene preguntas o problemas, o le faltan piezas? Antes de devolver a la tienda,
llame a Atención al Cliente de Everbilt
Lunes a viernes de 8:00 a.m. a 7:00 p.m., EST y los sábados de 9:00 a.m. a 6:00 p.m., EST

1-844-883-1872

HOMEDEPOT.COM

GRACIAS

Agradecemos la confianza que ha puesto en Everbilt con la compra de esta bomba de sumidero. Nos esforzamos continuamente para crear productos de calidad diseñados para mejorar su hogar. Visítenos en línea para ver nuestra línea completa de productos disponibles para sus necesidades de mejoramiento del hogar. ¡Gracias por elegir a Everbilt!

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Instalación 7
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Resolución de problemas. 10

Información de seguridad

- □ No empalme el cable de alimentación.
- □ No permita que el cable eléctrico quede sumergido.
- □ No use cables de extensión. Estos representan un peligro de incendio y pueden reducir el voltaje lo suficiente para detener el bombeo o dañar el motor.
- □ No manipule ni le dé mantenimiento a la bomba mientras está conectada al suministro eléctrico.
- □ NO quite la clavija de conexión a tierra del enchufe ni modifique al enchufe para estar protegido de descargas eléctricas. El cable de alimentación es un conductor de tres cables que incluye un enchufe de 3 clavijas con conexión a tierra. Conecte la bomba a un tomacorriente de 3 clavijas con conexión a tierra. Conecte la bomba de acuerdo a las normas eléctricas correspondientes.

PELIGRO: No bombee líquidos inflamables o explosivos como aceite, gasolina, queroseno, etanol, etc. No la use cerca de vapores inflamables o explosivos. Usar esta bomba con o cerca de líquidos inflamables puede provocar una explosión o incendio, lo que resultaría en daños a la propiedad, lesiones graves o la muerte.

PELIGRO: SIEMPRE desconecte la alimentación de la bomba antes de darle mantenimiento.

PELIGRO: No toque la carcasa del motor mientras esté funcionando. El motor está diseñado para funcionar a temperaturas altas. No desarme la carcasa del motor.

PELIGRO: No manipule la bomba o el motor de la bomba con las manos húmedas o si está parado sobre una superficie mojada o húmeda, o en agua antes de desconectar la electricidad.

ADVERTENCIA: Libere toda la presión y drene toda el agua del sistema antes de dar mantenimiento a cualquier componente.

ADVERTENCIA: Fije la línea de descarga antes de arrancar la bomba. Una línea de descarga que no esté fija se moverá como un látigo, lo cual puede causar lesiones personales o daños a la propiedad.

ADVERTENCIA: Los cables de extensión podrían no proporcionar suficiente voltaje al motor de la bomba. Los cables de extensión presentan peligros de seguridad que ponen en riesgo la vida en caso de que el aislamiento se dañe o el extremo de la conexión caiga al agua. No se permite el uso de cables de extensión para alimentar esta bomba.

ADVERTENCIA: Use anteojos de seguridad en todo momento cuando trabaje con bombas.

ADVERTENCIA: Esta unidad está diseñada solo para su uso en líneas de 115 voltios (monofásicas), 60 Hz, y está equipada con un cable de 3 conductores y un enchufe de 3 clavijas con conexión a tierra, ambos aprobados. No quite la clavija de conexión a tierra bajo ninguna circunstancia. El enchufe de 3 clavijas debe insertarse directamente en un tomacorriente de 3 clavijas con conexión a tierra instalado correctamente. No use esta bomba con un tomacorriente de 2 clavijas. Cambie el tomacorriente de 2 clavijas por uno de 3 con conexión a tierra (un tomacorriente GFCI) instalado de acuerdo con el Código Eléctrico nacional y los códigos y ordenanzas locales. Un electricista certificado debe realizar todo el cableado.

ADVERTENCIA: Proteja el cable eléctrico de objetos filosos, superficies calientes, aceite y sustancias químicas. Evite retorcer el cable. No use cables dañados o desgastados.

ADVERTENCIA: No cumplir con las instrucciones y el uso designado para esta unidad puede anular la garantía. INTENTAR USAR UNA BOMBA DAÑADA puede provocar daños a la propiedad, lesiones graves o la muerte.

ADVERTENCIA: Asegúrese de que el circuito eléctrico de la bomba esté protegido por un fusible o disyuntor eléctrico de 15 A.

PRECAUCIÓN: No levante la bomba tirando del cable de alimentación.

PRECAUCIÓN: Conozca la bomba, sus usos, limitaciones y peligros posibles.

Información de seguridad (continuación)

PRECAUCIÓN: Fije la bomba a una base sólida. Esto ayudará a mantener la bomba en posición vertical. Esto es esencial para mantener la bomba funcionando con la eficiencia máxima. También ayudará a evitar que la bomba se obstruya y cause una avería prematura.

PRECAUCIÓN: Inspeccione periódicamente los componentes del sistema y la bomba para garantizar que el filtro de succión de la bomba esté libre de barro, arena y desechos. Desconecte la bomba del suministro eléctrico antes de inspeccionarla.

PRECAUCIÓN: Cumpla con todas las normas eléctricas y de seguridad locales, así como con el Código Nacional Eléctrico (NEC, por sus siglas en inglés). Además, se deben seguir todas las pautas de la Administración de Seguridad y Salud Ocupacional (OSHA, por sus siglas en inglés).

IMPORTANTE: Asegúrese de que la fuente de alimentación eléctrica sea la adecuada para los requisitos de la bomba.

IMPORTANTE: Esta bomba está hecha de materiales de alta dureza y resistentes a la corrosión. Funcionará sin problemas por mucho tiempo si se instala, mantiene y utiliza correctamente. Sin embargo, un suministro eléctrico inadecuado, la suciedad y los desechos pueden hacer que la bomba se averíe. Lea detenidamente el manual y siga las instrucciones relacionadas con los problemas comunes de la bomba y sus soluciones.

IMPORTANTE: El motor de esta bomba tiene un protector térmico que se activará si el motor se calienta demasiado. El protector se reiniciará por sí solo cuando el motor se enfría lo suficiente y alcanza una temperatura aceptable. La bomba puede arrancar inesperadamente si está conectada.

Garantía

El fabricante garantiza los productos contra los defectos en el material y la mano de obra durante un periodo de un año a partir de la fecha de compra. Esta garantía aplica solo al consumidor que hace la compra original y solo a productos que se usan para servicio y uso normales. Si en el plazo de un año el fabricante encuentra defectos en este producto, la única obligación del fabricante, y su exclusivo remedio, es la reparación o reemplazo del producto, a criterio del fabricante, suponiendo que el producto no haya sido dañado debido al uso inadecuado, abuso, accidente, modificaciones, alteraciones, negligencia o manejo inadecuado. Se requiere el recibo de compra original para determinar la elegibilidad de la garantía.

El comprador debe pagar por todos los costos de mano de obra y envío necesarios para reemplazar el producto cubierto por esta garantía.

Esta garantía limitada no aplica a productos con daños resultado de un accidente, uso indebido, abuso, negligencia, alteración, instalación o mantenimiento inapropiado, no operar los productos de acuerdo a las instrucciones incluidas, o fallas de funcionamiento causadas por corrosión, óxido u otros materiales extraños en el sistema.

Las solicitudes de servicio bajo esta garantía se realizarán retornando el producto defectuoso al fabricante lo antes posible una vez descubierto el supuesto defecto. El fabricante tomará acciones correctivas tan pronto como sea razonablemente posible.

El fabricante no garantiza la idoneidad para cualquier propósito en particular y en especial renuncia a cualquier garantía expresa o implícita sobre ella, aparte de la garantía contenida en el presente documento. Este es su exclusivo remedio y se excluye cualquier responsabilidad por daños o gastos indirectos o consecuentes.

Algunos estados no permiten la exclusión o limitación de los daños incidentales o resultantes, ni las limitaciones en la duración de las garantías implícitas, de manera que las limitaciones o excepciones mencionadas quizás no se apliquen en su caso. Esta garantía le brinda derechos legales específicos y quizás usted tenga otros derechos que varían según el estado.

Comuníquese con el equipo de Atención al Cliente al 1-844-883-1872 o visite www.HomeDepot.com.

Antes de la instalación

PLANIFICACIÓN DE LA INSTALACIÓN

Esta bomba de sumidero sumergible está diseñada para aplicaciones de sumideros domésticos. Use esta bomba solo para bombear agua. La unidad no está diseñada como bomba para cascadas o fuentes, ni para aplicaciones que involucren agua salada o agua de mar. El uso con cascadas, fuentes, agua salada o agua de mar anulará la garantía. No usar donde haya recirculación de agua. Esta bomba no está diseñada para su uso como drenaje para piscina.

REQUISITOS DE INSTALACIÓN

AVISO: Instale la bomba sobre una superficie dura y nivelada (cemento, asfalto, etc.). Nunca coloque la bomba directamente sobre la tierra, arcilla o grava.

- □ Use una tubería de plástico rígida para la descarga. No utilice pasta ordinaria para uniones de tuberías. La pasta para uniones de tuberías puede atacar los plásticos.

PRECAUCIÓN: Riesgo de inundación. Puede causar lesiones personales o daños a la propiedad. Si se utiliza una manguera de descarga flexible, asegúrese de que la bomba esté fija al sumidero para evitar el movimiento. No fijar la bomba puede causar que se mueva, interferir con el interruptor y evitar que la bomba arranque o se detenga.

- □ Para reducir los ruidos y vibraciones del motor, se puede conectar una manguera de goma de poca longitud (1-7/8 pulgada (47.6 mm) de diámetro interno, por ejemplo, manguera de radiador) a la línea de descarga cerca de la bomba mediante abrazaderas adecuadas.
- □ Si la válvula de retención no está equipada con un orificio de drenaje de aire para evitar que el aire bloquee la bomba, taladre un orificio de 1/8 pulgada (3.2 mm) en la tubería de descarga justo encima de donde la tubería de descarga se enrosca a la descarga de la bomba. Asegúrese de que el orificio esté por debajo de la línea de agua y la válvula de retención para evitar bloqueos por aire.
- □ Si la línea de descarga de la bomba está expuesta a exteriores con temperaturas bajo cero, una parte de la línea se debe instalar de manera que si queda algo de agua en la tubería esta drenará por caída libre. No hacer esto puede hacer que el agua atrapada en la descarga se congele y dañe la bomba.
- □ El sello del eje depende del agua para lubricarse. No utilice la bomba a menos que esté sumergida en agua ya que el sello puede dañarse si funciona en seco.
- □ No cambie la longitud del interruptor flotador.

REQUISITOS ELÉCTRICOS

- □ Para el funcionamiento automático, enchufe la bomba a un tomacorriente GFCI. Conecte la bomba a un circuito independiente sin otros tomacorrientes o equipos en el circuito.
- □ Tamaño de fusibles o disyuntores según esta tabla:

CV	Voltaje	Requiere un circuito derivado independiente (A)
1/2	115	15

TABLA DE DESEMPEÑO

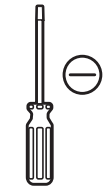
SKU	CV	Amperaje	LPM de agua a pies de elevación total					Elevación máx.
			0 pies	5 pies	10 pies	15 pies	20 pies	
1004 118 355 1004 118 361	1/4	6.0	151	140	124	105	--	20 pies
1004 118 371 1004 118 379	1/3	6.0	162	151	136	121	49	23 pies
1004 118 292 1004 118 395	1/2	6.0	177	162	151	132	68	25 pies

Antes de la instalación (continuación)

ESPECIFICACIONES

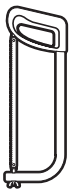
Alimentación	Circuito de 115 V, 60 Hz, 15 A	
Rango de temperatura del líquido	32° – 95 °F (0° – 35 °C)	
Tamaño de descarga	1-1/2 pulg. FNPT o 1-1/4 pulg. FNPT (con adaptador)	
Estanque sumidero	Mín. 14 pulg. (356 mm) de diámetro, 18 pulg. (457 mm) de ancho para el interruptor flotador Mín. 10 pulg. (254 mm) de diámetro, 14 pulg. (356 mm) de profundidad para el interruptor vertical	
Nivel de agua encendido / apagado	**1004 118 361 1004 118 379 1004 118 395**	**ENCENDIDO: 13.8 - 15.7 pulg. (350 - 400 mm), APAGADO: 5.9 - 7.0 pulg. (150 - 200 mm)**
	1004 118 355 1004 118 371 1004 118 292	**ENCENDIDO: 6.3 - 6.7 pulg. (160 - 170 mm), APAGADO: 2.3 - 3.15 pulg. (60 - 80 mm)**

HERRAMIENTAS REQUERIDAS

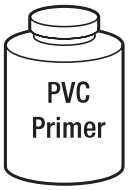

Destornillador de cabeza plana

Destornillador Phillips

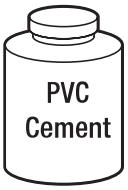
Llave


Segueta

Cinta para rosca

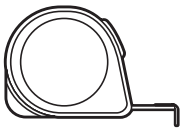


Pintura base para PVC



Cemento para PVC

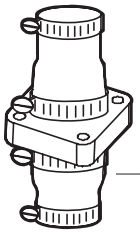
Gafas de seguridad

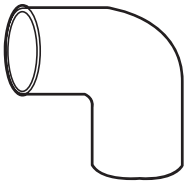

Cinta métrica

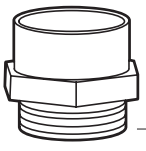
MATERIALES REQUERIDOS (NO INCLUIDOS)

NOTA: El herraje no se muestra en su tamaño real.

AA


BB


CC

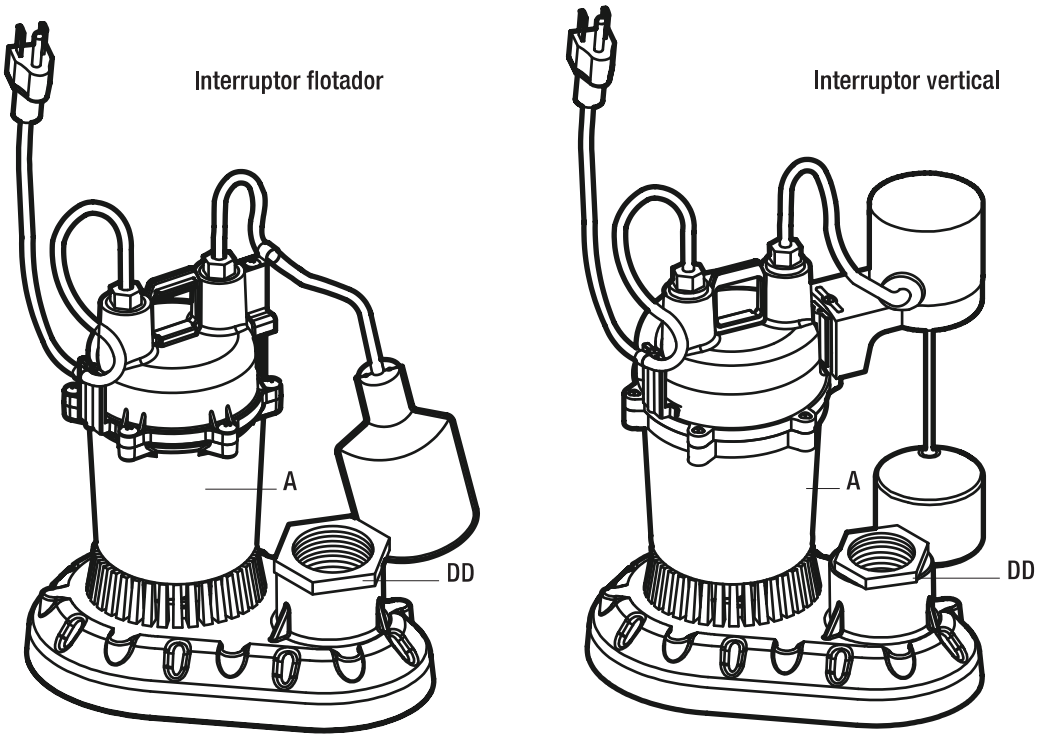

DD

Pieza	Descripción	Cantidad
AA	Tubería de descarga de 1-1/4 pulgada o 1-1/2 pulgada	1
BB	Válvula de control de 1-1/4 pulgada o 1-1/2 pulgada	1

Pieza	Descripción	Cantidad
CC	Codo de 90° de 1-1/4 pulgada o 1-1/2 pulgada	1
DD	Adaptador de tubería	1

Antes de la instalación (continuación)

CONTENIDO DEL PAQUETE

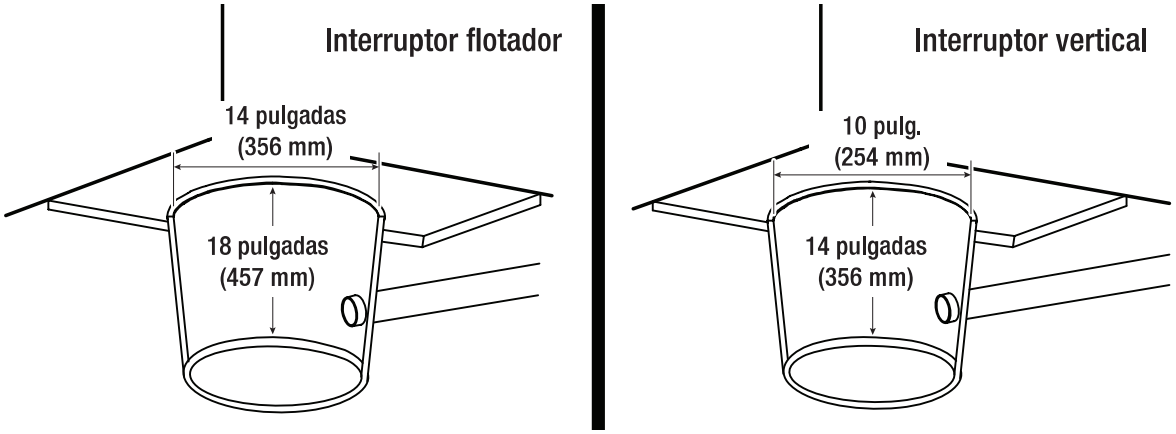


Pieza	Descripción
A	Bomba
DD	Adaptador (1-1/2 pulgada NPT macho X 1-1/4 pulgada NPT hembra)

Instalación

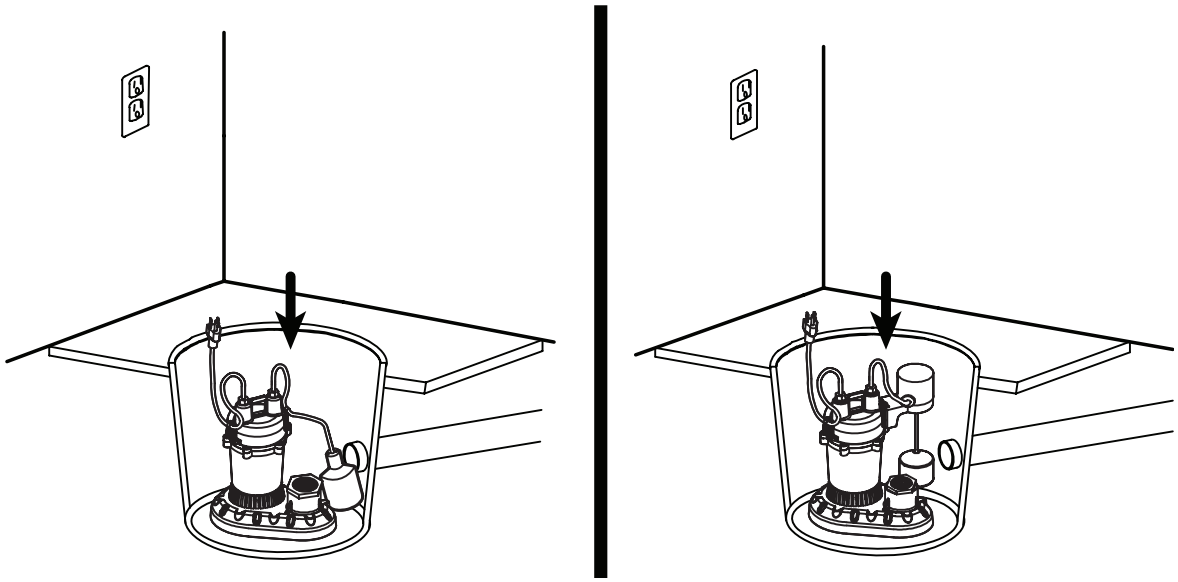
1 Preparación del sumidero de la bomba

- □ El sumidero de la bomba se debe instalar en un estanque sumidero con un diámetro mínimo de 10 pulgadas (254 mm) para modelos con interruptor vertical y 14 pulgadas (356 mm) para modelos con interruptor flotador.
- □ El estanque sumidero debe tener una profundidad mínima de 14 pulgadas (356 mm) para modelos con interruptor vertical y 18 pulgadas (457 mm) para modelos con interruptor flotador.
- □ El estanque sumidero se puede construir con baldosas, concreto, acero o plástico. Verifique las normas locales para conocer los materiales aprobados y la instalación correcta.



2 Colocación de la bomba en un estanque

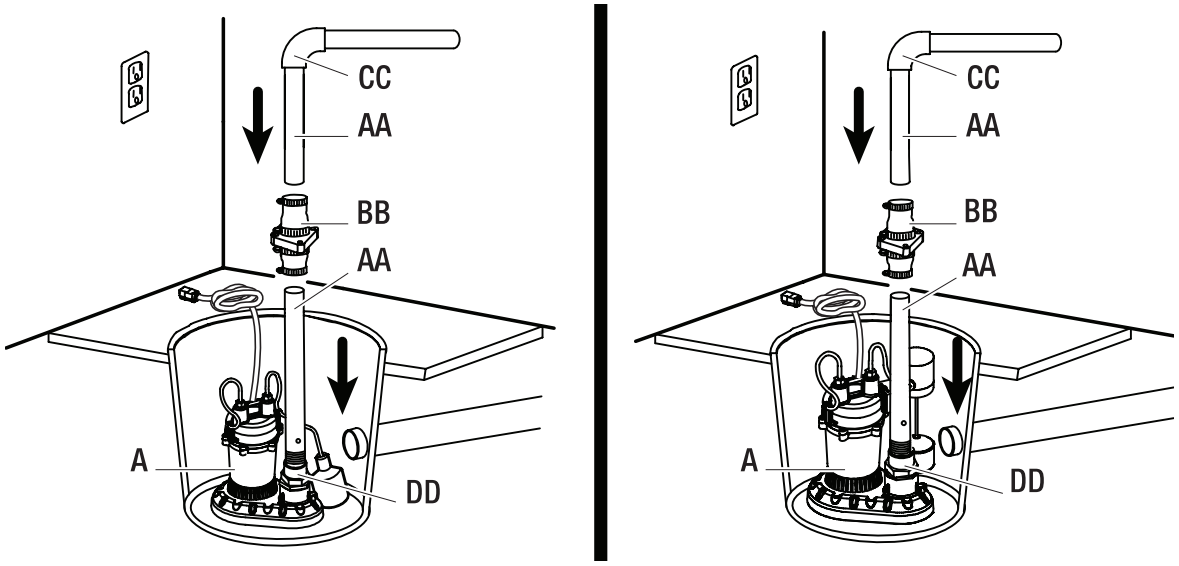
- □ Coloque la bomba sobre una superficie dura dentro del estanque sumidero. No instale la bomba en superficies de arcilla, tierra o arena.
- □ Quite los desechos del estanque sumidero que puedan atascar la bomba. Mantenga el filtro de entrada limpio.



Instalación (continuación)

3 Instalación de la tubería de descarga

- □ Fije un adaptador de tubería (DD) a la tubería de descarga (AA). Coloque cinta selladora de rosca de tubería PTFE en las roscas.
- □ Enrosque la tubería de descarga (AA) a la bomba (A) de manera que quede apretada a mano, más 1-1/2 vueltas.
- □ Instale una válvula de retención (BB) en la línea o en la bomba.

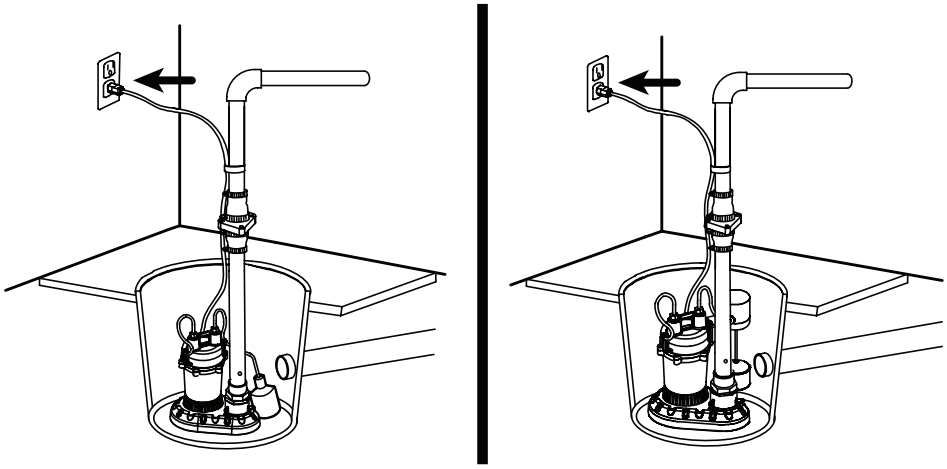


Funcionamiento

1 Conexión de la alimentación

- □ Enchufe el cable de alimentación a un tomacorriente GFCI de 115 V.

ADVERTENCIA: No manipule esta bomba ni la enchufe o desenchufe con las manos húmedas, o si está parado en agua, a menos que esté seguro de que se ha desconectado la alimentación de la bomba. Recuerde, la bomba solo se debe conectar a un tomacorriente GFCI bien conectado a tierra.

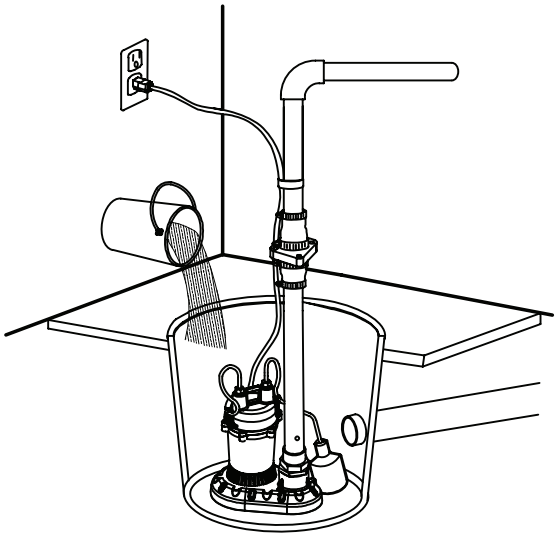


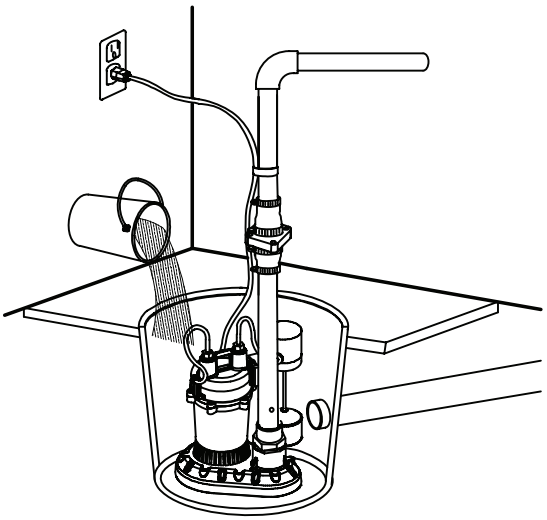
Funcionamiento (continuación)

2 Funcionamiento de la bomba

- □ Después de conectar la alimentación a la bomba, pruébela llenando el estanque sumidero con agua y observando su funcionamiento por un ciclo completo.
- □ El motor posee un protector de sobrecarga térmica con reinicio automático. Si el motor se calienta demasiado, el protector por sobrecarga apagará la bomba antes de que se dañe. Cuando el motor se haya enfriado lo suficiente, el protector por sobrecarga se reiniciará, y el motor volverá a encenderse.
- □ La bomba no extraerá toda el agua. Si opera una bomba manualmente, y de repente deja de salir agua por la manguera de descarga, apague la unidad de inmediato. Es probable que el nivel de agua sea muy bajo y la unidad haya perdido el cebado.

AVISO: Si el protector por sobrecarga detiene la bomba repetidas veces, desconecte la alimentación de la bomba y realice una verificación para encontrar el problema. Las posibles causas de que el motor se sobrecaliente son la baja tensión, un cable de extensión largo, un propulsor atascado, que el filtro esté obstruido con desechos o que el agua esté muy caliente.

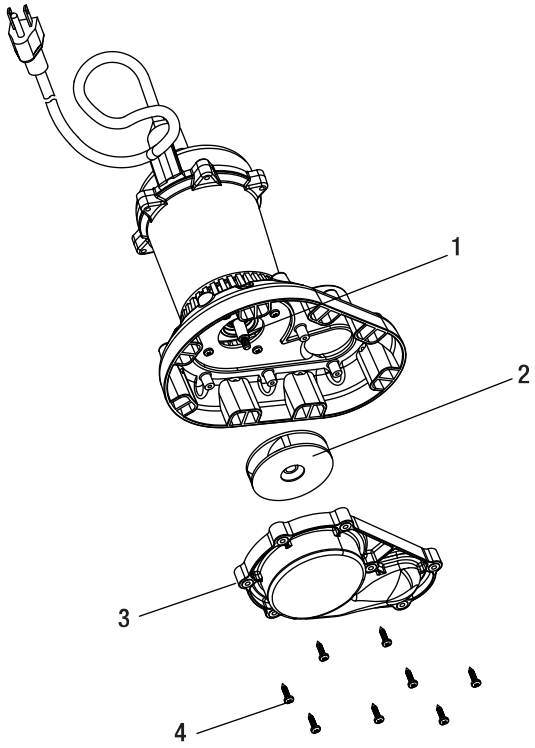




Cuidado y limpieza

ADVERTENCIA: Antes de extraer la bomba del estanque para realizarle servicio, desconecte siempre la alimentación eléctrica a la bomba y al interruptor de control. No levante la bomba tirando del cable de alimentación.

- □ Desatornille los pernos (4) y quite la voluta (3).
- □ De ser necesario use un destornillador de cabeza plana para sostener el eje (1); luego gire el propulsor (2) en sentido antihorario para liberarlo.
- □ Quite los desechos de alrededor del eje (1) y del propulsor (2). El propulsor se muestra afuera para brindar claridad al proceso. No extraiga el propulsor.
- □ Vuelva a ensamblar la bomba.



Resolución de problemas

Problema	Causa probable	Solución
La bomba no funciona.	No hay alimentación.	□ Reinicie el interruptor GFCI □ Reinicie el disyuntor □ Asegúrese de que la bomba esté enchufada □ Limpie las clavijas del enchufe
	El propulsor está bloqueado.	Quite los desechos de alrededor del propulsor.
	El interruptor flotador está averiado.	Reemplace el interruptor flotador.
	El motor está averiado.	Reemplace la bomba.
La bomba funciona, pero bombea poca agua o nada.	El filtro está bloqueado.	Limpie el filtro.
	Hay desechos en el propulsor o la descarga.	Quite los desechos.
	El propulsor está roto.	Reemplace el propulsor.
La bomba arranca y se detiene muy seguido.	Hay un reflujo de agua de la tubería o la válvula de retención tiene pérdidas.	Instale o reemplace la válvula de retención.
	El interruptor flotador está trabado.	Limpie el interruptor flotador.
	El interruptor flotador está averiado.	Reemplace el interruptor flotador.
La bomba no se apaga.	El interruptor flotador está enredado.	Vuelva a colocar la bomba y asegúrese de que el interruptor se mueva libremente.
	El interruptor flotador está averiado.	Reemplace el interruptor flotador.

EVERBILT™

¿Tiene preguntas o problemas, o le faltan piezas? Antes de devolver a la tienda,
llame a Atención al Cliente de Everbilt
Lunes a viernes de 8:00 a.m. a 7:00 p.m., EST, y los sábados de 9:00 a.m. a 6:00 p.m., EST

1-844-883-1872

HOMEDEPOT.COM

Guarde este manual para su uso futuro.

Ver. 08/2019

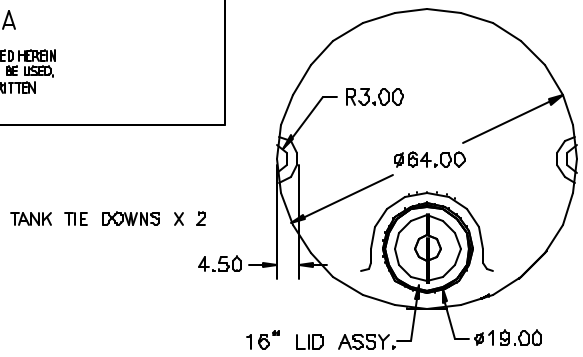
2. TANKS & FILTERS

Submittal #4 Equalization Tank

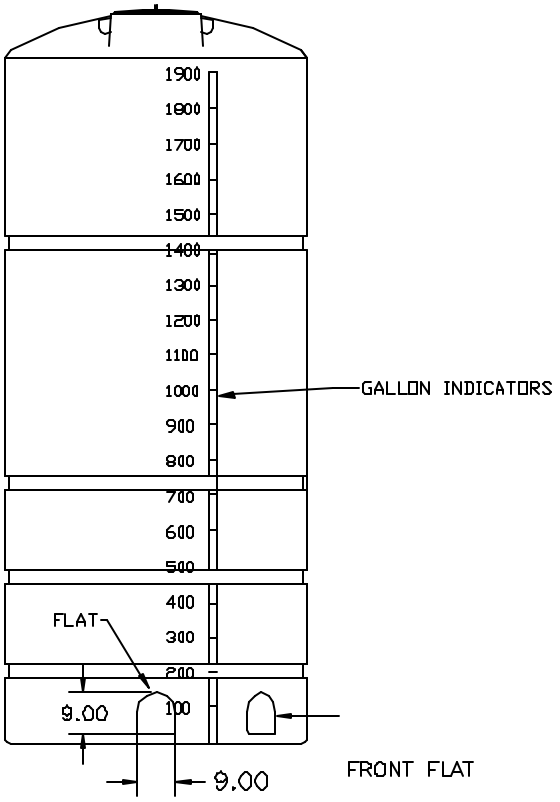
PROPRIETARY DATA

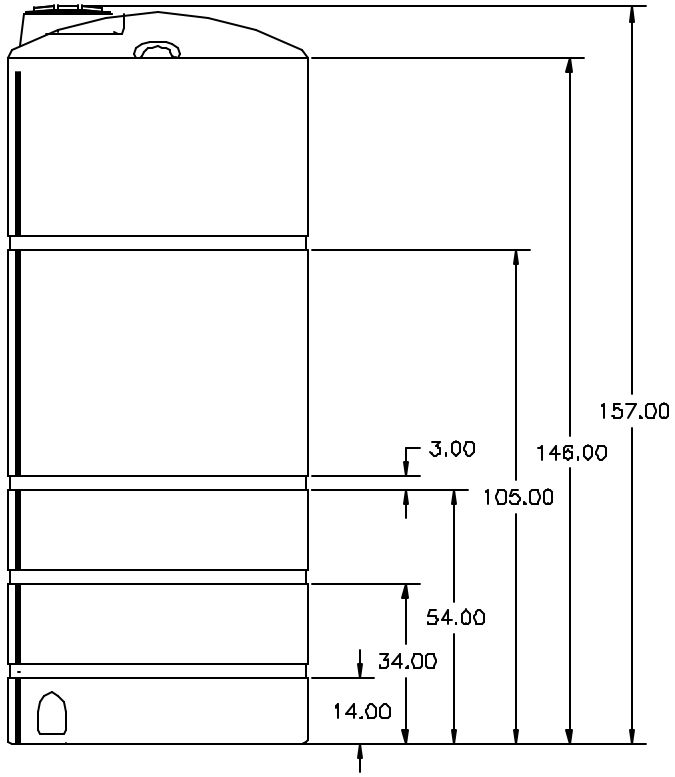
PROPERTY OF ACE ROTO-MOLD MFG. INC. INFORMATION FURNISHED HEREIN IS THE PROPERTY OF ACE ROTO-MOLD MFG., INC. AND SHALL NOT BE USED, DISCLOSED TO OTHERS, OR COPIED WITHOUT THE EXPRESSED WRITTEN CONSENT OF ACE ROTO-MOLD MFG., INC. ALL RIGHTS RESERVED.

VT2000-64



1. HEAVY DUTY POLYETHYLENE CONSTRUCTION
2. 1 PIECE ROTATIONALLY MOLDED
3. TRANSLUCENT
4. FDA APPROVED RESIN
5. CALIBRATED IN GALLONS
6. THREE YEAR WARRANTY
7. UV STABILIZED





REV	DESCRIPTION	DATE	APPRD

DRAWN / DATE
REH 5/8/98

APPRD. / DATE
REH 5/8/98

MATERIAL
HDPE OR EQUIVALENT
REFERENCE MATERIAL DATA SHEET FOR SPECIFIC PROPERTIES.

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± 1% @ 68° F

THIRD ANGLE PROJECTION
ANSI 14.5M

NOTES:
1. 2.7 % SHRINK ALLOWANCE
2. SHOT WEIGHT 654 LBS.
3. BLUE, GREEN, BLACK, WHITE OR YELLOW COLOR

Ace Roto-Mold
A DIVISION OF DON HANTEN INDUSTRIES, INC.
4118 HWY. 61 BLVD., BOX 421, HOSPERS, IOWA 51238

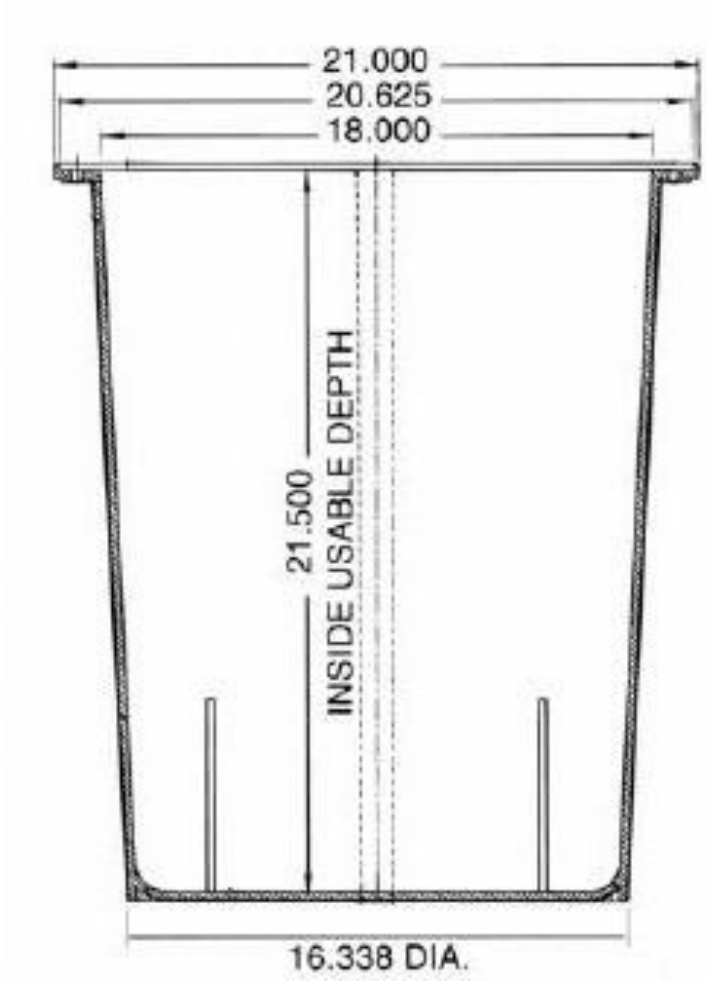
CLIENT / DESCRIPTION
2000 GALLON VERTICAL TANK

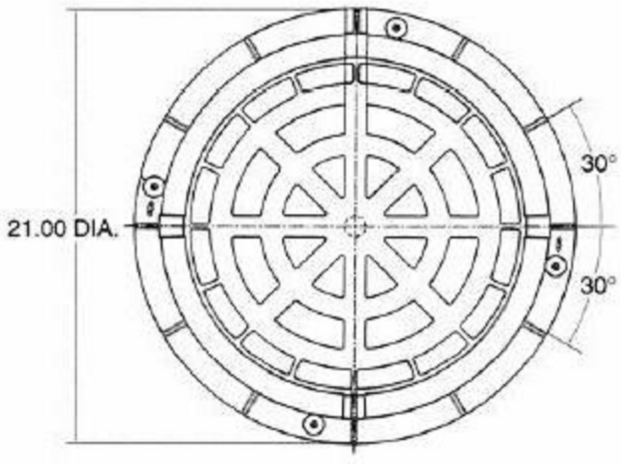
SCALE
N.S.

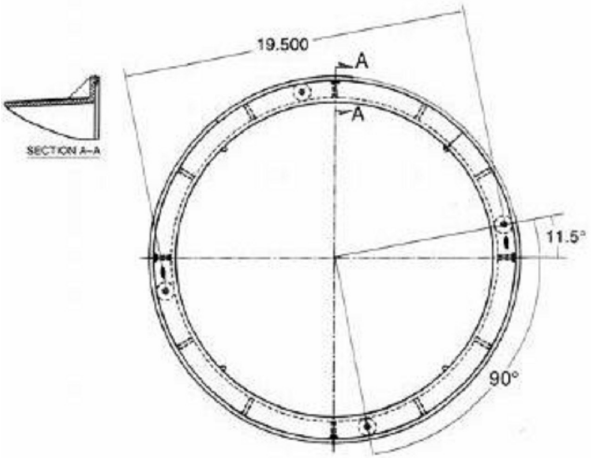
PART NO.
VT2000-64

18 in. x 22 in. Sump Pump Basin

Store SKU #1000027544 | Model SF20







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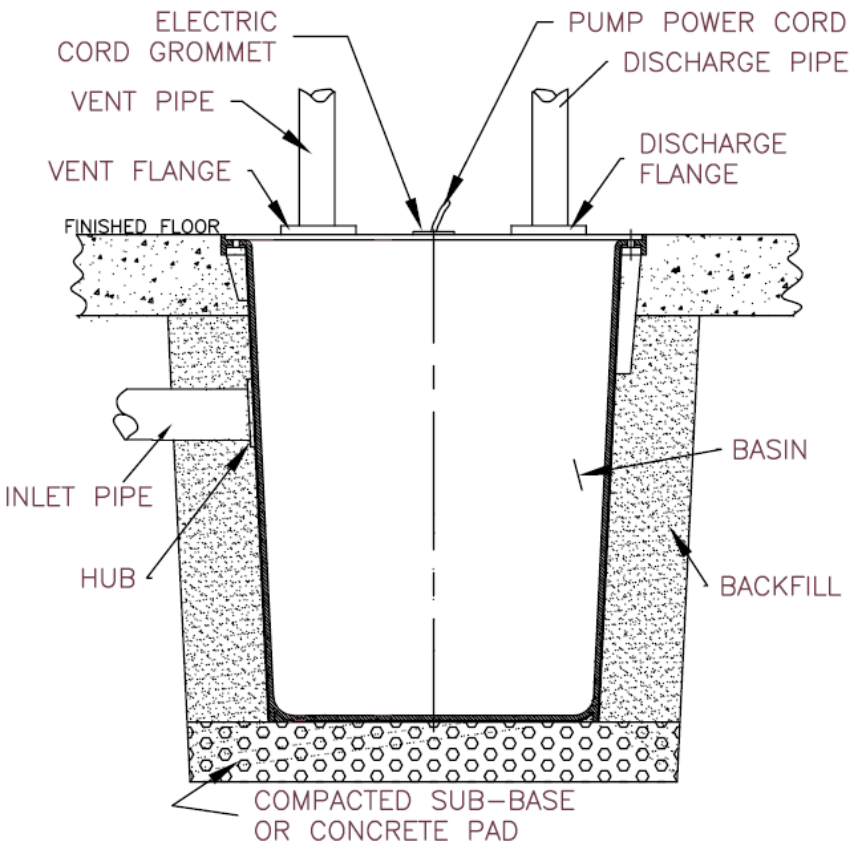
EverbiltTHDSF60913, 06/18

Installation Guide for Molded Sump and Sewage Basins

The below serves only as an installation guide for Everbilt™ molded sump and sewage basins. Please refer to your state and/or local plumbing or onsite wastewater treatment and disposal regulations for details pertaining to your systems design, installation and maintenance requirements.

1. Inspect all parts and materials supplied by The Home Depot to assure that no shipping damage occurred.
2. Excavate hole large enough to accommodate basin, backfill material and inlet piping.
3. Add 4” - 6” of clean backfill material or concrete to the bottom of the hole. Assure that it is level, compacted and smooth.
4. Place the basin in the hole making sure that it is level.
5. Carefully backfill with naturally rounded gravel or stone, larger than 3/8” and smaller than 3/4” diameter, around the periphery of the basin.
6. Connect all piping as required.
7. Finish floor around the basin as required.



Questions, problems, missing parts? Before returning to the store,
call Everbilt Customer Service
8 a.m. - 7 p.m. EST, Monday - Friday and Saturday 9 a.m. - 6 p.m. EST

1-877-297-6069

HOMEDEPOT.COM

PRM Carbon Systems - HP-2000-RDL

The HP Series Carbon units are used on remediation systems where standard flow volumes are required with minimal back-pressure. These units offer a 25% freeboard area for excellent backwash ratios. Typical applications are groundwater remediation for VOCs or industrial sites with similar applications. Several media types are available for removal of more specific compounds such as metals and other contaminants. Aggregate media specifically designed to be backwashed is also available.

APPLICATIONS:

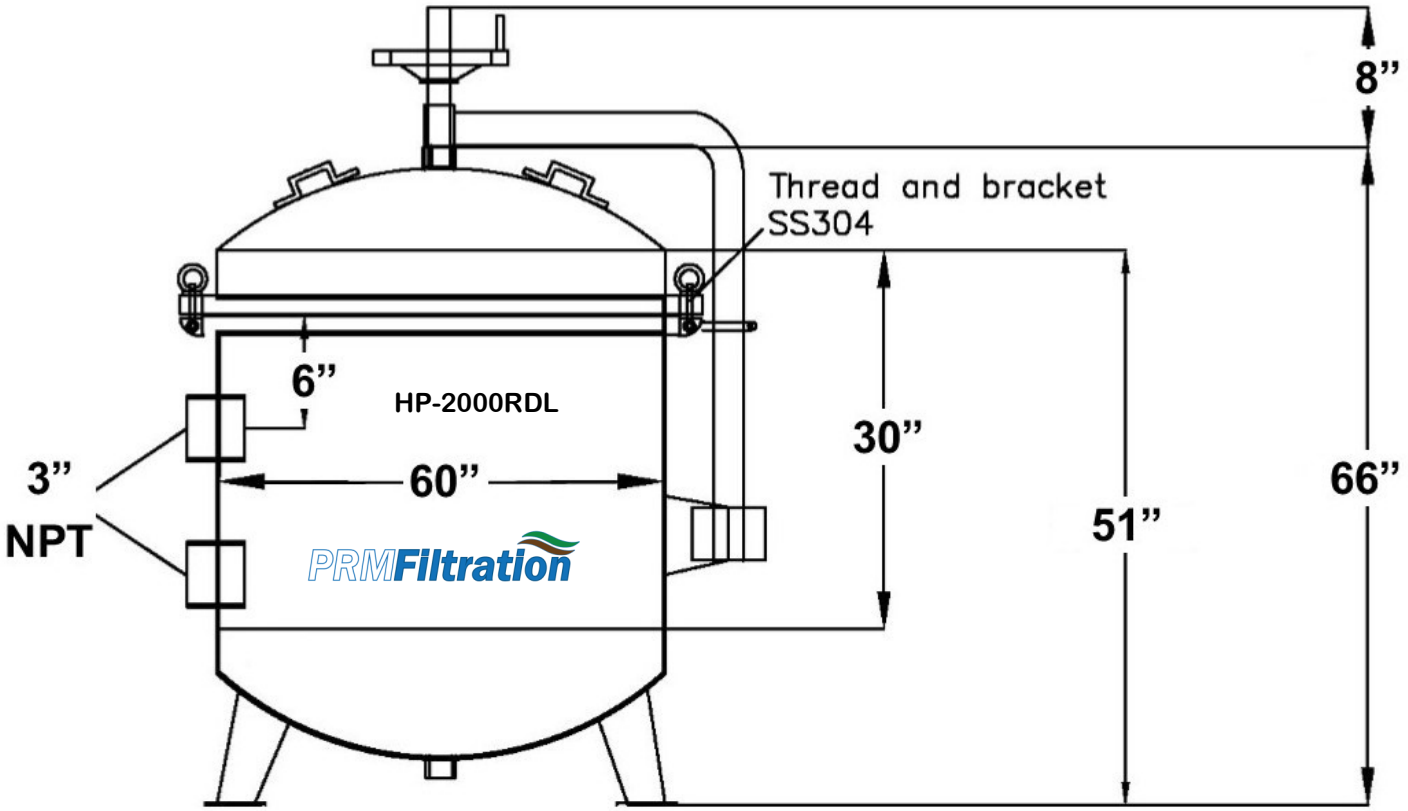
- Remediation of contaminated water streams

STANDARD SPECIFICATIONS:

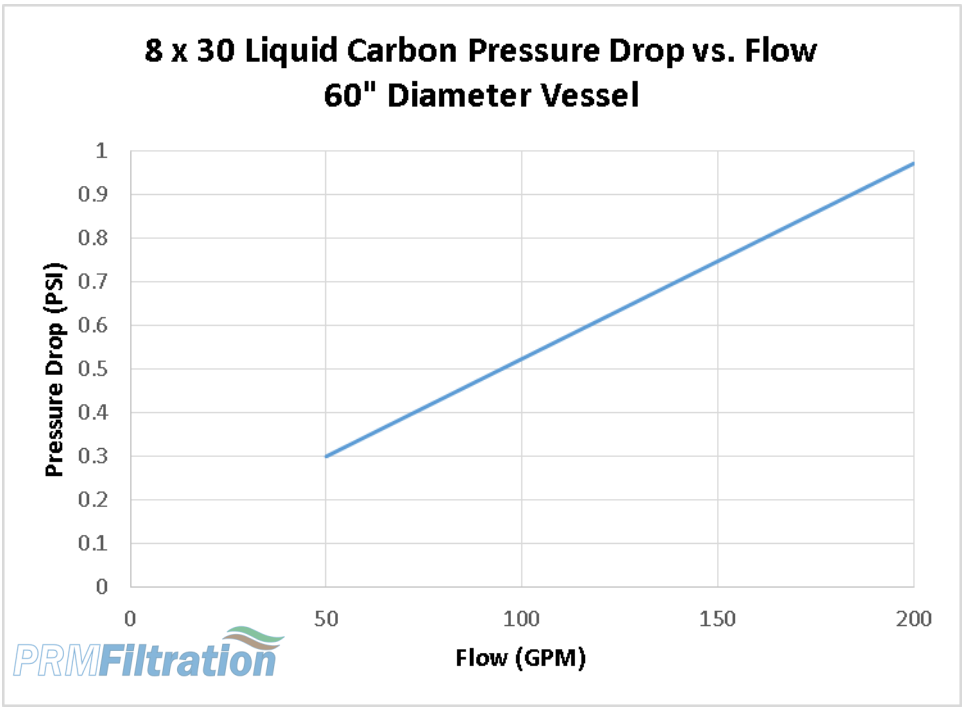
- 60”D x 73”H Tank Vessel With Removable Lid for easy access when changing your carbon media without affecting efficiency or performance
- 3 Inch Inlet/Outlet
- 80 psig maximum pressure
- High Flow Distributor Manifold
- Heavy Duty Welded Legs
- Approx. 2000 lbs. of GAC media based on a packed density bed of 30lbs/ft^3

888-TREAT-IT • www.prmfiltration.com • sales@prmfiltration.com

PRM Carbon Systems - HP-2000-RDL



Dimensions shown in inches.



AVAILABILITY: Build Item: Allow 3 to 6 weeks for manufacturing and shipping

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SUBMITTAL #26 LGAC Media (4,000-lbs)

"CLEANING THE WORLD WITH ACTIVATED CARBON"

GENERAL CARBON CORP.

GC 8 x 30R

regenerated activated carbon

GC 8x30R is a regenerated carbon which is granular in form. Made from bituminous coal, it is ideal for many liquid phase applications including the removal of organic contaminants from liquid streams. Its size makes it appealing where low pressure drop is needed. It is not recommended for use in the purification of drinking water or other food grade applications.

Specifications

Mesh size – 8 x 30, %:	90 (min)
Less than No. 8, %:	5 (max)
Greater than No. 30, %:	5 (max)
Iodine No., mg/g:	800 (min)
Surface Area, m^2/g:	800 (min)
Moisture, % (as packaged):	5 (max)
Typical Density, lbs./cu.ft.:	28-32
g/cc:	0.45-0.51

*Standard packaging is in 1,000lb vinyl bags. Other packaging is available upon request with an additional cost.

Caution!

Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels. Confined space/low oxygen procedures should be put in place before any entry is made. Such procedures should comply with all applicable Local, State and Federal guidelines.

33 Paterson Street, Paterson, New Jersey 07501 Tel: 973 523 2223 Fax: 973 523 1494
www.generalcarbon.com sales@generalcarbon.com

Filter Bag Pressure Drop

The graphs give the clean pressure drop through a number 2 size bag for water, 1 CPS @ 68°F

To determine the pressure drop caused by the filter bag, follow these steps:

Step 1 Select the type of bag, micron rating and flow rate, determine the pressure drop for water, 1 cps @ 68°F, for a size #2 bag.

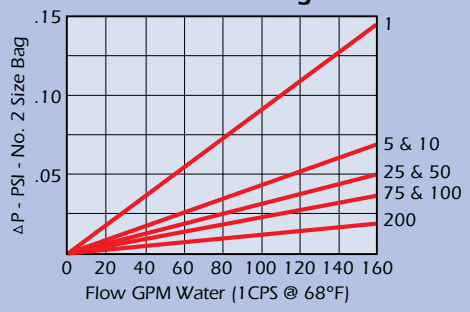
Step 2 Correct for bag size from the Bag Size Correction table at the right if the bag size is different than a #2 size.

Step 3 If the viscosity of the liquid is greater than 1 cps (water@ 68°F.),multiply the result from step 2 by the proper correction factor from the Viscosity Correction table at the right.

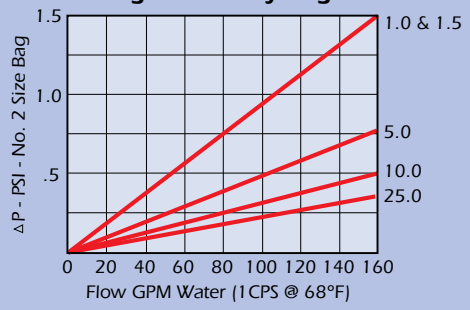
The value obtained in Step 3 is the clean pressure drop caused by the filter bag.

SUMMARY
For new applications, the clean pressure drop of the system, housing and bag should be 2.0 PSI or less. The lower the value is, the more contaminant a bag will hold. For applications with low dirt loading, this value can go to 3.0 PSI or more. Consult the factory for recommendations when the clean pressure drop of the system exceeds 3.0 PSI.

Felt & Mesh Bags



High Efficiency Bags



Bag Size Correction		
Bag Size	Dia. x Length	Multiply By
1	7.2 x 16	2.25
2	7.2 x 32	1.0
3	4.3 x 8	9.0
4	4.3 x 14	4.5
8	5.7 x 21	2.25
9	5.7 x 37	1.50

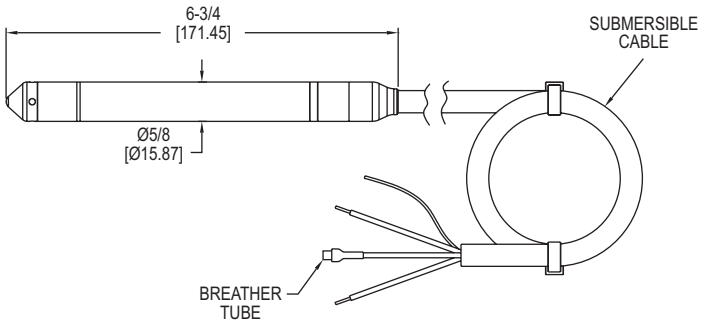
Viscosity Correction	
Viscosity CPS	Correction Factor
50	4.5
100	8.3
200	16.6
400	27.7
800	50.0
1000	56.2
1500	77.2
2000	113.6
4000	161.0
6000	250.0
8000	325.0
10,000	430.0

3. INSTRUMENTATION

Bulletin L-MBLT

Series MBLT Miniature Submersible Level Transmitter

Specifications - Installation and Operating Instructions



The **MBLT Miniature Submersible Level Transmitter** is only 0.63″ in diameter making it ideal for level monitoring in well and borehole applications with 4 to 20 mA or 0 to 5 V output. Designed for years of trouble free service, the MBLT has a welded 316 SS body and 316 SS nose cap. Body top is also 316 SS and tapered to prevent damage or snares when pulling the unit out of the installation. Featured in the MBLT is a precision ±0.10% or 0.25% of full scale accuracy output, better than BFSL or BSL rated outputs used by most competitors. Lightning and surge protection (not guaranteed or covered by standard warranty) is included standard to stand up in harsh applications. MBLT comes with a choice of polyether polyurethane or ETFE cable materials and all are vented for barometric pressure compensation. Vent is covered with a maintenance-free filter preventing particulate or water droplets from entering the transmitter. Voltage output models work down to 8 VDC for power requirements making them ideal for battery powered telemetry systems.

APPLICATIONS

- Ballast tanks; Ground water monitoring; Surface water monitoring; Dewatering; Down hole; Remediation; Telemetry and other environmental monitoring applications.

SPECIFICATIONS

Service: Compatible liquids.
Wetted Materials: Body and nose: 316 SS; Cable: Polyether polyurethane or 0ETFE; Seals: Fluoroelastomer; Label: Polyolefin.
Accuracy: ±0.25% or ±0.10% of FS.
Temperature Limits: -4 to 176°F (-20 to 80°C).
Compensated Temperature Limits: 0.25%: (0 to 70°C); 0.10%: (0 to 60°C).
Thermal Effect: 0.25%: ±0.45% FS TEB; 0.10%: ±0.30% FS TEB.
Pressure Limit: 2x FS.
Power Requirements: Current Output: 10 to 33 VDC; Voltage Output: 8 to 33 VDC; 5 mA max (no load).
Output Signal: 4 to 20 mA DC 2-wire or 0 to 5 V*.
Response Time: < 50 ms.
Max Loop Resistance: 1000Ω @ 30 VDC (current output);
Voltage Output Impedance: 10Ω + 4.4Ω / 100´ cable (voltage output).
Electrical Connections: Wire pigtail.
Mounting Connection: Suspended below point being monitored.
Electrical Protection: Surge/lightning protected per EN61000-4-5, Class 5.
Weight: Body: 0.235 lb (0.107 kg); Cable: 0.037 lb (0.017 kg) per foot.
Agency Approvals: CE.

*Consult factory for additional outputs.

MODEL CHART

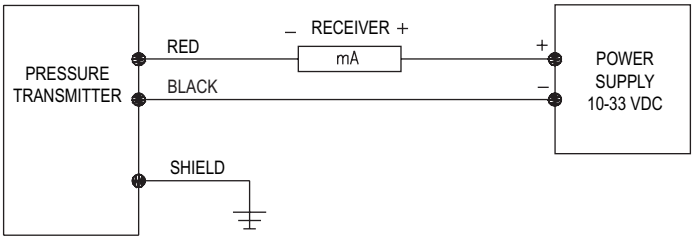
Example	MBLT	-2	S	C	-I	V	P	F	-30	-50	-NIST	MBLT-2SC-IVPF-30-50-NIST
Construction	MBLT											Miniature submersible level transmitter
Circuit Options		2										Lightning surge protected
Body Material			S									316 SS
Accuracy				B C								0.10% 0.25%
Output					I V							4 to 20 mA 0 to 5 V
Reference						V						Vented
Cable Material							P E					Polyether polyurethane ETFE
Range Units								F M P				Feet of water column Meter of water column PSI
Range Value									X			Dependent on range unit
Cable Length										X		In feet for feet and psi range, in meters for meter range
Options											NIST	NIST traceable certificate

MERCOID A DIVISION OF DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Phone: 219/879-8000 www.dwyer-inst.com
Fax: 219/872-9057 e-mail: info@dwyermail.com

ELECTRICAL INSTALLATION

An external power supply delivering 10 to 33 VDC for a current output unit, with minimum current capability of 40 mA DC (per transmitter) and 8 to 33 VDC with minimum current capability of 10 mA DC (per transmitter) for a voltage output unit is required to power the control loop. See figure below for connection of the power supply, transmitter and receiver.

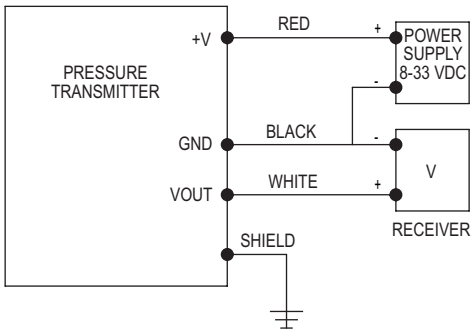
Current Output:



The maximum loop resistance (RLmax) for the DC power supply voltage (Vsup) is expressed by the formula:

Current Output: $RLmax = \frac{Vsup - 10V}{0.02A}$

Voltage Output:



Note: Observe polarities.
Shielded cable is recommended for control loop wiring.

WARNING

A voltage potential between the ground wire of the unit and the ground of other equipment can lead to electrolytic corrosion. Ensure the grounding system provides an equipotential between the transmitter and the earthing ground connection. Avoid using the power system protective ground since this will often have a significant potential difference to the transmitter ground. Also note that dissimiliar metals in the ground system may cause electrolysis corrosion of the transmitter or other components in the ground system.

During installation, connect a voltmeter or ammeter between the shield ground wire and the grounding connection. If there is a measurable voltage or current electrolytic corrosion may be a serious possibility. If there is a potential difference then some isolation system will be required. Improper grounding may lead to damage or poor signal integrity.

Note: “Lightning Protected” means that the product incorporates protection circuitry that will reduce the likelihood of damage to the product by lightning induced transients on interconnection wiring. The product may not operate within specification during the transient but will recover afterwards to full specified operation. “Lightning Protected” products are not intended for direct exposure to conducted lightning discharges nor are they intended to be protective devices for other equipment connected to them.

MAINTENANCE/REPAIR

Upon final installation of the Series MBLT, no routine maintenance is required. The Series MBLT is not field serviceable and should be returned if repair is needed (field repair should not be attempted and will void warranty).

WARRANTY/RETURN

Refer to “Terms and Conditions of Sales” in our catalog and on our website. Contact customer service to receive a Return Goods Authorization number before shipping the product back for repair. Be sure to include a brief description of the problem plus any additional application notes.

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DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Phone: 219/879-8000 **www.dwyer-inst.com**
Fax: 219/872-9057 **e-mail: info@dwyermail.com**

ProSense® SPT25 Series Pressure Transmitters

The ProSense SPT25 pressure transmitter series is engineered to meet many industrial, commercial, and OEM pressure measurement applications. The all stainless steel welded thin film sensing element provides very fast response time and is compatible with many different media sensing applications. With a robust design resistant to vibration, shock, and EMI/RFI, the SPT25 series provides high accuracy over a wide compensated temperature range. Pressure sensing ranges from vacuum to 5000 psig are available along with a ¼ inch NPT male threaded process connection. Choose from linear outputs of 4-20 mA or 0-10VDC with electrical connections of either a DIN 175301-803C L-connector or 6.6 foot (2 m) integral shielded cable.

Applications

- Process control & automation
- Pump & compressor control
- Hydraulic systems
- Pneumatic systems
- Engine monitoring
- Refrigeration equipment
- Presses
- Machine tools

Features

- All stainless steel welded sensing element
- Fast response time
- Pressure sensing ranges from vacuum to 5000 psig
- 1/4 inch NPT male threaded process connection
- Output options: 4-20 mA or 0-10 VDC
- Integral 6.6 foot shielded cable or DIN form C electrical connections
- Made in the USA
- CE marked
- 3-year warranty

Click on the thumbnail or go to https://www.automationdirect.com/VID-PR-0001 for a short video on ProSense Air Differential and Pressure Transmitters

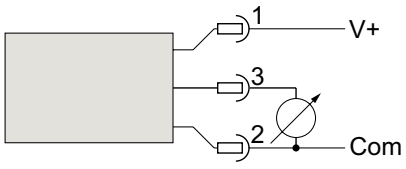
ProSense SPT25 Series Pressure Transmitters (Shielded Cable)

Part Number	Description	Electrical Connection	Input Voltage	Wt(lb)	Price
SPT25-20-V30A	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	Integral 6.6 ft (2m) shielded cable	9 - 36 VDC	0.38	$153.00
SPT25-20-0030A	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-20-0060A	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-20-0100A	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-20-0150A	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-20-0200A	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-20-0300A	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-20-0500A	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-20-1000A	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-20-1500A	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-20-2000A	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-20-3000A	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-20-5000A	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$153.00
SPT25-10-V30A	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$153.00
SPT25-10-0030A	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$153.00
SPT25-10-0060A	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$153.00
SPT25-10-0100A	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$153.00
SPT25-10-0150A	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$153.00
SPT25-10-0200A	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$153.00
SPT25-10-0300A	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$153.00
SPT25-10-0500A	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$153.00
SPT25-10-1000A	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$153.00
SPT25-10-1500A	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$153.00
SPT25-10-2000A	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$153.00
SPT25-10-3000A	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$153.00
SPT25-10-5000A	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$153.00

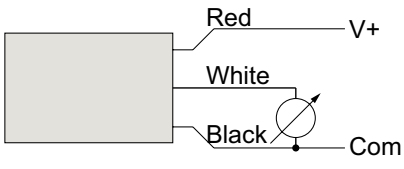
ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series Pressure Transmitters (DIN Connector)					
Part Number	*Description*	*Electrical Connection*	*Input Voltage*	*Wt(lb)*	*Price*
SPT25-20-V30D	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	DIN 175301-803C L-connector	9 - 36 VDC	0.30	$147.00
SPT25-20-0030D	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-20-0060D	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-20-0100D	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-20-0150D	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-20-0200D	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-20-0300D	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-20-0500D	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-20-1000D	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-20-1500D	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-20-2000D	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-20-3000D	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-20-5000D	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port				$147.00
SPT25-10-V30D	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		$147.00
SPT25-10-0030D	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				$147.00
SPT25-10-0060D	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				$147.00
SPT25-10-0100D	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				$147.00
SPT25-10-0150D	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				$147.00
SPT25-10-0200D	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				$147.00
SPT25-10-0300D	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				$147.00
SPT25-10-0500D	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port				$147.00
SPT25-10-1000D	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port				$147.00
SPT25-10-1500D	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port				$147.00
SPT25-10-2000D	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port				$147.00
SPT25-10-3000D	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port				$147.00
SPT25-10-5000D	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port				$147.00

0 to 10 VDC Output Wiring Diagram

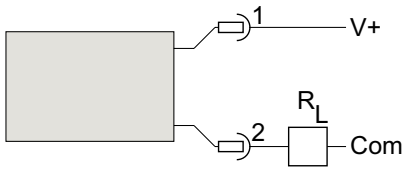


With DIN Connector

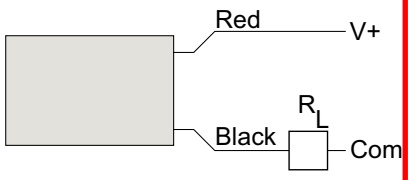


With Integral Cable

4 to 20 mA Output Wiring Diagrams



With DIN Connector



With Integral Cable

Shielded Cable Models Wire Designation		
Wire Color	*0 - 10 VDC Output*	*4 - 20 mA Output*
Red	V +	V +
Black	Com	Output
White	Output	None
*Bare**	Shield Drain Wire	Shield Drain Wire

** Where shielded wiring is being used; Connect the drain wire to the guard terminal on the read out device or measuring instrument if available. In all other cases connect to the power supply negative terminal.*

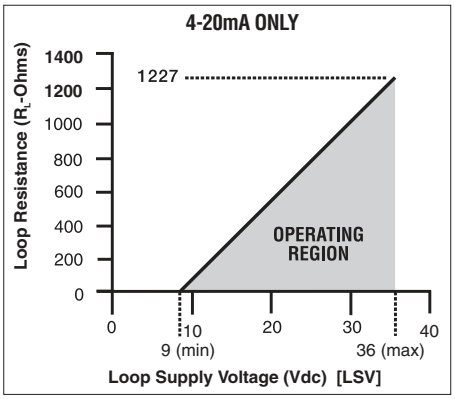
DIN Form C Models Pin Designation		
Pin No.	*0 - 10 VDC Output*	*4 - 20 mA Output*
1	V+	V+
2	Com	Output
3	Output	None
4	Case Ground	Case Ground

ProSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series General Specifications	
Housing Material	20% Glass Reinforced Nylon, Fire retardant to UL94 V1 / 304 Series Stainless steel
Materials (wetted parts)**	304 Series Stainless steel / 17-4PH Stainless Steel
Operating Temperature	–40 to 257°F (–40 to 125°C)
Medium Temperature	–40 to 257°F (–40 to 125°C)
Storage Temperature	–40 to 257°F (–40 to 125°C)
Protection	IP 67 for cabled models IP 65 For DIN connector models
Accuracy*	± 0.50% of full range
Temperature Coefficient	0.15% of full range / 10°F (0.25% of full range / 10°C)
Reference Temperature	70°F ± 1°F (21°C ± 1°C)
Compensated Temperature	–4 to 185°F (–20 to 85°C)
Insulation Resistance	Greater than 100 megohms at 100 VDC
Shock Resistance	100 gs, 6 ms
Vibration Resistance	Random vibration (20 g) over temperature range (-40° to 125°C). Exceeds typical MIL. STD. requirements
Drop Test	Withstands 1 meter on concrete 3 axis
Response Time	Less than 1 msec
Warm-up time	Less than 500 msec
Position Effect	Less than ±0.01% span, typical
Insulation Breakdown Voltage	100 VAC
Reverse Polarity & Miswired Protected	Yes
Durability	Tested to 50 million cycles
Humidity	0 to 100% R.H., no effect
Stability	Less than ±0.25% full range / year
Agency Approvals	CE
****Note - Includes non-linearity, hysteresis & non-repeatability.***	
***** Not cleaned for oxygen service***	

ProSense SPT25 Series Technical Specifications	
Technical Specifications SPT25-20-xxxx	
Operating Voltage	9 – 36 VDC
Analog Output	4 – 20 mA
Maximum Load	Determine Maximum Loop Resistances $\frac{V_L - 9\ VDC}{0.022\ amps} = R_L$ For example [(24 VDC – 9 VDC) / 0.022 amps] = 681Ω
Technical Specifications SPT25-10-xxxx	
Operating Voltage	14 – 36 VDC
Current Consumption	4 mA
Minimum Load	10 kΩ

Power Supply Voltage vs Loop Resistance



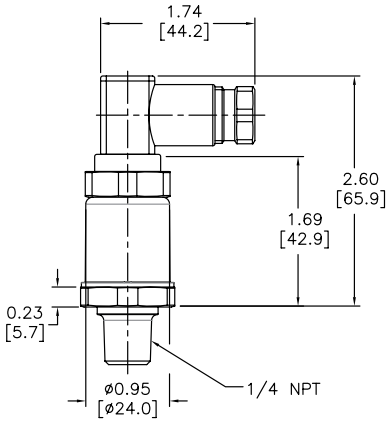
DIN Connector Specifications	
Number of contacts	3 + PE
Cable glands	PG 7
Conductor size max.	0.75 mm² / 18AWG
Type of termination	Screw
Suitable cables	4.5 mm to 6mm
Standard DIN	EN 175 301-803-C

ProSense SPT25 Proof & Burst Pressures		
	Proof	***Burst***
500 psig & below	200% full scale	1000% full scale
1000 – 2000 psig	200% full scale	500% full scale
3000 psig	200% full scale	500% full scale
5000 psig	150% full scale	500% full scale

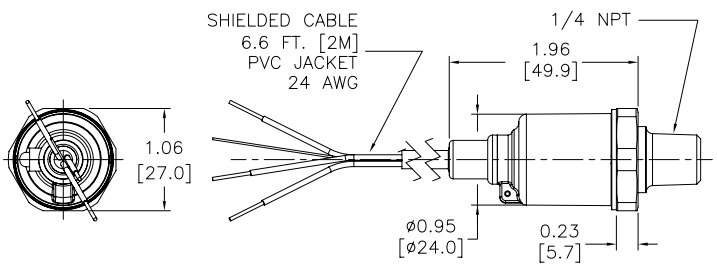
See our website www.AutomationDirect.com for complete Engineering drawings.

Dimensions

inches [mm]



DIN Connector Models



Shielded Cable Models

MODEL SPT25
PRESSURE TRANSDUCER
INSTALLATION & MAINTENANCE SHEET

⚠ WARNING! READ ⚠ BEFORE INSTALLATION

1. GENERAL:
A failure resulting in **injury** or **damage** may be caused by excessive overpressure, excessive vibration or pressure pulsation, excessive instrument temperature, corrosion of the pressure containing parts, or other misuse. Consult Automation Direct, Cumming, GA, USA at 1-800-633-0405 before installing if there are any questions or concerns.

2. OVERPRESSURE:
Pressure spikes in excess of the rated overpressure capability of the transducer may cause **irreversible electrical and/or mechanical damage** to the pressure measuring and containing elements.
Fluid hammer and surges can destroy any pressure transducer and must always be avoided. A pressure snubber should be installed to eliminate the damaging hammer effects. Fluid hammer occurs when a liquid flow is suddenly stopped, as with quick closing solenoid valves. Surges occur when flow is suddenly begun, as when a pump is turned on at full power or a valve is quickly opened.
Liquid surges are particularly damaging to pressure transducers if the pipe is originally empty. To avoid damaging surges, fluid lines should remain full (if possible), pumps should be brought up to power slowly, and valves opened slowly.
To avoid damage from both fluid hammer and surges, a surge chamber should be installed.

Symptoms of fluid hammer and surge's damaging effects:

- Pressure transducer exhibits an output at zero pressure (large zero offset).
- Pressure transducer output remains constant regardless of pressure
- In severe cases, there will be no output.

ProSense SPT25 Proof & Burst Pressures		
	Proof	**Burst**
500 psi & below	200% FS	1000% FS
1000-2000 psi	200% FS	500% FS
3000 psi	200% FS	500% FS
5000 psi	150% FS	500% FS

FREEZING:
Prohibit freezing of media in pressure port. Unit should be drained (mount in vertical position with electrical termination upward) to prevent possible overpressure damage from frozen media.

3. STATIC ELECTRICAL CHARGES:
Any electrical device may be susceptible to damage when exposed to static electrical charges. To avoid damage to the transducer observe the following:
- Ground the body of the transducer BEFORE making any electrical connections.
- When disconnecting, remove the ground LAST!

Note: The shield and drain wire in the cable (if supplied) is not connected to the transducer body, and is not a suitable ground.

DESCRIPTION
The SPT25 pressure transducer is a high performance instrument intended for use in industrial applications where the process media is compatible with the 17-4PH stainless steel sensor material and the 304 SS process connection.

MECHANICAL INSTALLATION
Environmental
The SPT25 transducer can be stored and used within the temperature limits of –40°C to 125°C (-40°F to 257°F). Ingress protection ratings of the units are dependent on the electrical termination specified.

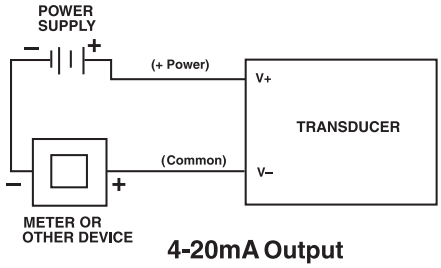
Mounting
The SPT25 transducer requires no special mounting hardware and can be mounted in any orientation with negligible position error. Although the units can withstand considerable vibration without damage or significant output effects, it is always good practice to mount the transducer where there is minimum vibration. For units with NPT type pressure fittings apply sealing tape or an equivalent sealant to the threads before installing. When installing or removing the unit apply a wrench to the hex wrench flats, located above the pressure fitting.
DO NOT tighten by using a pipe wrench on the housing. A 27mm (1⅛″) wrench can be used on the wrench flats of the hex.

Electro-Magnetic Interference
The circuitry of the SPT25 transducer is designed to minimize the effect of electromagnetic and radio frequency interference. To minimize susceptibility to noise, avoid running the termination wiring in a conduit which contains high current AC power cables. Where possible avoid running the termination wiring near inductive equipment.

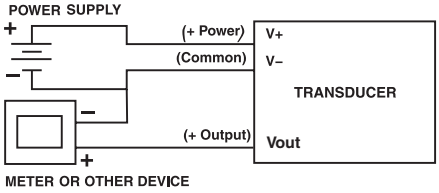
Field Adjustments
The SPT25 transducer is precisely calibrated and temperature compensated at the factory to ensure long and stable performance. There are no field accessible adjustments on the SPT25 transducer.

SPT25 ELECTRICAL INSTALLATION

Wiring Diagrams



4-20mA Output



3-Wire Voltage Output

Power Supply Requirements:

Output Signal	Min Supply	Max Supply
0-10V	14Vdc	36Vdc
4-20mA*	9Vdc	36Vdc

*For transmitters with 4-20mA output signal, the minimum voltage at the terminals is 9Vdc. However, the minimum supply voltage should be calculated using the adjacent graph and formula.

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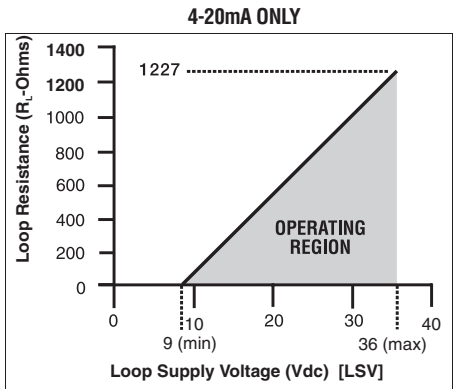
MODEL SPT25
PRESSURE TRANSDUCER
INSTALLATION & MAINTENANCE SHEET

prosense™

SPT25 ELECTRICAL INSTALLATION

Power Supply Voltage vs Loop Resistance



Determine Maximum Loop Resistance
VL - 9Vdc
_____ = RL
0.022 amps
For example:
[(24Vdc – 9Vdc)/0.022 amps] = 682Ω

0-10V Output
Minimum resistance: 10,000Ω

SPT25 ELECTRICAL TERMINATIONS AND WIRING

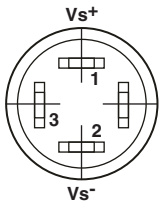
DIN-C Connector

4-20 ma output

V_S+: #1

V_S–: #2

Connection - PIN



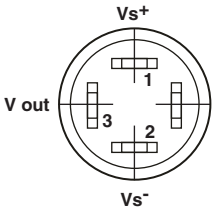
0-10V output

V_S+: #1

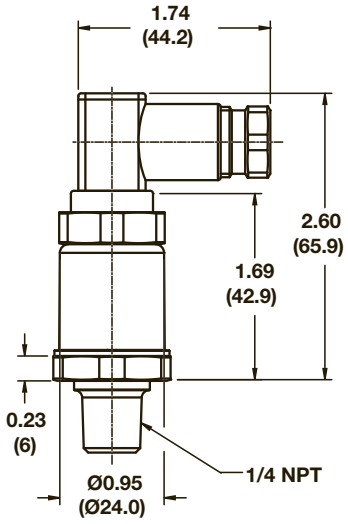
V_S–: #2

V_{OUT}: #3

Connection - PIN



IP 65 Ingress Rating



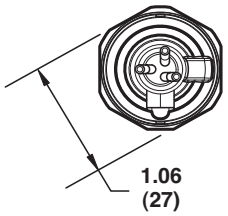
Dimension shown in inches (mm)

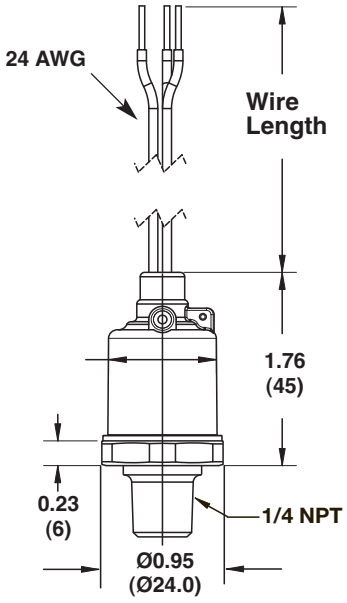
Shielded Cable

PVC JACKET, 24AWG LEADS

Wire Color	Voltage Output	4-20mA Output
Red	V +	V +
Black	Common	V –
White	Output	
Bare	Shield Drain Wire	Shield Drain Wire

IP67 Ingress rating





Dimension shown in inches (mm)

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Signet 2537 Paddlewheel Flowmeter

The Signet 2537 Flowmeter is the next generation in fluid measurement technology from the inventor of the original paddlewheel flowmeter. This sensor is an improvement on what's already an industry standard. It has the added functionality of various output options including flow switch, multi-functional pulse, digital (S^3L) or 4 to 20 mA. Additionally, it offers low flow, low power and high resolution and can be configured on-site directly through the built-in user interface.

Installation is simple because the Signet 2537 utilizes the same fittings as the popular Signet 515 and 2536 Paddlewheel Sensors and fits into pipe sizes ranging from DN15 to DN200 (½ to 8 inches). Available in Polypropylene and PVDF, it is ideal for a variety of applications including chemical processing, water and wastewater monitoring and scrubber control.

Features

- **Digital (S^3L) or 4 to 20 mA outputs or (Multi-function)**
- **Allows for up to six sensors to Signet 8900 Controller**
- **Low flow capabilities down to 0.1 m/s (0.3 ft/s)**
- **Polypropylene or PVDF sensor bodies**
- **Polypropylene or PVDF retaining nuts**
- **Installs into pipe sizes DN15 to DN200 (½ to 8 in.)**
- **Test certificate included for -X0, -X1**
- **Low power and high resolution**

Applications

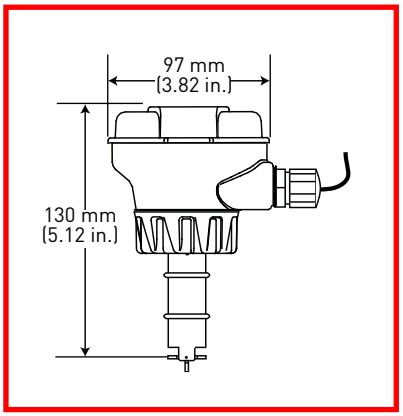
- **Process Flow Monitoring**
- **Pump Protection**
- **Pure Water Production**
- **Filtration Systems**
- **Chemical Production**
- **Reverse Osmosis**
- **Demineralization/Regeneration**
- **Fume Scrubbers**
- **Cooling Towers**
- **Proportional Metering Pump**

Specifications

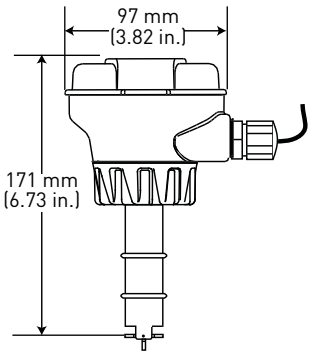
General			
Operating Range		0.1 m/s to 6 m/s	0.3 ft/s to 20 ft/s
Pipe Size Range		DN15 to DN200	½ to 8 in.
Linearity		±1% of max. range @ 25 °C (77 °F)	
Repeatability		±0.5% of max. range @ 25 °C (77 °F)	
System Response		100 ms update rate nominal	
Wetted Materials			
Sensor Body	Glass-filled PP (black) or PVDF (natural)		
O-rings	FPM (std) optional EPR (EPDM) or FFPM		
Rotor Pin	Titanium, Hastelloy-C or PVDF; optional Ceramic, Tantalum or Stainless Steel		
Rotor	Black PVDF or Natural PVDF; optional ETFE, with or w/o carbon fiber reinforced PTFE sleeve for rotor pin		
Electrical			
Multi	With Dry-Contact Relay	24 VDC nominal, ±10%, regulated, 30 mA max current	
	With Solid-State Relay	6 V to 24 VDC, ±10%, regulated, 30 mA max current	
	Digital (S^3L)	5.0 VDC min to 6.5 VDC max., 30 mA max current (1.5 mA nominal)	
	4 to 20 mA	400 mV max ripple voltage, 30 mA max current	
	Maximum Pulse Rate	300 Hz	
	Maximum Pulse Width	50 ms	
	Minimum Pulse Rate	0.5 Hz	
	Compatible with PLC, PC or similar equipment		
	Compatible with customer supplied metering pump		
Digital (S^3L) Version		5 VDC nominal, regulated, 3 mA max current	
	Type	Serial ASCII, TTL level 9600 bps	
	Max. Cable Length	Refer to Signet 8900 wiring specifications.	
	Compatible with Model Signet 8900 controller		
4 to 20 mA Version		12 to 32 VDC nominal, ±10%, regulated, 21 mA max current	
	Loop Accuracy	±32 µA @ 25 °C @ 24 VDC)	
	Loop Resolution	5 µA	
	Temp. Drift	±1µA per °C max.	
	Power Supply Rejection	±1µA per V	
	Max. Cable	305 m	1000 ft
	Maximum Loop Resistance	600 Ω @ 24 VDC	1 KΩ @ 32 VDC
	Load Impedance	375 Ω	
Reverse Polarity and Short Circuit Protected		Up to 40 V, 1 hour	
Over-voltage Protection		> 40 VDC over 1 hour	
Relay Specifications			
	Mechanical SPDT	5 A @ 30 VDC, 5 A @ 250 VAC	
	Solid-State Relay	100 mA @ 40 VDC, 70 mA @ 33 VAC	
	Relay Modes	Low, High	
	Time Delay	0.0 to 6400.0 seconds	
	Hysteresis	Adjustable for exiting alarm condition	
Max. Temperature/Pressure Rating			
Storage Temperature		-10 °C to 75 °C	14 °F to 167 °F
Operating Temperature		0 °C to 65 °C	32 °F to 149 °F
Relative Humidity		0 to 90%, non-condensing	
Flow Sensor/ Retaining Nut	PP	12.5 bar @ 20 °C	181 psi @ 68 °F
		1.7 bar @ 85 °C	25 psi @185 °F
	PVDF	14 bar @ 20 °C	203 psi @ 68 °F
		1.7 bar @ 85 °C	25 psi @ 185 °F
Operating Temperature			
	PP	-18 °C to 85 °C	0 °F to 185 °F
	PVDF	-18 °C to 85 °C	0 °F to 185 °F
Environmental			
Enclosure	NEMA 4X/IP65		
Shipping Weight			
	0.640 kg	1.41 lb	
Standards and Approvals			
	CE, FCC, UL		
	RoHS compliant, China RoHS		
	Manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.		

Dimensions

½ in. to 4 in. pipe



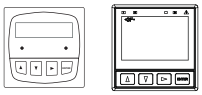
~~5 to 8 in. pipe~~

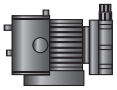


In-Line Installation

System Overview

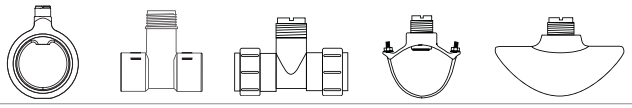
Panel Mount	4 to 20 mA Input	4 to 20 mA Dry Contact, Solid State
Signet Instruments 8900 9900	Customer Supplied Chart Recorder or Programmable Logic Controller	Customer supplied Metering Pump





Signet 2537 Paddlewheel Flowmeter

Signet Fittings



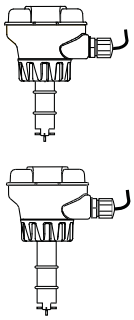
All sold separately

Application Tips

- Select PVDF Rotor Pin for use in Deionized Water.
- Use a sleeved rotor in abrasive liquids to reduce wear.
- Sensor plug is used to plug installation fitting after extraction of sensor from pipe.
- For liquids containing ferrous particles, use Signet Magmeters.
- For systems with components of more than one material, the maximum temperature/pressure specification must always be referenced to the component with the lowest rating.

Please refer to Wiring, Installation, and Accessories sections for more information.

Ordering Information



Mfr. Part No.	Code	Output
Paddlewheel Flowmeter - Integral Mount (8512 sensors)		
DN15 to DN100 - ½ to 4 in.		
Polypropylene body, black Polypropylene retaining nut, black PVDF rotor, Titanium pin, FPM O-rings		
~~3-2537-1C-P0~~	~~**159 001 291**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-P0~~	~~**159 001 292**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-P0~~	~~**159 001 295**~~	~~Digital (S^3L)~~
3-2537-6C-P0	**159 001 296**	4 to 20 mA
Natural PVDF body, Natural PVDF retaining nut, rotor and pin, FPM O-rings		
~~3-2537-1C-T0~~	~~**159 001 315**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-T0~~	~~**159 001 316**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-T0~~	~~**159 001 319**~~	~~Digital (S^3L)~~
~~3-2537-6C-T0~~	~~**159 001 320**~~	~~4 to 20 mA~~
DN125 to DN200 - 5 to 8 in.*		
Polypropylene body, black Polypropylene retaining nut, black PVDF rotor, Titanium pin, FPM O-rings		
~~3-2537-1C-P1~~	~~**159 001 303**~~	~~Pulse/Flow Switch DCR~~
~~3-2537-2C-P1~~	~~**159 001 304**~~	~~Pulse/Flow Switch SSR~~
~~3-2537-5C-P1~~	~~**159 001 307**~~	~~Digital (S^3L)~~
~~3-2537-6C-P1~~	~~**159 001 308**~~	~~4 to 20 mA~~

*PVDF available ½ in. to 4 in. only

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
Rotors		
3-2536.320-1	**198 820 052**	Rotor, PVDF Black
3-2536.320-2	**159 000 272**	Rotor, PVDF Natural
3-2536.320-3	**159 000 273**	Rotor, ETFE
3-2536.322-1	**198 820 056**	Sleeved rotor, PVDF Black
3-2536.322-2	**198 820 057**	Sleeved rotor, PVDF Natural
3-2536.322-3	**198 820 058**	Sleeved rotor, ETFE
Rotor Pins		
M1546-1	**198 801 182**	Pin, Titanium
M1546-2	**198 801 183**	Pin, Hastelloy-C
M1546-3	**198 820 014**	Pin, Tantalum
M1546-4	**198 820 015**	Pin, Stainless Steel
P51545	**198 820 016**	Pin, Ceramic
O-Rings		
1220-0021	**198 801 186**	O-ring, FPM (2 required per sensor)
1224-0021	**198 820 006**	O-ring, EPR (EPDM) (2 required per sensor)
1228-0021	**198 820 007**	O-ring, FFPM (2 required per sensor)
Miscellaneous		
P31536	**198 840 201**	Sensor plug, Polypropylene
3-2536.321	**198 820 054**	PVDF Natural, Rotor kit
3-8050.391	**159 001 703**	Retaining Nut Replacement Kit, NPT, Stainless Steel
3-8050.390-1	**159 001 702**	Retaining Nut Replacement Kit, NPT, Valox
3-8050.390-3	**159 310 116**	Retaining Nut Replacement Kit, NPT, PP
3-8050.390-4	**159 310 117**	Retaining Nut Replacement Kit, NPT, PVDF
3-8050.396	**159 000 617**	RC Filter kit (for relay use)
3-9000.392-1	**159 000 839**	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	**159 000 841**	Liquid tight connector kit, PG13.5 (1 piece)
7310-1024	**159 873 004**	24 VDC Power Supply, 10W, 0.42 A
7310-2024	**159 873 005**	24 VDC Power Supply, 24W, 1.0 A
7310-4024	**159 873 006**	24 VDC Power Supply, 40W, 1.7 A
7310-6024	**159 873 007**	24 VDC Power Supply, 60W, 2.5 A
7310-7024	**159 873 008**	24 VDC Power Supply, 96W, 4.0 A

3-2537.099 Rev G (4/13)
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English

Signet 2537 Paddlewheel Flowmeter

3-2537.090 Rev. 11 03/19

Operating Instructions

Description

The 2537 Paddlewheel Flowmeter Series offer low flow, low power and high resolution with various output options such as a Volumetric Pulse, Pulse Divider, Flow Switch, Digital (S^3L), or 4 to 20 mA. This unit can be configured on-site directly through the built-in user interface.

- The 4 to 20 mA model provides a blind current loop output.
- The Digital (S^3L) model provides a Digital (S^3L) output for use with the Signet 8900 Multi-Parameter Controller or 9900 Transmitter.
- The Multi model uses a single relay (mechanical or solid state) and has three selectable operating modes:
  - Divider Mode scales the paddlewheel frequency down to accommodate low frequency input devices.
  - Total Mode outputs one pulse per a set volume of fluid.
  - Flow Switch Mode uses a single relay for Hi or Lo alarm operation.

A small LCD enables the 2537 to be programmed without any external equipment. During normal operation the display is not visible.

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- English
- Deutsch
- Français
- Español
- Italiano
- 中文

For earlier versions of this sensor, the Rev. C version of the 2537 manual is available at **www.gfsignet.com**, under **Resource Center**.

Select **Sensors and Instrumentation**, click **Archived Products**, select 2537, click **Instruction Manuals**.

Warranty Information

Refer to your local Georg Fischer Sales office for the most current warranty statement.

All warranty and non-warranty repairs being returned must include a fully completed Service Form and goods must be returned to your local GF Sales office or distributor. Product returned without a Service Form may not be warranty replaced or repaired.

Signet products with limited shelf-life (e.g. pH, ORP, chlorine electrodes, calibration solutions; e.g. pH buffers, turbidity standards or other solutions) are warranted out of box but not warranted against any damage, due to process or application failures (e.g. high temperature, chemical poisoning, dry-out) or mishandling (e.g. broken glass, damaged membrane, freezing and/or extreme temperatures).

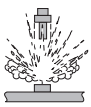
Product Registration

Thank you for purchasing the Signet line of Georg Fischer measurement products.
If you would like to register your product(s), you can now register online in one of the following ways:

- Visit our website **www.gfsignet.com.** Under **Service and Support** click on **Product Registration Form**
- If this is a pdf manual (digital copy), **click here**

Safety Information

1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. DO NOT exceed maximum temperature or pressure specs.
4. ALWAYS wear safety goggles or faceshield during installation and/or service.
5. DO NOT alter product construction.
6. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired
7. **This device is not approved for use or installation in hazardous locations.**

	Caution / Warning / Danger Indicates a potential hazard. Failure to follow all warnings may lead to equipment damage, injury, or death
	Personal Protective Equipment (PPE) Always utilize the most appropriate PPE during installation and service of Signet products.
	**Pressurized System Warning** Sensor may be under pressure, take caution to vent system prior to installation or removal. Failure to do so may result in equipment damage and/or serious injury.
	Hand Tighten Only Overtightening may permanently damage product threads and lead to failure of the retaining nut.
	Do Not Use Tools Use of tool(s) may damage product beyond repair and potentially void product warranty.
	Note / Technical Notes Highlights additional information or detailed procedure.

Chemical Compatibility

Georg Fischer Signet products are manufactured in a variety of wetted materials to suit various liquids and chemicals.

All plastic materials including typical piping types (PVC, PVDF, PP and PE) are more or less permeable to contained media, such as water or volatile substances, including some acids. This effect is not related to porosity, but purely a matter of gas diffusion through the plastic.

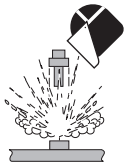
If the plastic material is compatible with the medium according to the application guidelines, the permeation will not damage the plastic itself. However, if the plastic encloses other sensitive components, as is the case with GF Signet plastic paddlewheel sensors, these may be affected or damaged by the media diffusing through the plastic body and rotor.

Failures of PVDF paddlewheel sensors when used in hot nitric acid applications have been reported. PVDF is known to allow for substantial permeation of nitric acid constituents without being damaged itself. No clear guideline can be given here, since the damaging effect to the sensor is highly dependent on temperature, pressure and concentration.

Utilizing sensors in applications with aggressive substances is possible. On special request GF Signet can provide sensors with a different internal resin encapsulation (potting) that will delay the damaging effect of acids to the sensors.

For all Special Product inquiries or to place an order, please email **signet-specialproduct@georgfischer.com.**

WARNING!



Paddlewheel Retaining Nuts:

The retaining nuts of paddlewheel sensors are not designed for prolonged contact with aggressive substances. Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances, e.g. due to leakage or spilling, must be replaced.

Paddlewheel Maintenance:

Paddlewheel flow sensors are subject to wear and may require maintenance and replacement of mechanical parts (rotors, pin, O-rings, bearings, retainers, etc.). The frequency of recommended maintenance will vary based upon application specifications, characteristics of the measured fluid, and installation details. These can include, but are not limited to: process flowrate, occurrence of water hammer, fluid corrosiveness and abrasiveness, sensor installation relevant to other equipment.

GF Signet offers individual replacement parts and rotor replacement kits, which include replacement instructions, allowing customers to perform field maintenance and reduce application down-time. Please refer to the Paddlewheel Replacement section (page 15) or contact your local GF Sales Representative with any questions.

515, 2536, 8510, 8512, 2537 Only:

To support our customers, the GF Signet Repair Department offers services to recertify the plastic paddlewheel products to factory specification. Contact your distributor or visit **www.gfsignet.com** for more information.

Specifications

General

Flow Rate Range ..... 0.1 m/s to 6 m/s (0.3 ft/s to 20 ft/s)
Pipe Size Range ..... DN15 to DN200 (½ in. to 8 in.)
Min. Reynolds Number 4500
Wiring Ports ..... ½ in. NPT threads; liquid-tight connector accepts cables 7 mm to 10 mm OD (0.275 in. to 0.394 in.)

Materials

Case ..... PBT, Yellow
Inside Cover ..... Valox, Black

Wetted Materials

-P0, -P1

Sensor Body ..... Glass Filled Polypropylene
O-Rings ..... FKM
Pin ..... Titanium
Rotor ..... PVDF, Black; optional ETFE with or without carbon fiber reinforced PTFE sleeve for rotor pin

-T0

Sensor Body ..... PVDF, Natural
O-Rings ..... FKM
Pin ..... PVDF, Natural
Rotor ..... PVDF, Natural; optional ETFE with or without carbon fiber reinforced PTFE sleeve for rotor pin

Performance

Input Frequency Range ..... 1 to 1000 Hz
System Response ..... 100 ms update rate nominal
Paddlewheel Frequency ..... 49 Hz per m/s nominal (15 Hz per ft/s nominal)
Linearity ..... ±1% of maximum range @ 25 °C (77 °F)
Repeatability ..... ±0.5% maximum range @ 25 °C (77 °F)

Electrical

Relay Specifications

Dry Contact SPDT ..... 5 A @ 30 VDC, 5 A @ 250 VAC
Solid-State Relay ..... 100 mA @ 40 VDC, 70 mA @ 33 VAC

Power Requirements

Multi:
with Dry-Contact Relay ..... 24 VDC nominal ±10%, regulated, 30 mA max. current
with Solid-State Relay ..... 5 to 24 VDC nominal ±10%, regulated, 30 mA max. current
Digital (S^3L) ..... 5.0 VDC min. to 6.5 VDC max., 30 mA max. current (1.5 mA nominal)
4 to 20 mA ..... 400 mV max. ripple voltage, 30 mA max. current
Reverse Polarity and Short Circuit Protected ..... Up to 40 V, 1 hour
Over-Voltage Protection ..... > 40 VDC over 1 hour

Output

Signal Averaging ..... Programmable 0 to 100 seconds
Sensitivity Response ..... Programmable 0 to 9 scale

Pulse Divider/Total Pulse Output

Pulse Divider Setting ..... 1.0000 to 99999
Maximum pulse rate ..... 300 Hz
Maximum pulse width ..... 50 ms

Flow Switch Output

Relay Modes ..... Low, High
Time Delay ..... 0.0 to 6400.0 seconds
Hysteresis ..... Adjustable in Engineering Units

Digital (S^3L) output

Type ..... Serial ASCII, TTL level 9600 bps
Maximum Cable Length ..... Application dependent (See 8900 manual)

Current output (Passive 4 to 20 mA)

Loop Accuracy ..... ±32 µA (@ 25 °C @ 24 VDC)
Loop Resolution ..... 5 µA
Temp. Drift ..... ±1 µA per °C max.
Power Supply Rejection ..... ±1 uA per V
Maximum Cable Length ..... 305 m (1,000 ft)
Max. Loop Resistance ..... 600 Ω @ 24 VDC, 1 KΩ @ 32 VDC

Environmental Requirements

Enclosure Rating ..... NEMA 4X/IP65
Storage Temperature ..... -10 °C to 75 °C (14 °F to 167 °F)
Ambient Temperature ..... 0 °C to 65 °C (32 °F to 150 °F)
Relative Humidity ..... 0 to 90% RH, non-condensing
Altitude ..... 2000 m (6,562 ft)
Pollution Degree 2

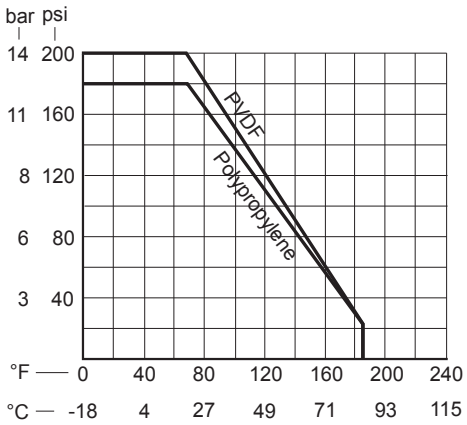
Pressure/Temperature Ratings

Polypropylene Body

- 12.5 bar (180 psi) max. @ 20 °C (68 °F)
- 1.7 bar (25 psi) max. @ 85 °C (185 °F)

PVDF Body

- 14 bar (200 psi) max. @ 20 °C (68 °F)
- 1.7 bar (25 psi) max. @ 85 °C (185 °F)



Intended Use

This product is intended for use in industrial water treatment and wastewater treatment applications where the chemical content and the fluid temperatures are consistent with the specifications listed herein.

This device is not approved for use or installation in flammable liquids.

Standards and Approvals

- CE, UL
- NSF (3-2537-xC-Px versions only)
- China RoHS (Go to www.gfsignet.com for details)
- Manufactured under ISO 9001 for Quality, ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.

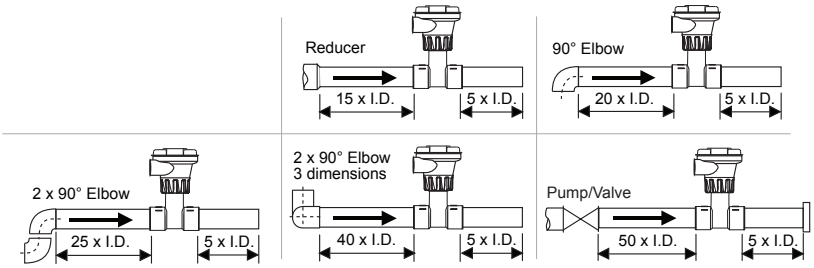
Declaration of Conformity according to FCC Part 15

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

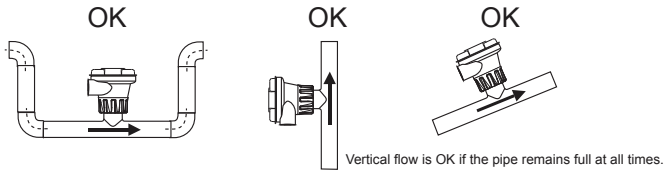
Location of Fitting

Recommended sensor upstream/downstream mounting requirements:

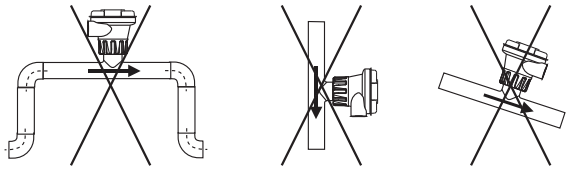
Select a location with sufficient length of straight pipe immediately upstream of the sensor.



Locating the sensor in a trap or where the flow is upward helps to protect the sensor from exposure to air bubbles when the system is in operation.



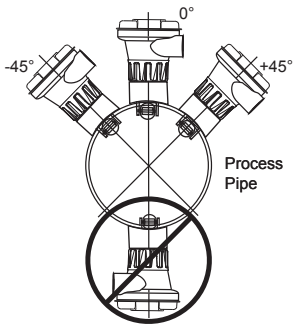
These configurations are not recommended because it is difficult to keep the pipe full.



Sensor Mounting Position

Horizontal pipe runs:
Mount sensor in the upright (0°) position for best performance. Mount at a maximum of 45° when air bubbles are present (pipe must be full).
Do not mount on the bottom of the pipe when sediments are present.

Vertical pipe runs:
Mount sensor in any orientation; however, downward flow is not recommended. Upward flow is preferred to ensure full pipe.



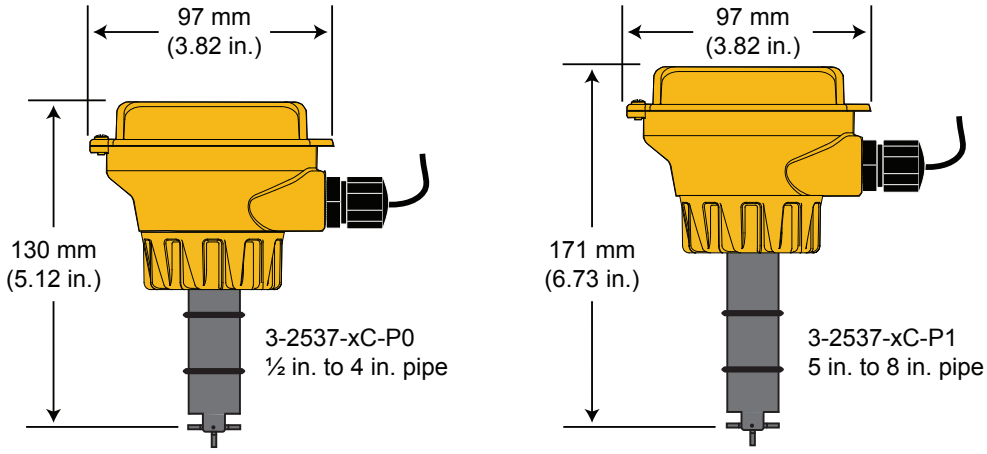
Pipe Fittings

Georg Fischer Signet offers a wide selection of installation fittings that control the position of the paddlewheel in relation to the dimensions of the pipe.

Type	Description
Plastic tees	• 0.5 to 2 inch versions (MPVC or CPVC) • 2.5 to 4 inch versions (PVC)
PVC Glue-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/2 inch hole in pipe • Weld in place using solvent cement
PVC Saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/8 inch hole in pipe
Iron Strap-on saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe • Special order 14 in. to 36 in.
Metric Wafer Fitting	• For pipes DN65 to 200 mm • PP or PVDF

Type	Description
Iron, Carbon Steel, 316 SS Threaded tees	• 0.5 to 2 in. versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/8 inch hole in pipe
Fiberglass tees FPT	• 1.5 in. to 2 in. PVDF insert
Metric Union Fitting	• For pipes from DN 15 to 50 mm • PP or PVDF

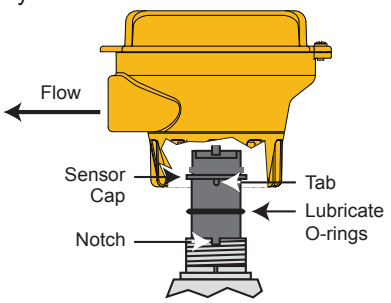
Dimensions



Installation

Plastic sensor installation tips

- Inspect the sensor O-rings for nicks and other damage that may compromise the seal.
- Lubricate O-rings with a non-petroleum based, viscous lubricant (grease) compatible with the system.
- Using an alternating/twisting motion, lower the sensor into the fitting, making sure the conduit ports on the yellow housing are pointing in the direction of flow.
- Engage one thread of the sensor cap then turn the sensor until the alignment tab is seated in the fitting notch.



HAND-TIGHTEN THE THREADED NUT ONTO THE INSTALLATION FITTING. DO NOT USE TOOLS!

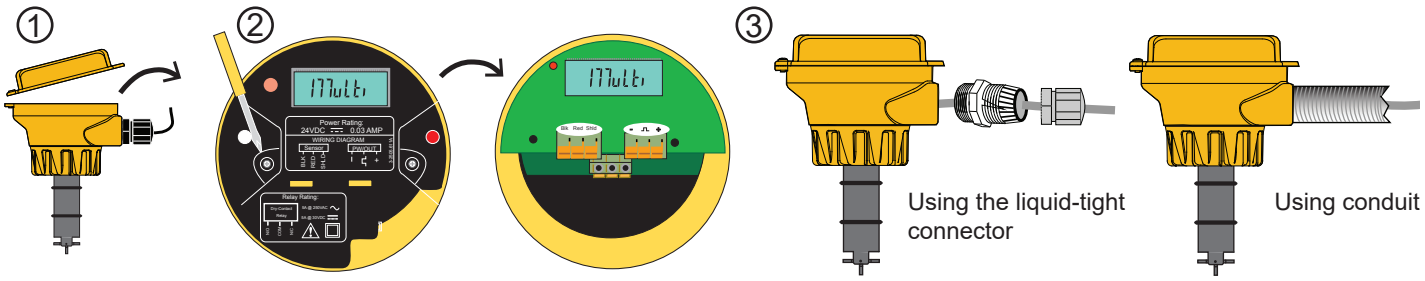
DO NOT USE THREAD SEALANT OR LUBRICANTS ON THE FITTING THREADS OR THE SENSOR CAP.

Wiring

Electrical connections to this product should be made only by qualified personnel.

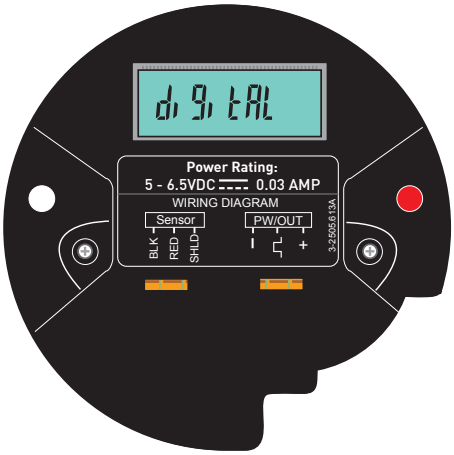
To access the wiring terminals:

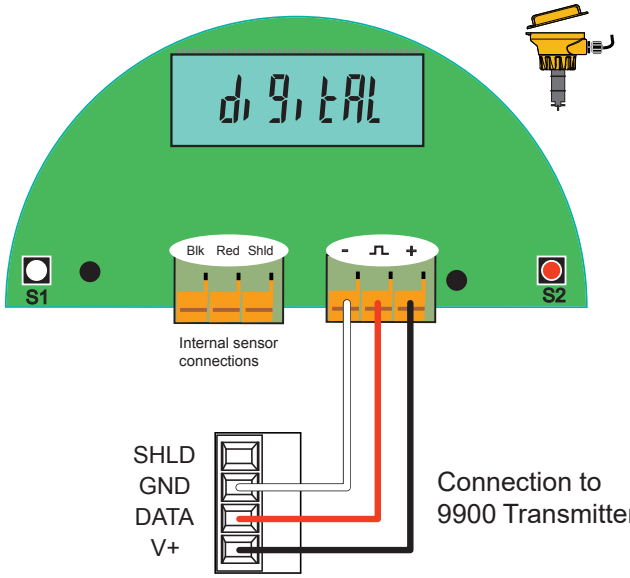
1. Turn yellow cap ¼ turn counterclockwise to remove.
2. Remove the two retaining screws and remove the black cover.
   - Route all cables through the conduit ports before connecting them to the terminals.
   - Wiring terminals are rated for 16 to 22 AWG conductors.
   - The cable must be 7 mm to 10 mm in diameter (0.275 in. to 0.394 in.) to seal properly in the liquid tight connector.
3. The conduit ports have ½ inch NPT threads. After routing the cables, seal the port with a liquid tight conduit connector (3-9000.392-1) or with conduit.
   - For conduit installations:
     - Thread conduit with ½ in. NPT threads directly into the conduit port.
     - For conduit with ISO threads, use the black thread adapter included with the connector kit.
     - To comply with NEC requirements, do not use any metal conduit in the installation.

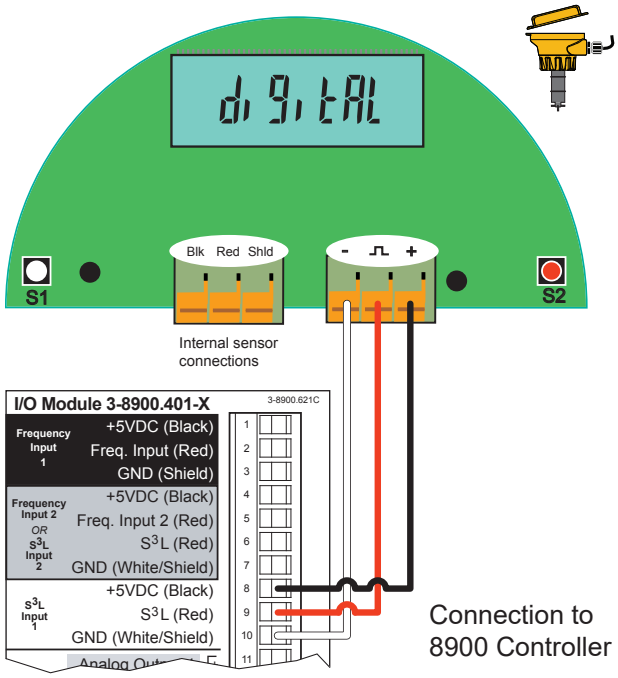


Digital (S^3L) Output Wiring

The Digital (S^3L) output is compatible with the 3-8900 Multi-Parameter Controller and the 3-9900 Transmitter.

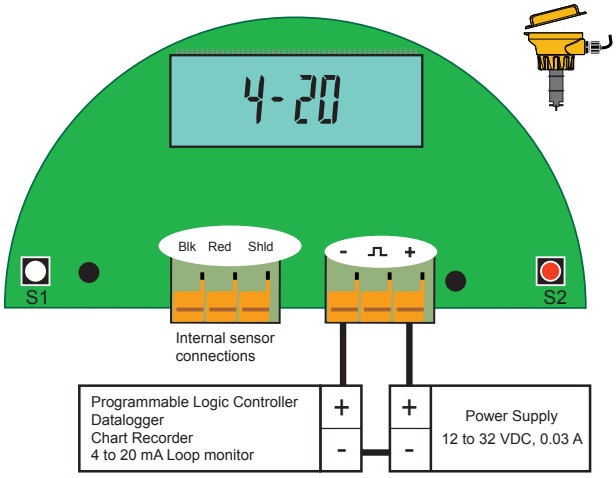






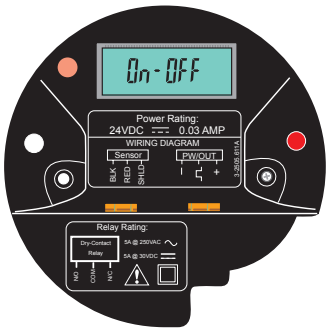
4 to 20 mA Output Wiring

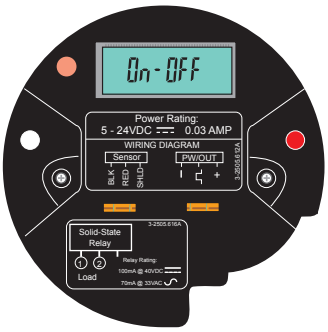
- The 4 to 20 mA output can be connected to Chart Recorders, PLCs or any device that requires a 4 to 20 mA signal.
- The 4 to 20 mA model requires an external power source of 12 to 32 VDC.



Flow Switch Output (On-Off)

- The Flow Switch mode allows a single relay that is programmable as a HIGH setpoint or LOW setpoint.
- The relay may be a dry-contact type or a solid state type:

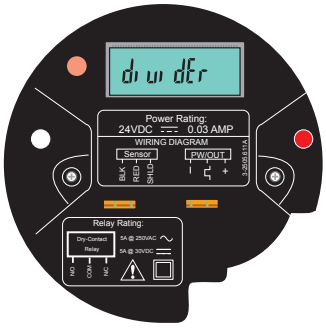


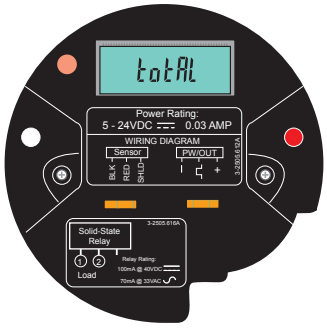


- The **Dry Contact Relay** requires an external power source of 24 VDC ± 10%.
- The **Solid State Relay** requires an external power source of 5 to 24 VDC.

Pulse Output

- The "Multi" mode allows a single relay that is programmable as a Flow Switch, Volumetric pulse output or as a simple pulse divider output.
- The relay may be a dry-contact type or a solid state type.

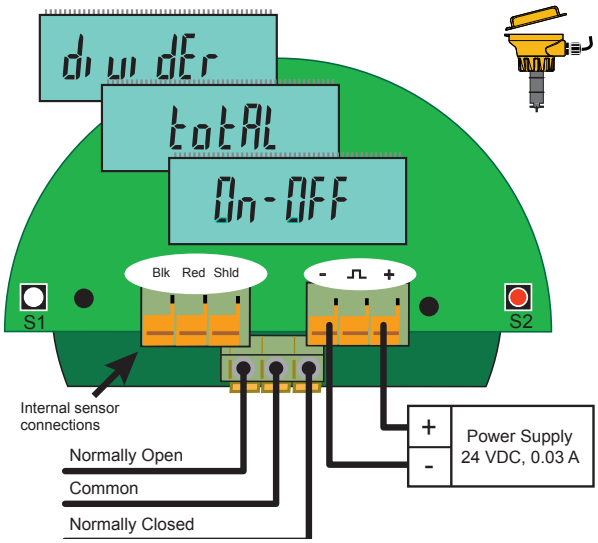




- The **Dry Contact Relay** requires an external power source of 24 VDC ± 10%.
- The **Solid State Relay** requires an external power source of 5 to 24 VDC.
- Solid State Relay requires a pull-up resistor (10K ohm recommended). Consult your instrument/ PLC manual for wiring information.

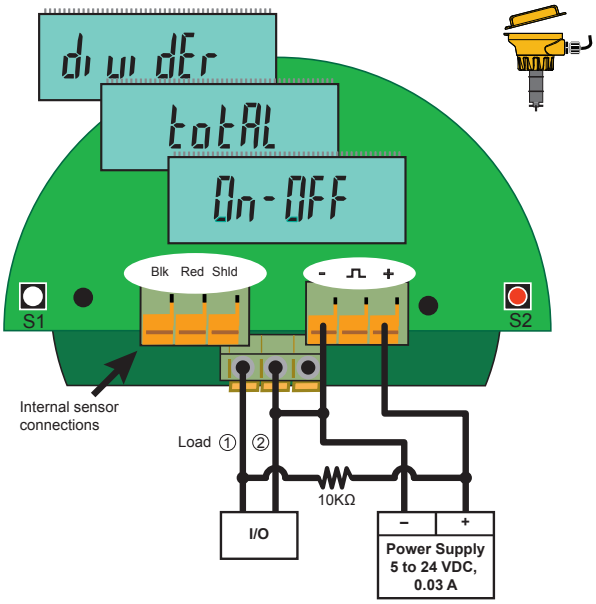
Dry Contact Relay Wiring

- The wiring is identical for On-OFF and Pulse modes.



Solid State Relay Wiring

- The wiring is identical for On-OFF and Pulse modes.



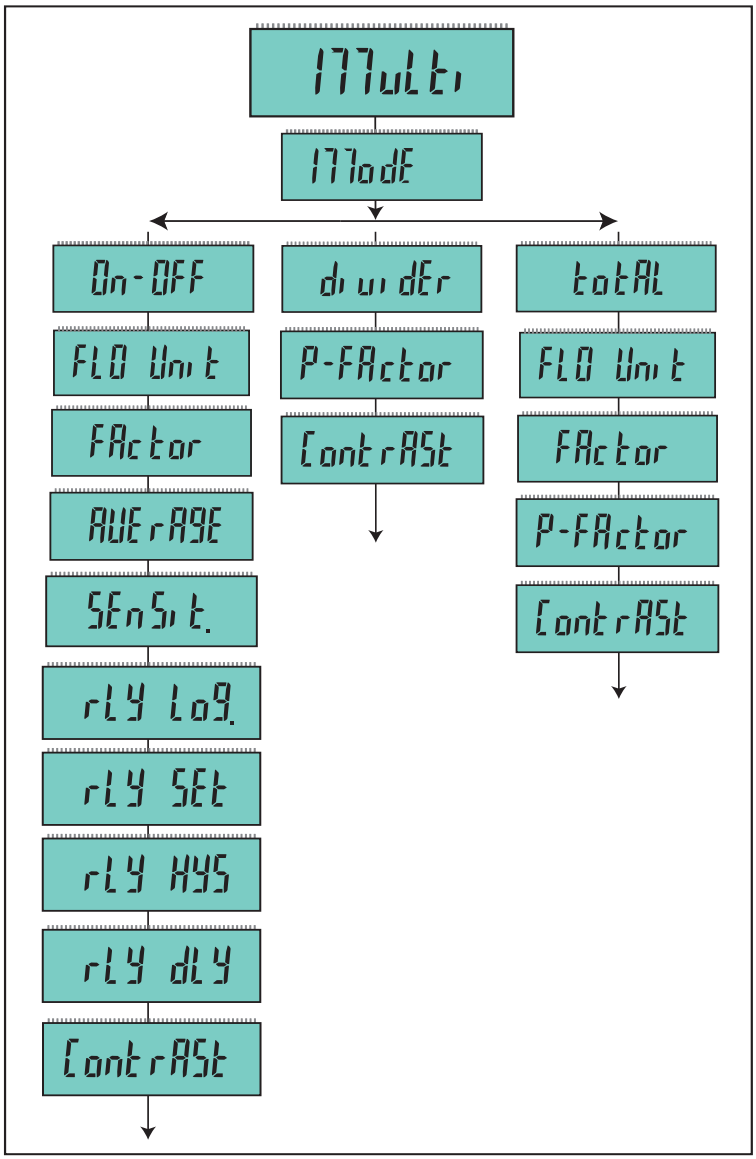
Operation

The 2537 Flowmeter is available in three different models. The programming menus vary significantly from one model to another. This chart is provided inside the yellow cover to assist in navigating the menus in the 2537.

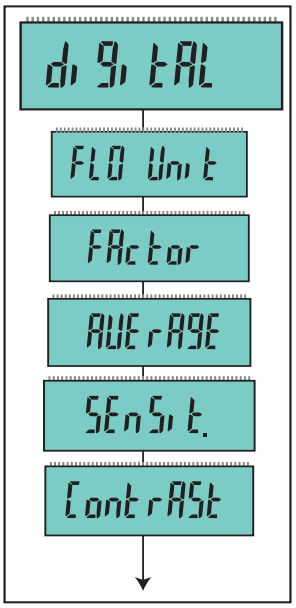
Mode	Action		
View	→ Display Flow Rate	→ Go to MENU	Go to VIEW
Menu	1X → Next Menu	1X → Display Current Value	Previous Mode
		→ Go to Edit	Previous Mode
		1X → Shift digit to right	Previous Mode
Edit	1X → Increment Value	→ Go to SAVE	Previous Mode
SAVE	1X → Toggle	1X → Store Change	N/A

Menus

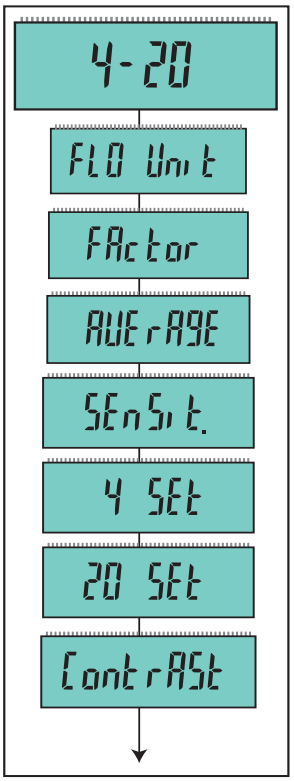
3-2537-1C-XX, 3-2537-2C-XX



3-2537-5C-XX



3-2537-6C-XX



VIEW Mode Function

- All models display the model name: **Multi**, **Digital** or **4-20**.
- If the white key (S1) is held down for three seconds, the flow rate is displayed for 10 minutes before reverting back to the model name.
  - In the **Multi** Model, if the “Multi” menu item is set to “divider”, then the divided pulse output will be displayed in pulses / seconds (p/s).

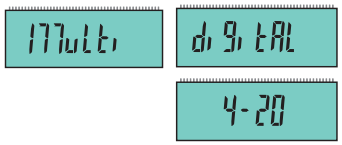
Menu Details

This table shows the definition of each menu function, the setting parameters and the page where detailed instructions can be located.

Menu Function	Definition	Setting Parameters	More Information
Flow Unit	Liters or Gallons per sec., min., hour or day	See list on page 10	page 10
K-Factor	Set PULSES per VOLUME UNIT	0.0001 to 999999	page 10
Average	Smooths out erratic flow conditions	0 to 100 seconds	page 11
Sensitivity	Overrides Average for large rate changes	0 to 9	page 11
Mode	Select the output mode	Total or Divider or On-OFF	page 12
P-Factor	As PULSE DIVIDER, divides input freq.	1.0000 to 99999	page 12
P-Factor	As PULSE TOTAL, multiplies K-Factor	1.0000 to 99999	page 12
Relay Logic	Select Hi alarm or Lo alarm mode	Hi or Lo	page 13
Relay Set	Set Relay Setpoint	0.0000 to 99999	page 13
Relay Hysteresis	Rate inside Setpoint to DEENERGIZE relay	0.0000 to 99999	page 13
Relay Delay	Time delay before relay is ENERGIZED	0000.0 to 6400.0	page 13
4 Set	Set flow RATE to be represented by 4 mA	0.0000 to 99999	page 10
20 Set	Set flow RATE to be represented by 20 mA	0.0000 to 99999	page 10
Contrast	Adjust visibility of liquid crystal display	1 to 3	page 10

Set Flow Units

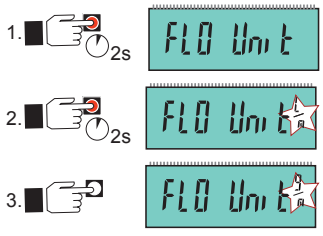
This function is available on these versions of the 2537:

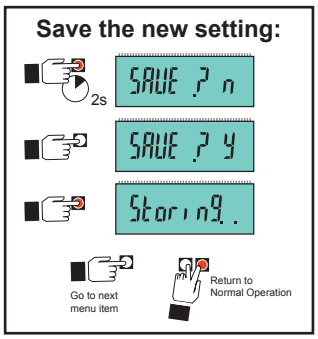


Select the volumetric units for the flow measurement:

L/s	Liters/second	G/s	Gallons/second
L/m	**Liters/minute (Factory setting)**	G/m	Gallons/minute
L/h	Liters/hour	G/h	Gallons/hour
L/d	Liters/day	G/d	Gallons/day

Example: Set the Flow Units to Gallons per minute:





Set 4 and Set 20

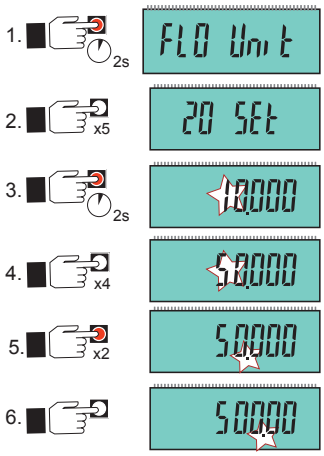
This function is available on these versions of the 2537:

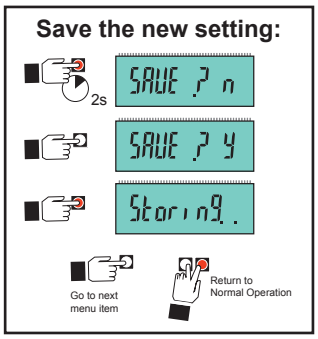
These two functions are used to span the 4 to 20 mA output signal to the required range.

The factory setting is 4 to 20 mA = 0 to 10.000

Only the 20 mA span is illustrated here.

Example: Set 20 mA = 500 GPM.

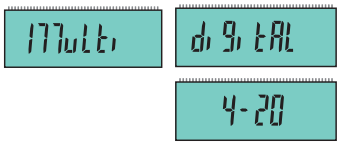




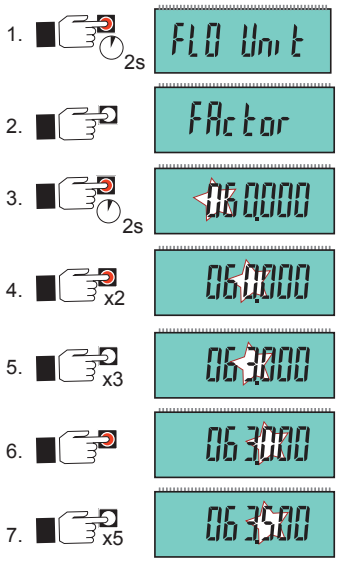
Set K-Factor

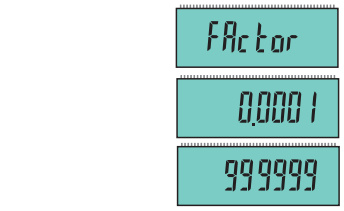
A K-Factor is the number of pulses a sensor will generate for each engineering unit of fluid that passes the sensor. The factory setting is 60.0000. Locate the K-Factor in the tables on page 14 and 15.

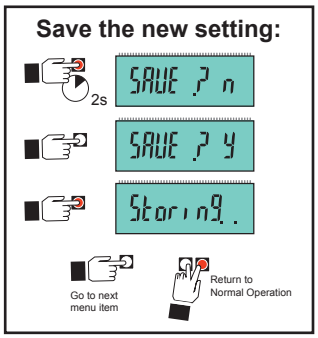
This function is available on the above versions of the 2537:



Example: Set the K-Factor to 63.5 Pulses per Gallon:

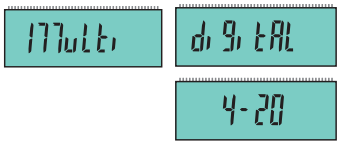






Set Contrast

This function is available on these versions of the 2537:



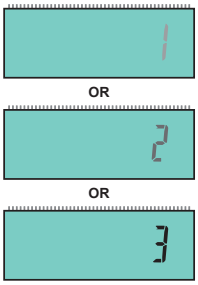
All models of the 2537 have the CONTRAST adjustment. It is always located at the end of the menu.

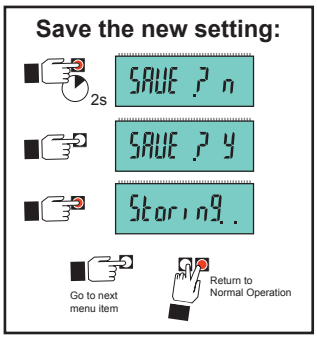
1. 2s — To access the adjustment, enter the menu and scroll until the Contrast display appears.
2. x1

Repeat until ⋮

Three levels of adjustment are available. The factory setting of 3 is the highest contrast setting.

Choose:





Averaging and Sensitivity Settings

- Because ideal flow conditions are often impossible to achieve, the flow rate is often erratic, which causes erratic readings in control features (e.g., relays, 4 to 20 mA loops, etc.) that are associated with the flow rate.
- The best solution to these problems is to correct any piping deficiency that causes the instability. This may involve longer straight runs upstream, reducing the pipe size to maintain a full pipe at all times, and other installation changes. In many situations, however, these measures are simply not possible.
- The 2537 meter provides two tools that are designed to "work around" these deficiencies. The Averaging and the Sensitivity features should be studied before making adjustments.

Averaging Time in Seconds (Factory set: 0 seconds)

- Set the time the meter will use as the averaging period. The range is from 0 (no average applied to input) to 100 (seconds of averaging applied to input).
  Use higher averaging times to smooth the display and current output where the flow in the pipe is erratic.

Quick Response Sensitivity (Factory set: 0)

- Set the relative degree of change in the flow rate required to allow the 2537 to disable the AVERAGING and jump to a new flow rate immediately. The scale is from 0 (least sensitive, averaging is never disabled.) to 9 (a very small change in flow rate will disable the averaging).

No AVERAGING, no SENSITIVITY

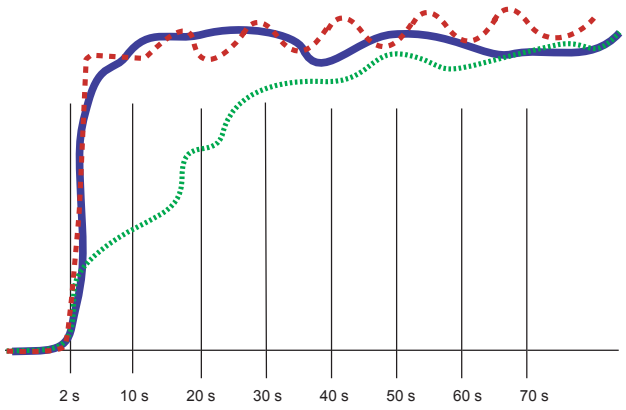
With AVERAGING set to 0 (zero) and with SENSITIVITY set to zero, the 2537 responds to every unstable shift in the flow. The dashed red line represents the actual output of the flow sensor in unstable flow conditions.

AVERAGING only

With AVERAGING set to 50 seconds and SENSITIVITY still set to zero the flow rate is stabilized, but a sharp change in flow rate is not represented for 50 seconds or longer (dotted green line).

AVERAGING and SENSITIVITY

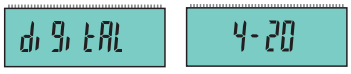
With AVERAGING at 50 seconds and SENSITIVITY set to 4 OR 5, the flow rate is stabilized, while the sudden shift in flow is reflected very quickly (solid blue line).



NOTE: The SENSITIVITY function is ineffective if the AVERAGING function is set to zero (seconds).

Set Averaging

This function is available on these versions of the 2537:

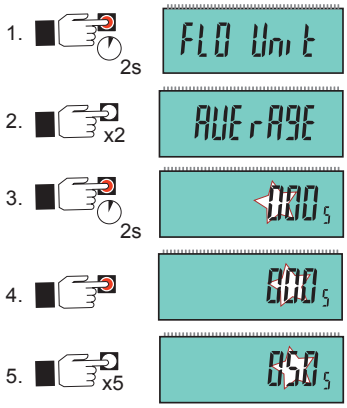


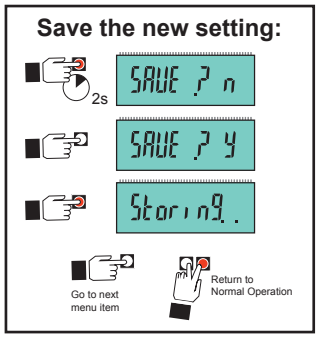
The factory setting is 0 (zero).

Minimum value

Maximum value

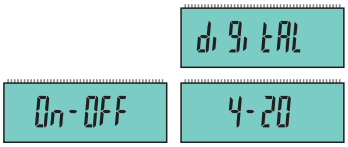
Example: Set the Averaging for 50 seconds.



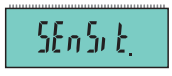


Set Sensitivity

This function is available on these versions of the 2537:



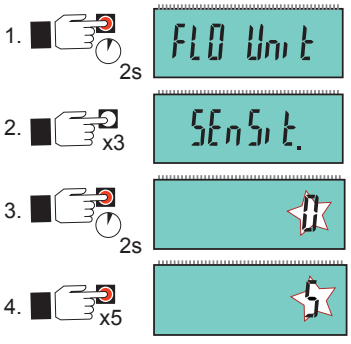
The factory setting is 0 (zero).

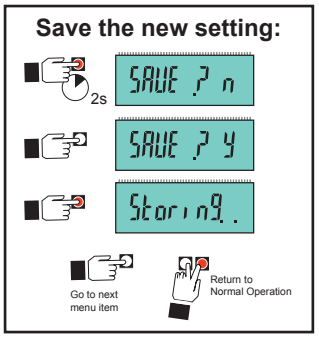


Minimum value

Maximum value

Example: Set the Sensitivity to 5.





Multi Mode

This function is available on these versions of the 2537:

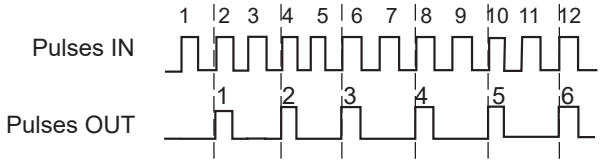
Select **DIVIDER** or **TOTAL** operation.
The factory setting is TOTAL.

PULSE DIVIDER Output = Input pulses ÷ P-Factor

DIVIDER allows you to set a scaling value (P-Factor) from 1.0000 to 99999.

Example: If the P-Factor is set for 2, then the 2537 will output one pulse for every 2 pulses received from the sensor.
This selection enables the output frequency to be scaled down to match associated equipment capabilities.

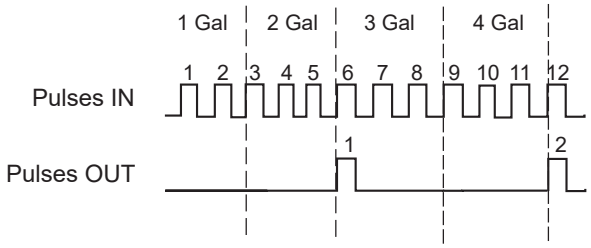
When using the PULSE DIVIDER output, associated equipment must divide the K-Factors in this manual by the P-Factor for correct calibration.

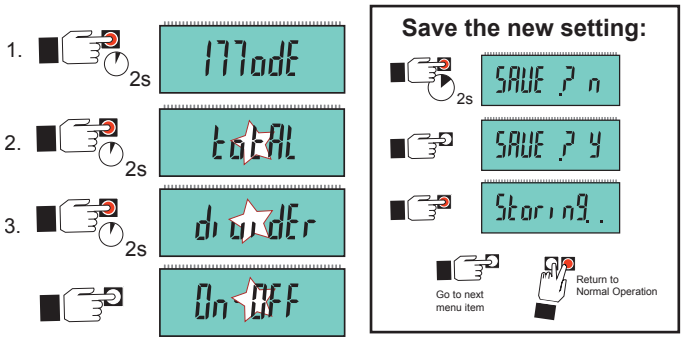


PULSE TOTAL Output = Input pulses ÷ (K-Factor × P-Factor)
TOTAL is a traditional pump pulse function. This selection will allow the entry of a K-Factor to define a volumetric unit, then set a P-Factor to define the number of volumetric units required to generate one pulse out.

Example:
Set the Total Pulse output so there is one pulse out for each 2 gallons that passes the sensor if the K-Factor is 3.0.

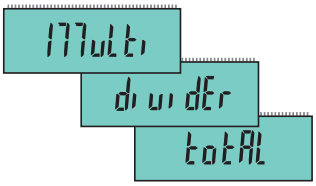
1. K-Factor = 3.0 (pulses in per gallon)
2. P-Factor = 2 (gallons out per pulse)





P-Factor

This function is available on the above versions of the 2537:



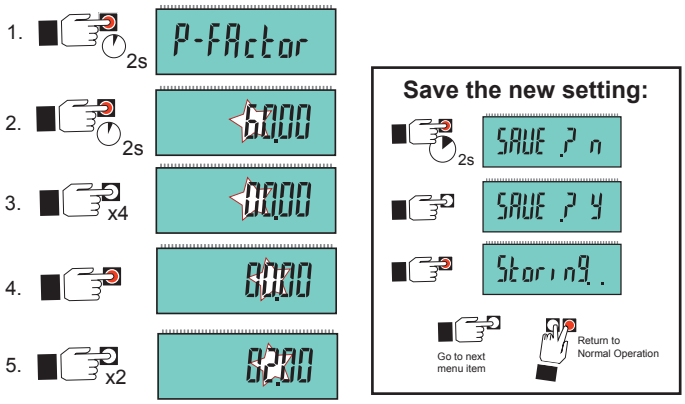
The factory setting is 1.0000

Minimum value

Maximum value

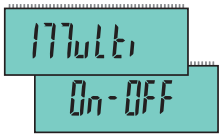
In PULSE DIVIDER mode the P-Factor divides:
The pulse stream from the paddlewheel sensor will be divided by the P-Factor. The resulting frequency is output through a relay.

In PULSE TOTAL mode the P-Factor multiplies:
The pulse stream from the paddlewheel sensor is divided by the K-Factor MULTIPLIED by the P-factor. The resulting frequency is output through a relay.



Set Relay Operation

The On-OFF mode has one relay (SPDT or solid-state) that can be programmed as a HIGH (Hi) alarm or a LOW (Lo) alarm.



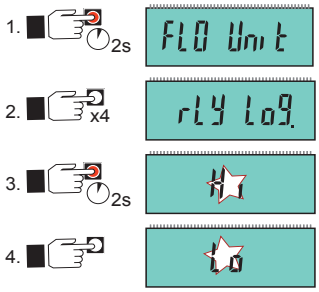
1. Select HI or LO Relay Alarm logic

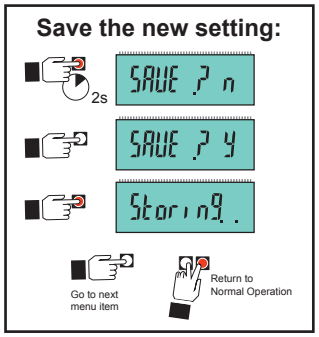
A HI alarm will be activated when the flow rate rises ABOVE the setpoint.

A LO alarm will be activated when the flow rate falls BELOW the setpoint.

The factory setting is Hi(gh).

Example: Change the Relay Logic to Low:





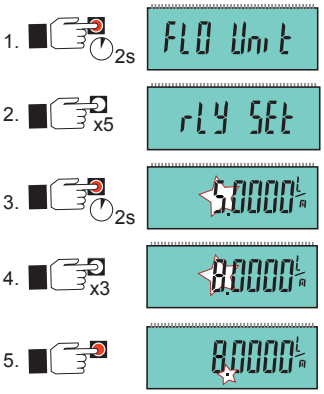
2. Program the SETPOINT.

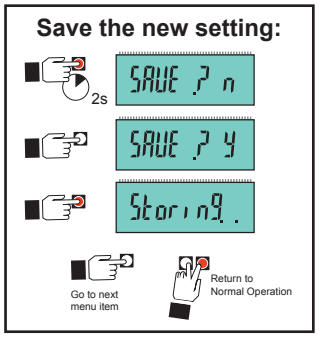
The SETPOINT is the flow rate where the relay will be energized.
The factory setting is 5.0000.

Minimum value 0.0000

Maximum value 99999

Example: Change the Setpoint to 8.0000:





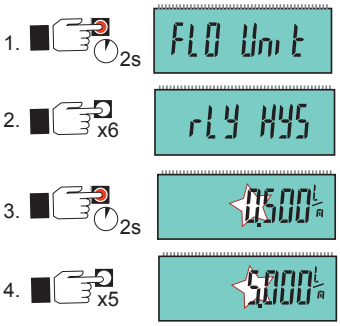
3. Program the HYSTERESIS.

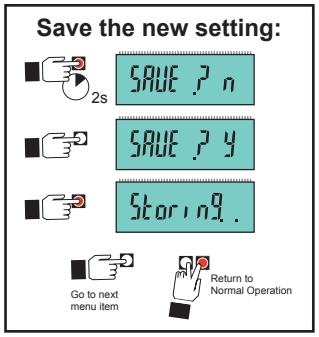
Hysteresis holds a relay energized until the flow rate moves this amount past the setpoint.
The factory setting is 0.5000

Minimum value 0.0000

Maximum value 99999

Example: Change the Hysteresis to 5.0000:





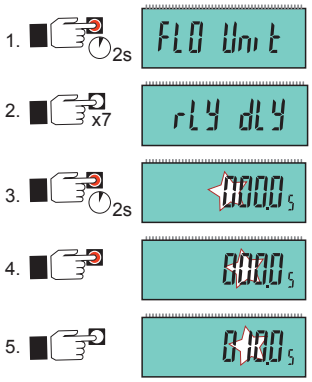
4. Program the DELAY.

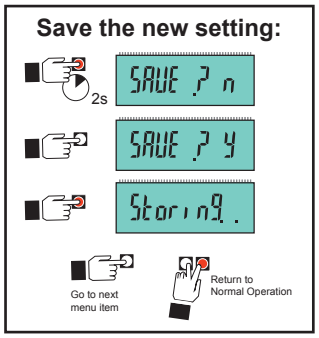
When the flow rate reaches the setpoint, the 2537 will wait this long (in seconds) before triggering the alarm.
The factory setting is 0000.0 seconds.

Minimum value 0000.0

Maximum value 6400.0

Example: Change the Delay to 10.0:



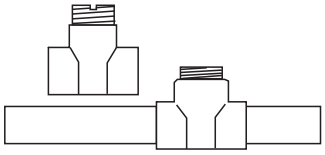


K-Factor

When using the PULSE DIVIDER mode, associated equipment must divide the K-Factors by the P-Factor.

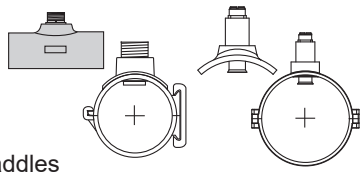
A **K-Factor** is the number of pulses a sensor will generate for each engineering unit of fluid that passes the sensor. K-Factors for water are listed below in U.S. gallons and liters.

For example, in a 1 inch SCH 80 PVC pipe, using the MPV8T010 PVC fitting, the 2537 paddlewheel generates 335.53 pulses per gallon of water passing the rotor.



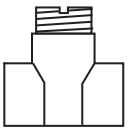
Molded Tees

PIPE SIZE (IN.)	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
SCH 80 MOLDED TEES FOR SCH 80 PVC PIPE			
1/2	MPV8T005F MPV8T005 MCPV8T005F	1027.1	271.37
3/4	MPV8T007F MPV8T007 MCPV8T007F	583.19	154.08
1	MPV8T010F MPV8T010 MCPV8T010F	335.53	88.65
1-1/4	MPV8T012F MPV8T012 MCPV8T012F	178.79	47.24
1-1/2	MPV8T015F MPV8T015 MCPV8T015F	121.42	32.08
2	MPV8T020F MPV8T020 MCPV8T020F	71.44	18.87
2-1/2	PV8T025	42.994	11.359
3	PV8T030	26.652	7.0414
4	PV8T040	15.006	3.9645



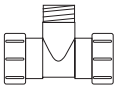
Saddles

PIPE SIZE (IN.)	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE			
2	PV8S020	66.739	17.633
2-1/2	PV8S025	42.994	11.359
3	PV8S030	26.652	7.0414
4	PV8S040	15.006	3.9645
6	PV8S060	8.3246	2.1994
8	PV8S080	5.0164	1.3253
SCH 80 PVC SADDLE ON SCH 40 PVC PIPE			
2	PV8S020	54.700	14.452
2-1/2	PV8S025	37.159	9.8175
3	PV8S030	23.697	6.2608
4	PV8S040	13.456	3.5552
6	PV8S060	7.4594	1.9708
8	PV8S080	4.5292	1.1966



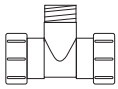
Metal Tees

PIPE SIZE (IN.)	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
CARBON STEEL TEES ON SCH 40 PIPE			
1/2	CS4T005	756.00	199.74
3/4	CS4T007	438.69	115.90
1	CS4T010	286.78	75.768
1-1/4	CS4T012	121.22	32.026
1-1/2	CS4T015	91.139	24.079
2	CS4T020	54.468	14.391
STAINLESS STEEL TEES ON SCH 40 PIPE			
1/2	CR4T005	734.20	193.98
3/4	CR4T007	412.10	108.88
1	CR4T010	252.70	66.764
1-1/4	CR4T012	128.12	33.849
1-1/2	CR4T015	77.320	20.428
2	CR4T020	45.780	12.095
GALVANIZED IRON TEES ON SCH 40 PIPE			
1	IR4T010	213.01	56.277
1-1/4	IR4T012	127.75	33.751
1 1/2	IR4T015	94.401	24.941
2	IR4T020	59.420	15.699
BRONZE TEES ON SCH 40 PIPE			
1	BR4T010	213.01	56.277
1-1/4	BR4T012	127.75	33.751
1-1/2	BR4T015	94.401	24.941
2	BR4T020	59.420	15.699
COPPER TEE ON COPPER PIPE SCH K			
1/2	CUKT005	917.84	242.50
3/4	CUKT007	428.27	113.15
1	CUKT010	256.43	67.749
1-1/4	CUKT012	176.44	46.615
1-1/2	CUKT015	115.69	30.565
2	CUKT020	63.385	16.746
COPPER TEE ON COPPER PIPE SCH L			
1/2	CUKT005	858.22	226.74
3/4	CUKT007	385.74	101.91
1	CUKT010	241.64	63.841
1-1/4	CUKT012	170.90	45.152
1-1/2	CUKT015	112.03	29.598
2	CUKT020	61.74	16.310



Union Tees

PIPE SIZE	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
POLYPROPYLENE TEES (DIN/ISO, BS, ANSI)			
DN15	PPMT005	952.87	251.75
DN20	PPMT007	563.10	148.77
DN25	PPMT010	291.60	77.042
DN32	PPMT012	169.22	44.709
DN40	PPMT015	103.90	27.450
DN50	PPMT020	60.789	16.060
DN65	PPMT025	41.498	10.964
DN80	PPMT030	26.786	7.0769
DN100	PPMT040	17.415	4.6011
DN125	PPMT050	10.168	2.6864
DN150	PPMT060	7.3119	1.9318
DN200	PPMT080	3.9946	1.0554



Union Tees

PIPE SIZE	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
PVDF FITTINGS (DIN/ISO AND BS AND ANSI)			
DN15	SFMT005	827.26	218.56
DN20	SFMT007	489.87	129.42
DN25	SFMT010	283.55	74.915
DN32	SFMT012	158.59	41.899
DN40	SFMT015	86.980	22.980
DN50	SFMT020	50.385	13.312
PVC FITTINGS (DIN/ISO) - EUROPE ONLY			
DN15	PVMT005	972.37	256.90
DN20	PVMT007	485.69	128.32
DN25	PVMT010	297.27	78.540
DN32	PVMT012	170.25	44.980
DN40	PVMT015	103.71	27.400
DN50	PVMT020	59.500	15.720
DN65	PVMT025	34.973	9.2400
DN80	PVMT030	24.981	6.6000
DN100	PVMT040	16.275	4.3000
DN150	PVMT060	8.1756	2.1600
DN200	PVMT080	4.0878	1.0800

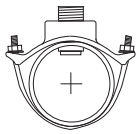
K-Factor

Weldolets and Brazolets

PIPE SIZE (IN.)	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CR4W025	37.600	9.9339
3	CR4W030	24.340	6.4306
4	CR4W040	13.920	3.6777
5	CR4W050	10.860	2.8692
6	CR4W060	7.5200	1.9868
8	CR4W080	4.3400	1.1466
CARBON STEEL WELDOLETS ON SCH 40 PIPE			
2-1/2	CS4W025	37.600	9.9339
3	CS4W030	24.340	6.4306
4	CS4W040	13.920	3.6777
5	CS4W050	10.860	2.8692
6	CS4W060	7.5200	1.9868
8	CS4W080	4.3400	1.1466
COPPER/BRONZE BRAZOLETS ON SCH 40 PIPE			
2-1/2	BR4B025	37.600	9.934
3	BR4B030	24.340	6.431
4	BR4B040	13.920	3.678
5	BR4B050	10.860	2.869
6	BR4B060	7.5200	1.987
8	BR4B080	4.3400	1.147

Wafer Fittings

PIPE SIZE	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
POLYPROPYLENE WAFER FITTINGS (DIN/ISO)			
DN65	PPMTE025 PPMTF025	41.498	10.964
DN80	PPMTE030 PPMTF030	26.786	7.0769
DN100	PPMTE040 PPMTF040	17.415	4.6011
DN125	PPMTE050 PPMTF050	10.168	2.6864
DN150	PPMTE060 PPMTF060	7.3119	1.9318
DN200	PPMTE080 PPMTF080	3.9946	1.0554
PVDF WAFER FITTINGS (DIN/ISO)			
DN65	SFMTF025	36.133	9.5465
DN80	SFMTF030	24.715	6.5297
DN100	SFMTF040	16.120	4.2589
DN125	SFMTF050	8.8624	2.3415
DN150	SFMTF060	6.4543	1.7052
DN200	SFMTF080	4.0720	1.0758

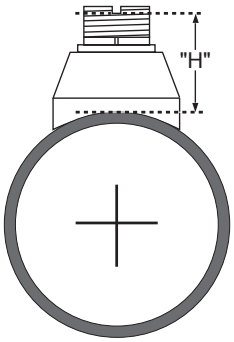
Iron Saddles 

PIPE SIZE (IN.)	FITTING	2537 SENSOR	
		U.S. GAL	LITERS
SCH 80 IRON SADDLES ON SCH 80 PIPE			
2	IR8S020	64.720	17.099
2-1/2	IR8S025	42.480	11.223
3	IR8S030	26.420	6.980
4	IR8S040	14.700	3.884
5	IR8S050	12.180	3.218
6	IR8S060	8.4400	2.230
8	IR8S080	4.9000	1.295
SCH 80 IRON SADDLE ON SCH 40 PIPE			
2	IR8S020	53.640	14.172
2-1/2	IR8S025	37.600	9.934
3	IR8S030	23.220	6.135
4	IR8S040	13.260	3.503
5	IR8S050	11.040	2.917
6	IR8S060	7.2400	1.913
8	IR8S080	4.4000	1.162

H-Dimension

The plastic insert in Weldolet fittings MUST be removed during the welding process. When reinstalled, it is important that the insert be threaded to the proper height ("H" dimension).

Weldolet	"H" dimension	
Part number	inches	mm
CS4W020	2.38	60.45
CS4W025	2.33	59.18
CS4W030	2.32	58.92
CS4W040	2.30	58.42
CS4W050	3.09	78.48
CS4W060	2.96	75.18
CS4W080	2.73	69.34



Weldolet	"H" dimension	
Part number	inches	mm
CR4W020	2.38	60.45
CR4W025	2.33	59.18
CR4W030	2.32	58.92
CR4W040	2.30	58.42
CR4W050	3.09	78.48
CR4W060	2.96	75.18
CR4W080	2.73	69.34

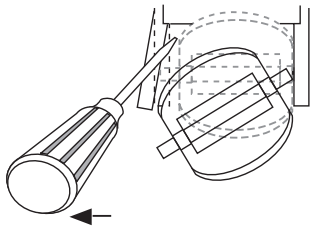
Maintenance and Cleaning

The 2537 requires very little maintenance.

- If the paddlewheel becomes fouled, it can be cleaned with mild detergents and a small brush.
- The electronics portion of the 2537 does not require maintenance or cleaning.

Rotor Replacement Procedure

1. To remove the rotor, insert a small screwdriver between the rotor and the ear of the sensor.
2. Twist the screwdriver blade to flex the ear outward enough to remove one end of the rotor and pin. DO NOT flex the ear any more than necessary! If it breaks, the sensor cannot be repaired.
3. Install the new rotor by inserting one tip of the pin into the hole, then carefully flex the opposite ear back enough to slip rotor into place.



Ordering Information

Mfr. Part No.	Code	Description
2537 system for 0.5 in. to 4 in. pipes:		
Polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P0	159 001 291	Pulse/Flow Switch, DCR, -P0, Integral Mount
3-2537-2C-P0	159 001 292	Pulse/Flow Switch, SSR, -P0, Integral Mount
3-2537-5C-P0	159 001 295	Digital (S^3L), Integral Mount
3-2537-6C-P0	159 001 296	4 to 20 mA, Integral Mount
2537 system for 5 in. to 8 in. pipes:		
Polypropylene body, Black PVDF rotor, Titanium pin, FPM O-rings		
3-2537-1C-P1	159 001 303	Pulse/Flow Switch, DCR, -P1, Integral Mount
3-2537-2C-P1	159 001 304	Pulse/Flow Switch, SSR, -P1, Integral Mount
3-2537-5C-P1	159 001 307	Digital (S^3L), Integral Mount
3-2537-6C-P1	159 001 308	4 to 20 mA, Integral Mount
2537 system for 0.5 in. to 4 in. pipes:		
Natural PVDF body, Natural PVDF rotor and pin, FPM O-rings		
3-2537-1C-T0	159 001 315	Pulse/Flow Switch, DCR, -T0, Integral Mount
3-2537-2C-T0	159 001 316	Pulse/Flow Switch, SSR, -T0, Integral Mount
3-2537-5C-T0	159 001 319	Digital (S^3L), Integral Mount
3-2537-6C-T0	159 001 320	4 to 20 mA, Integral Mount

Accessories

Mfr. Part No.	Code	Description
3-2536.320-1	198 820 052	Rotor, PVDF Black
3-2536.320-2	159 000 272	Rotor, PVDF Natural
3-2536.320-3	159 000 273	Rotor, ETFE
3-2536.321	198 820 054	Rotor and Pin, PVDF Natural
3-2536.322-1	198 820 056	Sleeved Rotor, PVDF Black
3-2536.322-2	198 820 057	Sleeved Rotor, PVDF Natural
3-2536.322-3	198 820 058	Sleeved Rotor, ETFE
M1546-1	198 801 182	Rotor Pin, Titanium
M1546-2	198 801 183	Rotor Pin, Hastelloy-C
M1546-3	198 820 014	Rotor Pin, Tantalum
M1546-4	198 820 015	Rotor Pin, Stainless Steel
P51545	198 820 016	Rotor Pin, Ceramic
1220-0021	198 801 000	O-Ring, FKM
1224-0021	198 820 006	O-Ring, EPDM
1228-0021	198 820 007	O-Ring, FFKM
P31536	198 840 201	Sensor Plug, Polypro
3-8050.390-1	159 001 702	Retaining Nut Replacement Kit, NPT, Valox®
3-8050.390-3	159 310 116	Retaining Nut Replacement Kit, NPT, PP
3-8050.390-4	159 310 117	Retaining Nut Replacement Kit, NPT, PVDF
3-9000.392-1	159 000 839	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	159 000 841	Liquid tight connector kit, PG 13.5 (1 piece)
7310-1024	159 873 004	24 VDC Power Supply, 10W, 0.42 A
7310-2024	159 873 005	24 VDC Power Supply, 24W, 1.0 A
7310-4024	159 873 006	24 VDC Power Supply, 40W, 1.7 A
7310-6024	159 873 007	24 VDC Power Supply, 60W, 2.5 A
7310-7024	159 873 008	24 VDC Power Supply, 96W, 4.0 A

+GF+

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3-2537.090 Rev. 11 03/19 English
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GF 2724-2726 pH/ORP Electrodes

General Purpose

Compatible with ALL GF pH/ORP instruments and SmartPro transmitters

The 2724-2726 pH and ORP electrodes are general purpose sensors ideal for a wide range of applications. These feature a patented reference design and uses the unique foul-proof patented DryLoc® connector. The large area PE reference junction and pathway is constructed to increase the total reference effectiveness and ensures long service life.

The DryLoc® connector with corrosion resistant gold plated contacts readily connects the sensor to the mating 2751 pH/ORP Smart Sensor Electronics or the 2760 Preamplifier. The robust PPS threaded sensor body and choice of flat pH, bulb pH, or flat ORP sensing elements allows a broad range of chemical and mechanical compatibility for a wide variety of applications.

There are two optional pH sensing versions available, HF and LC. The HF version is for applications where traces of hydrofluoric acid (2% or less) will attack standard pH glass. The LC version can be used for low conductivity fluids 20 - 100 µS/cm nominal and below 20 µS/cm when mounted under controlled conditions.

The quick temperature response is available in either a Pt1000 or 3 KΩ temperature sensor and allows compatibility with all pH/ORP instruments. The 2724-2726 electrodes incorporate ¾ inch NPT or ISO 7/1-R 3/4 threads for installing into GF standard pipe-tees. They can also be mounted directly into standard fittings, DN15 to DN100 (½ to 4 inch).

Features

- **Patented reference design for exceptional performance and prolonged life in harsh environments***
- **Memory chip enabled for access to a wide range of unique features when connected to the 2751 pH/ORP Smart Sensor Electronics**
- **PPS body for broad range of chemical compatibility**
- **Patented DryLoc® connector with gold plated contacts**
- **Special design allows for installation at any angle, even inverted or horizontal**
- **¾" NPT or ISO 7/1-R 3/4 threaded sensors for use with reducing tees DN15 to DN100 (½ to 4 in.)**
- **Mounts in GF standard fittings from DN15 to DN100 (½ to 4 in.)**
- **Quick temperature response**
- **Bulb and flat HF resistant glass available for trace HF, in less than 2% concentration applications**
- **Low conductivity sensor available for liquids down to 20 µS/cm**

Applications

- **Water & Wastewater Treatment**
- **Neutralization Systems**
- **Effluent Monitoring**
- **Sanitization Systems**
- **Pool & Spa Control**
- **Aquatic Animal Life Support Systems**
- **Process Control**
- **Cooling Towers**

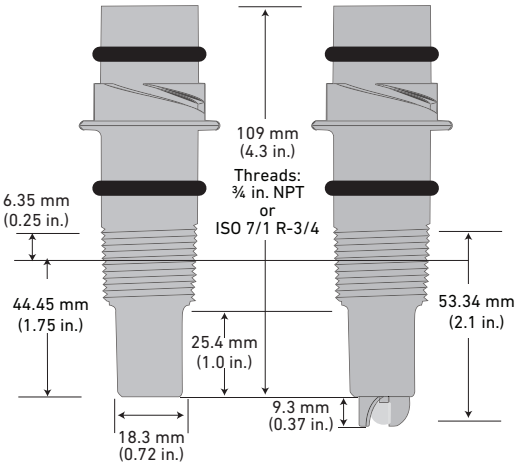
*U.S. Patent Nos.: 6,666,701, 7,799,193 B2, 7,867,371 B2 and 8,211,282 B2

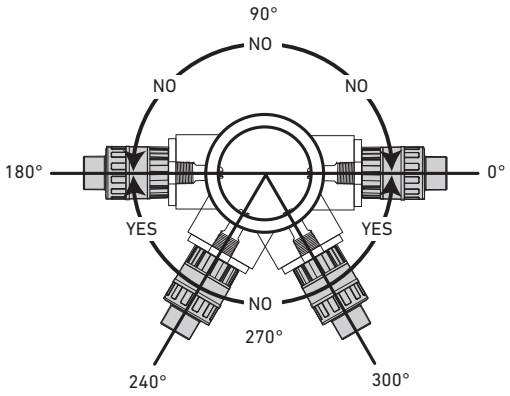
Specifications

General			
Performance	Efficiency	>97% @ 25 °C (77 ° F)	
Operating Range	pH	0 to 14 pH	
	ORP	±2000 mV	
	3-2726-LC	Low conductivity fluids; 20 - 100 µS/cm nominal < 20 µS; flow must be less than 150 ml/min in a properly grounded system	
	3-2724-HF, 3-2726-HF	Hydrofluoric acid resistant glass, pH 6 or below; trace HF ≤2%	
Compatibility			
	2751 Smart Sensor Electronics (for 8900, 9900, 9950, 4 to 20 mA or Profibus Concentrator), 2760 Preamplifier		
Temperature Sensor			
	Pt1000 versions	Compatible with 2751 pH/ORP Smart Sensor Electronics for connection to a PLC or to the 8900, 9900 or 9950 instruments	
	3 KΩ Balco versions	Compatible with 2751 pH/ORP Smart Sensor Electronics or with 2760 pH/ORP Preamplifier for connection to the 8750 pH/ORP Transmitter	
Process Connection			
	¾ in. NPT	ISO 7/1-R 3/4	Mounts into fittings
Wetted Materials			
	pH	PPS, glass, UHMW PE, FKM	
	ORP	PPS, glass, UHMW PE, FKM, Platinum	
Max. Temperature/Pressure Rating			
Operating Temperature Range*	bulb tip design	0 °C to 85 °C	32 °F to 185 °F
	flat tip design	10 °C to 85 °C	50 °F to 185 °F
Operating Pressure Range		6.8 bar @ 0 to 65 °C (100 psi @ 32 to 150 °F)	
		4 bar @ 65 to 85 °C (58 psi @ 150 to 185 °F)	
*Best performance for 2724-HF, 2726-HF sensors is above 10 °C (50 °F)			
Recommended Storage Temperature			
		0 °C to 50 °C	32 °F to 122 °F
The electrode glass will shatter if shipped or stored at temperature below 0 °C (32 °F)			
The performance life of the electrode will shorten if stored at temperatures above 50 °C (122 °F)			
Mounting			
In-line Mounting	Use the sensor threads		
	Use a standard fitting up to 4 in.		
	Sensor can be mounted at any angle		
Submersible Mounting	Use threads on models 2751 or 2760		
	Requires ¾ inch NPT or ISO 7/1-R 3/4 male threaded liquid tight extension conduit.		
Shipping Weight			
	0.25 kg	0.55 lb	
Standards and Approvals			
	RoHS compliant, China RoHS		
	Manufactured under ISO 9001, ISO 14001 and ISO 45001		

See Temperature and Pressure graphs for more information

Dimensions



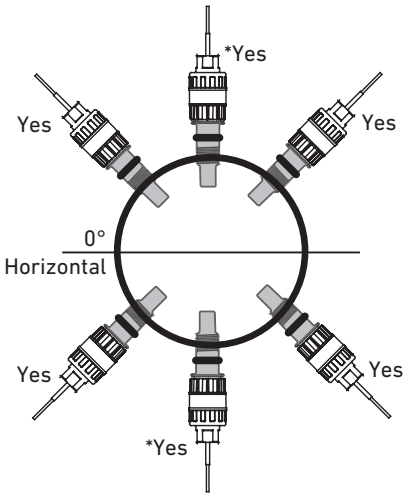


Mounting Angle

Models 2724-2726 may be mounted at any angle without affecting the performance.

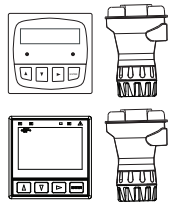
*Avoid locations with air pockets and sediment

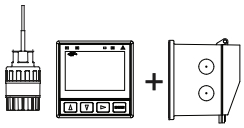
When mounting in standard threaded fittings the electrode must be mounted horizontally to 60 degrees below horizontal position only.

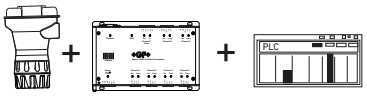


System Overview

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Output	Automation System
GF Instruments with 2751 Smart Sensor Electronics - 8900 - 9900 - 9950	GF Instruments with 2751 Smart Sensor Electronics - 9900 and Rear Enclosure	2751 Smart Sensor Electronics with - Customer Supplied Chart Recorder or Programmable Logic Controller or - Programmable Automation Controller	2751 Smart Sensor Electronics with - 0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or - Programmable Automation Controller



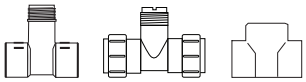




GF 2724-2726
DryLoc® pH/ORP
Electrodes

All sold separately

In-Line Installation -
GF and threaded 1/2 in to 4 in fittings only



Submersible Installation -
Customer supplied pipe extension
or conduit with 3/4 in. NPT or ISO 7/1-R 3/4 threads

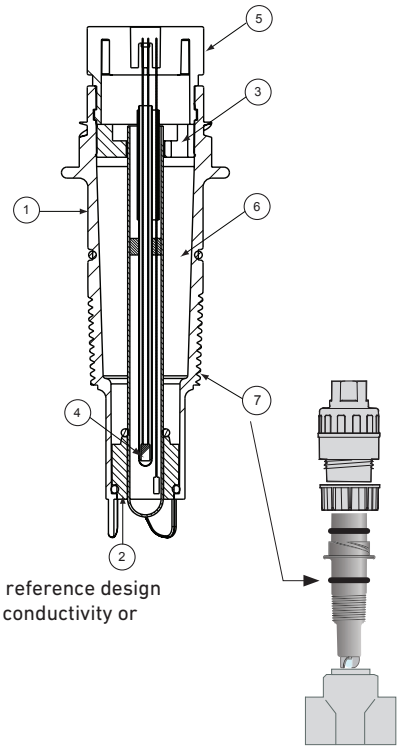
Electrode Key Features and Benefits:

1. PPS body for chemical compatibility with most harsh chemicals.
2. Porous UHMW PE (ultra high molecular weight polyethylene) junction resists fouling and build-up.
3. Memory chip enabled for convenient data storage and access (calibration data, operational data, and manufacturing data), electrode health monitoring via glass impedance measurement when used in connection with the 2751 pH/ORP Smart Sensor Electronics.
4. Internal temperature sensor located in the glass stem for a quick temperature response.
5. DryLoc® connector with corrosion resistant gold plated pins for quick and easy sensor removal. Resists moisture and dirt intrusion.
6. Dual-patented reference design with a 406 mm (16 in.) reference pathway for prolonged life in harsh environments. This enables the sensor to last significantly longer than other standard pH/ORP electrodes in most applications.

6a. With the patented reference design, the 2726-LC version performs better in low conductivity water between 20 - 100 µS and lasts longer than previous "DI" electrodes.

6b. The 2726-LC sensor also performs in applications with extremely low (less than 20 µS/cm) conductivity. Special precautions must be taken to avoid measurement complications. Please note the following.
   - Electrostatic charges (streaming potentials) can cause dramatic offsets in a system with very low conductivity water. To minimize this, sensors should be placed in a well grounded system.
   - To enhance performance, a low flow cell is recommended to provide a steady flow rate (150 ml/minute). Sensors placed in high flow applications will experience noisier readings due to streaming potential.

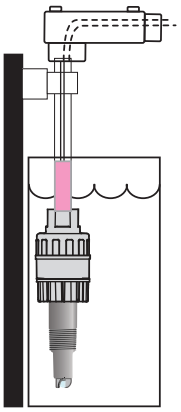
7. Threads for NPT or ISO process connection into reducing tees
   - Use off-the-shelf GF reducing tees DN20 to DN100 (¾ to 4 in.).
8. Mounts directly into fittings (½ to 4 in.) for easy sensor retrofitting.
9. Mount submersed into a tank via the 2751 or 2760 back threads.



Dual-patented reference design for long life in conductivity or chemicals.

Sensor in threaded reducing tee

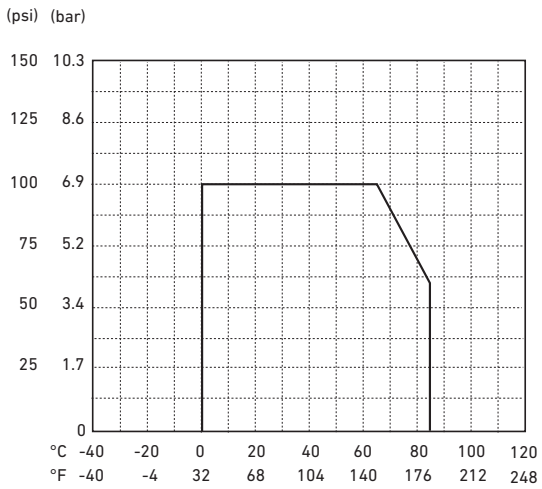
⑧ Sensor in fitting



⑨ Sensor submersible installation

Temperature/Pressure Graph

Note:
The pressure/temperature graphs are specifically for the GF sensor. During system design the specifications of all components must be considered. In the case of a metal piping system, a plastic sensor will reduce the system specification.



Application Tips
- Use the flat glass electrodes when a self-cleaning feature is desired; especially useful in applications with abrasive chemicals for in-line installations.
- Use bulb protected electrodes for low temperature applications or where fast response is required.
- ORP electrodes are generally used for chemical reaction monitoring, not control.
- Ensure that sensor materials are chemically compatible with the process liquid.
- Keep electrode tip wet, avoid air pockets and sediment.

Model 2724-2726 Ordering Notes
1) pH and ORP electrodes require connection to model 2751 pH/ORP Smart Sensor Electronics or 2760 Preamplifier.
2) The 2751 "EasyCal" feature recognizes common pH and ORP buffer values of 4, 7 and 10 pH and +87, +264 and +469 mV for ORP.

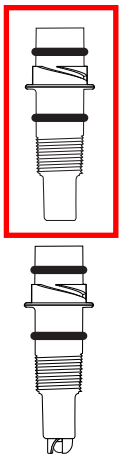
Buffer Solutions
3822-7004
3822-7007
3822-7010

Quinhydrone
3822-7115

The GF pH buffers are ideal for calibration.
The liquid solutions are conveniently packaged in one pint (473 ml) bottles. pH buffer kits in powder pillows are available for mixing fresh solutions with water at the time of use.

All pH buffers are color coded for easy identification; 4.01 pH is red, 7.00 pH is yellow, and 10.00 pH is blue.
All pH buffers are traceable to NIST standards.
The 4.01 and 7.00 pH buffer solutions can be used to calibrate ORP sensors when saturated with quinhydrone.

Ordering Information



Mfr. Part No.	Code	Tip Design	Process Connection Thread Options
pH Electrodes			
Temperature Element Pt1000; use with 2751 pH/ORP Smart Sensor Electronics* and Profibus Concentrator			
3-2724-00	**159 001 545**	Flat	¾ in. MNPT, Thread
3-2724-01	**159 001 546**	Flat	ISO 7/1-R 3/4 Thread
3-2726-00	**159 001 553**	Bulb	¾ in. MNPT, Thread
3-2726-01	**159 001 554**	Bulb	ISO 7/1-R 3/4 Thread
3-2726-HF-00	**159 001 549**	Bulb, HF Resistant[1]	¾ in. MNPT, Thread
3-2726-HF-01	**159 001 550**	Bulb, HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-LC-00	**159 001 557**	Bulb, Low Conductivity[2]	¾ in. MNPT, Thread
3-2726-LC-01	**159 001 558**	Bulb, Low Conductivity[2]	ISO 7/1-R 3/4 Thread
Temperature Element 3 KΩ Balco; Compatible with both the 2751 pH/ORP Smart Sensor Electronics* and the 2760 Preamplifier**			
3-2724-10	**159 001 547**	Flat	¾ in. MNPT, Thread
3-2724-11	**159 001 548**	Flat	ISO 7/1-R 3/4 Thread
3-2724-HF-10	**159 001 771**	Flat, HF Resistant[1]	3/4 in. NPT, Thread
3-2724-HF-11	**159 001 772**	Flat, HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-10	**159 001 555**	Bulb	¾ in. MNPT, Thread
3-2726-11	**159 001 556**	Bulb	ISO 7/1-R 3/4 Thread
3-2726-HF-10	**159 001 551**	Bulb HF Resistant[1]	¾ in. MNPT, Thread
3-2726-HF-11	**159 001 552**	Bulb HF Resistant[1]	ISO 7/1-R 3/4 Thread
3-2726-LC-10	**159 001 559**	Bulb, Low Conductivity[2]	¾ in. MNPT, Thread
3-2726-LC-11	**159 001 560**	Bulb, Low Conductivity[2]	ISO 7/1-R 3/4 Thread
ORP Electrodes; Compatible with both the 2751 pH/ORP Smart Sensor Electronics* and the 2760 Preamplifier**			
3-2725-60	**159 001 561**	Platinum, Flat, 10 KΩ ID, ¾ in. NPT	¾ in. MNPT, Thread
3-2725-61	**159 001 562**	Platinum, Flat, 10 KΩ ID, ISO 7/1 R¾	ISO 7/1-R 3/4 Thread

*The 2751 pH/ORP Smart Sensor Electronics has a digital (S^3L) output which is used with 8900, 9900 or 9950 instruments, and the Profibus Concentrator.
It also has a 4 to 20 mA output for connections to PLC's, data recorders, etc.

**The 2760 Preamplifier is used for connection directly to 8750 transmitter or other analog transmitters.

[1]HF resistant ≤2%HF

[2]Low conductivity applications, 20 - 100 µS/cm recommended

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
1220-0021	**198 801 000**	O-ring, FKM (2 required per sensor)
3-2700.395	**159 001 605**	Calibration Kit: includes 3 polypropylene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00
3822-7115	**159 001 606**	20 gm Bottle Quinhydrone for ORP Calibration (must use pH 4.01 and/or pH 7.00 buffer solutions)
3-2759	**159 000 762**	pH/ORP System Tester (adapter cable sold separately)
3-2759.391	**159 000 764**	2759 DryLoc Adapter Cable (for use with 2751 and 2760)
3-0700.390	**198 864 403**	pH Buffer Kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 ml of each)
3822-7004	**159 001 581**	pH 4.01 Buffer Solution, 1 pint (473 ml) bottle
3822-7007	**159 001 582**	pH 7.00 Buffer Solution, 1 pint (473 ml) bottle
3822-7010	**159 001 583**	pH 10.00 Buffer Solution, 1 pint (473 ml) bottle
3800-5000	**159 838 107**	3.0M KCl Storage Solution for pH and ORP, 1 pint (473 ml) bottle
3-2700.397	**159 001 870**	Protective Cap for pH/ORP Electrodes, 5 pieces
3-2700.398	**159 001 886**	O-ring Lubricant Kit (5 packs of Super Lube, 1cc each)

3-2724.099 Rev M (02/21)
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3401 Aero Jet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057 • www.gfsignet.com • e-mail: signet.ps@georgfischer.com
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+GF+

English

Signet 2724-2726 and 2734-2736 Series DryLoc pH and ORP Electrodes

3-2724.090 Rev. H 11/13

Operating Instructions

2724 & 2725 2734 & 2735 Flat Glass Electrode

2726 & 2736 Protected Bulb Glass Electrode

Description

The Signet 2724-2726 and 2734-2736 Series of pH and ORP electrodes are designed to minimize maintenance time and maximize value.

- The unique DryLoc® connector provides quick assembly and a secure connection featuring gold-plated contacts and an O-ring seal.
- The patented design features a lengthened reference chamber pathway to extend the operational life of the electrode.
- Wetted materials are selected to withstand a wide array of industrial applications.
- Multiple mounting features address the need for installation flexibility. These electrodes can be threaded into ¾ in. NPT or ISO 7/1 R¾ inch pipe fittings, submerged in a tank, or mounted into familiar Signet installation fittings.
- To build a stand-alone, self-contained pH control system, combine the 2724-2726 electrodes with a 2760 pH Preamplifier and add a 8750 pH/ORP Transmitter to move your control capability to the next level.
- Combine the 2427-2726 or 2734-2736 electrodes with the 2750 pH Sensor Electronics to provide a 4 to 20 mA loop to a Programmable Logic Controller (PLC), SCADA system, or datalogger.
- For more flexibility and unique features, pair the 2724-2726 or 2734-2736 series with a 2750 pH/ORP Sensor Electronics and the new 9900 Transmitter.
- Connect up to six 2724-2726 or 2734-2736 electrodes to one 8900 Multi-Parameter Controller with six 2750 pH/ORP Sensor Electronics using digital (S^3L) serial data output for a truly amazing set of features, options, and measurements.
- The 2724-2726 electrodes are recommended for general purpose applications.
- The 2734-2736 electrodes are recommended for harsh applications.
- The 2734-2736 electrodes utilize advanced reference technology to extend electrode life in all applications.

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Warranty Information

Refer to your local Georg Fischer Sales office for the most current warranty statement.

All warranty and non-warranty repairs being returned must include a fully completed Service Form and goods must be returned to your local GF Sales office or distributor. Product returned without a Service Form may not be warranty replaced or repaired.

Signet products with limited shelf-life (e.g. pH, ORP, chlorine electrodes, calibration solutions; e.g. pH buffers, turbidity standards or other solutions) are warranted out of box but not warranted against any damage, due to process or application failures (e.g. high temperature, chemical poisoning, dry-out) or mishandling (e.g. broken glass, damaged membrane, freezing and/or extreme temperatures).

Product Registration

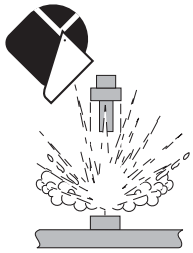
Thank you for purchasing the Signet line of Georg Fischer measurement products.
If you would like to register your product(s), you can now register online in one of the following ways:

- Visit our website **www.gfsignet.com** and click on **Product Registration Form**
- If this is a pdf manual (digital copy), **click here**
- Scan the QR Code on the left

Chemical Compatibility

The retaining nuts of pH and ORP sensors are not designed for prolonged contact with aggressive substances. Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances, e.g. due to leakage or spilling, must be replaced.

- The use of this product assumes operators are trained and familiar with this type of device.
- Operators should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators MUST follow all necessary safety procedures.

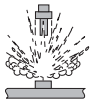


Safety Information

1. Use appropriate eye, face, hand, body and/or respiratory protection when using chemicals or solvents.
2. Prior to installation or removal:
   - Depressurize and vent system
   - Drain below sensor level.
3. Confirm chemical compatibility before use.
4. Do not exceed the max. temperature/pressure specifications.
5. Do not alter product construction.

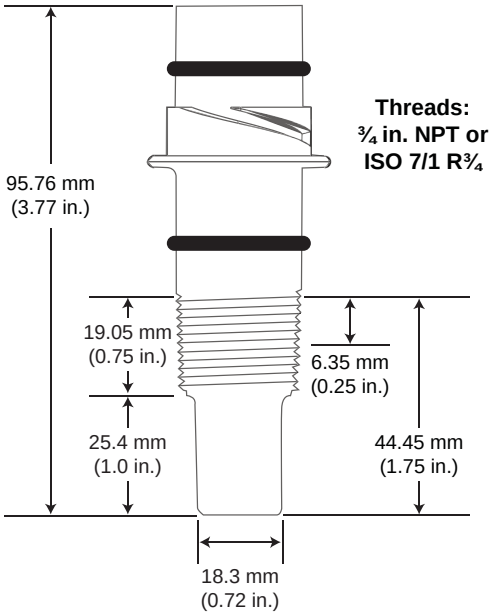
If installing into a threaded connection:

6. Inspect threads to ensure integrity. Do not install a sensor that has damaged threads.
7. Apply PTFE tape to the process connection threads in accordance with industry practices.
8. **HAND TIGHTEN** the sensor into the process connection. **DO NOT USE TOOLS.**

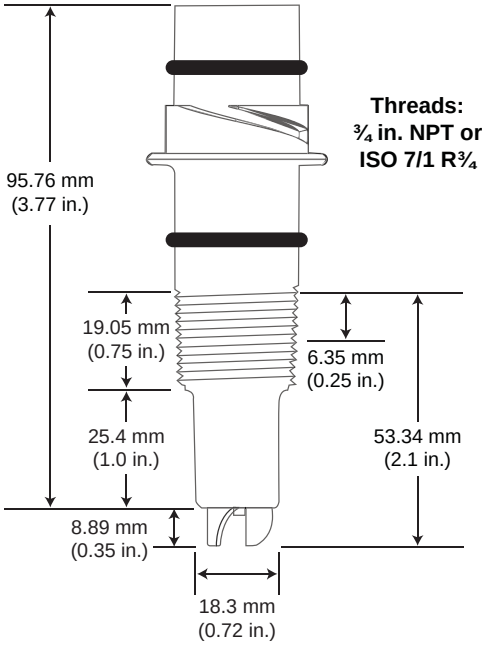
	Caution / Warning / Danger Indicates a potential hazard. Failure to follow all warnings may lead to equipment damage, injury, or death
	Personal Protective Equipment (PPE) Always utilize the most appropriate PPE during installation and service of Signet products.v
	**Pressurized System Warning** Sensor may be under pressure, take caution to vent system prior to installation or removal. Failure to do so may result in equipment damage and/or serious injury.
	Hand Tighten Only Overtightening may permanently damage product threads and lead to failure of the retaining nut.
	Do Not Use Tools Use of tool(s) may damage product beyond repair and potentially void product warranty.
	Note / Technical Notes Highlights additional information or detailed procedure.
	Do Not Freeze Products are temperature sensitive and may contain freezable liquids. Freezing damage to pH, ORP, and Chlorine electrodes voids product warranty.

Dimensions

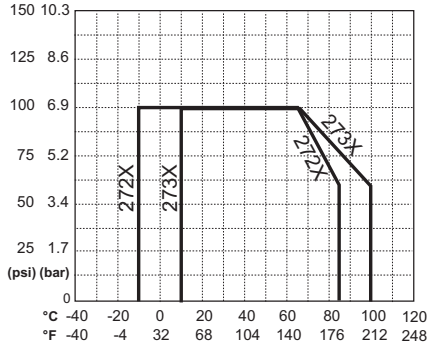
2724, 2725, 2734, & 2735 Flat Glass Electrode



2726 & 2736 Protected Bulb Glass Electrode



Maximum Temperature and Pressure Rating



Specifications

General

Compatibility ..... 2750 pH/ORP Sensor electronics, 2760 pH/ORP preamplifier (2724-2726 only)

pH Temp Sensor:

PT1000 ..... Compatible with 2750 electronics

Connection to ..... PLC, 9900 Transmitter, 8900 Multi-Parameter Controller

3 KΩ Balco ..... Compatible with 2760 preamplifier

Connection to ..... 8750 pH/ORP Transmitter

Process Connection ..... ¾ in. NPT or ISO 7/1 R¾ threads or Signet flow fittings

Wetted Materials:

pH (2724 & 2726) ..... Ryton (PPS), glass, UHMW PE, FPM

ORP (2725) ..... Ryton (PPS), glass, UHMW PE, FPM, Platinum

pH (2734 & 2736) ..... Ryton (PPS), glass, PTFE, FPM

ORP (2735) ..... Ryton (PPS), glass, PTFE, FPM, Platinum

Shipping Weight..... 0.25 kg (0.55 lb)

Performance

Efficiency (2724-2726) .... > 97% @ 25 °C (77 °F)

Efficiency (2734-2736) .... > 95% @ 25 °C (77 °F)

- Efficiency indicates the "wellness" of a new electrode.
- Efficiency is measured by comparing the actual slope (mV/pH) at 25 °C to the theoretical output of 59.16 mV/pH.
- An efficiency of 95% to 100% is equivalent to a slope of 56.20 to 59.16 mV/pH.

Measuring Range:

pH ..... 0 to 14

ORP ..... ±2000 mV

3-2726-LC ..... Low Conductivity fluids (20 to 100 µS/cm)

≤ 20 µS/cm ..... Flow must be less than 150 ml/min. in a properly grounded system

3-2724-HF, 3-2726-HF, 3-2734-HF, 3-2736-HF ..... Hydrofluric acid resistant glass, pH 6 or below; trace HF ≤ 2%

For applications where hydrofluoric acid, **in concentrations of 2% or less**, will attack standard pH glass in levels of pH 6 and below, or in situations where process upsets may temporarily drop to these pH levels.

Environmental Requirements

Operating Temperature

2724-2726* ..... -10 °C to 85 °C (14 °F to 185 °F)

2734-2736* ..... 10 °C to 100 °C (50 °F to 212 °F)

*Best performance for 3-2724-HF, 3-2726-HF, 3-2734-HF, 3-2736-HF is above 10 °C (50 °F)

Operating Pressure Range

2724-2726:

- 0 to 6.9 bar (0 to 100 psi) @ -10 °C to 65 °C (14 °F to 149 °F)
- Linearity Derated 6.9 to 4.0 bar (100 to 58 psi) @ 65 °C to 85 °C (149 °F to 185 °F)

2734-2736:

- 0 to 6.9 bar (0 to 100 psi) @ 10 °C to 65 °C (50 °F to 149 °F)
- Linearity Derated 6.9 to 4.0 bar (100 to 58 psi) @ 65 °C to 100 °C (149 °F to 212 °F)

Recommended storage temperature

pH/ORP electrodes ..... 0 °C to 50 °C (32 °F to 122 °F)

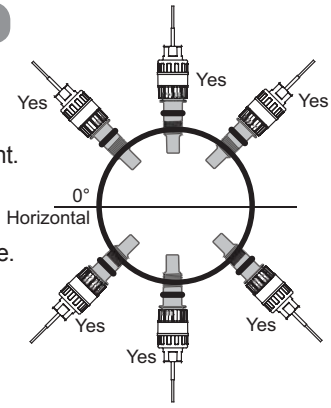
- The electrode glass will shatter if shipped or stored at temperatures below 0 °C (32 °F).
- The performance life of the electrode will be shortened if stored at temperatures above 50 °C (122 °F).

Standards and Approvals

- Manufactured under ISO 9001 for Quality, ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.
- RoHS Compliant

China RoHS (Go to www.gfsignet.com for details)

In-Line Installation



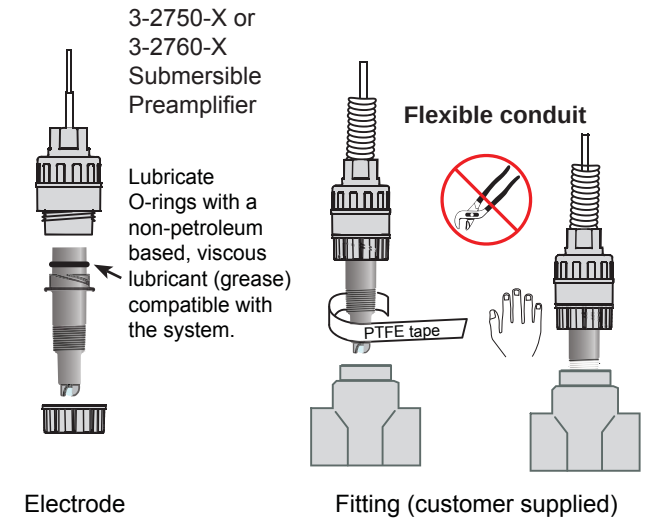
1. The electrode can be mounted at any angle.
2. Avoid air pockets and sediment.
3. The fitting must place the electrode in the flow but must not bottom out in the pipe.
4. Select a Signet installation fitting for convenience.
5. Use the ¾ in. threads on the electrode body to install the electrode into reducing tee fittings.
6. Inspect threads to ensure integrity. Do not install an electrode with damaged threads.
7. Apply PTFE tape to the process connection threads, in accordance with industry standards.
8. Use piping installation hardware with smooth, well-finished threads to facilitate the installation.
9. If necessary, the pipe should be plumbed with a depression (trap) so liquid is maintained around the electrode tip.
10. Hand-tighten the electrode into the process connection. Do not use any tools to install the electrode. The use of wrenches, pliers or similar may over-stress the sensor body and lead to breakage and subsequent spillage of the process liquid.

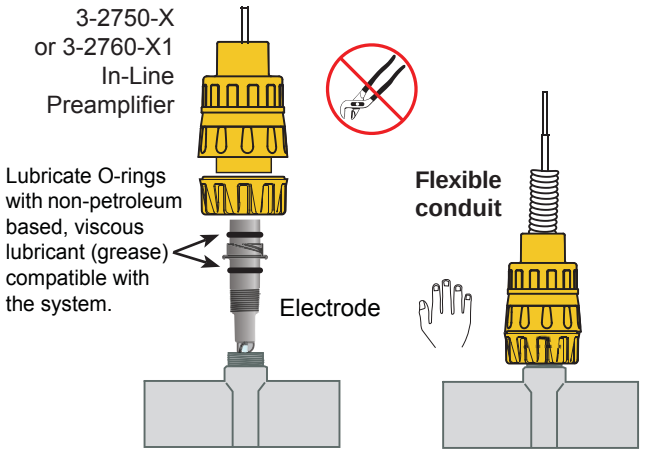
CAUTION:
A broken sensor may be ejected forcefully from the fitting and can cause severe injury.

11. The safety instructions have an adhesive label and should be placed near the sensor.

Low Conductivity Installation

- The 3-2726-LC pH electrodes can be used in low conductivity water of less than 100 µS.
- When used in the range of 20 to 100 µS, the flow range must not exceed 1 m/s (3 ft/s) velocity.
- When used in liquids of less than 20 µS, the flow range must not exceed 150 ml/min; the sensor should also be mounted in a well grounded cell.

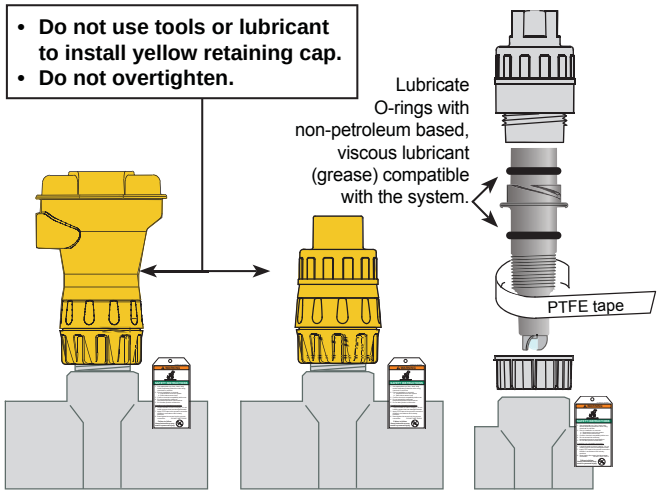




Signet Installation Fitting DN15 to DN100 (½ in. to 4 in.)

Do not use as a handle!

- **Do not use tools or lubricant to install yellow retaining cap.**
- **Do not overtighten.**



Signet Installation Fittings

Type	Description
Plastic tees	• Available in ½ in. to 4 in. sizes • PVC, CPVC w/solvent cement socket • PVDF or PP w/union end fittings
PVC saddles	• Available in 2 in. to 4 in. sizes • Requires 1-7/16 in. hole in pipe
Iron strap-on saddles	• Available in 2 in. to 4 in. sizes • Requires 1-7/16 in. hole in pipe

Type	Description
Carbon steel weldolets	• Available in 2 in. to 4 in. sizes • Requires 1-7/16 in. hole in pipe • Install by certified welder only
Carbon steel threaded tees	• Available in ½ in. to 2 in. sizes • Female NPT ends
Universal pipe adapters	• Use for installation in pipes >4 in. (1¼ in. NPT) • PVC, CPVC, or PVDF versions • Specify socket or 1¼ inch NPT male threads

Removing from In-Line Installations

- The use of this product assumes that operators are trained and are familiar with this type of device.
- They should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators MUST follow all necessary safety procedures.

In-line removal Instructions:

1. Depressurize and vent the piping system.
2. Drain the system to below sensor level.
3. Wear safety goggles or face shield during removal. Use all appropriate eye, face, hand, body and/or respiratory protection when working with chemicals or solvents.
4. Place a Lockout tag on the pipe when the sensor is removed for maintenance to prevent accidental opening and exposure to potentially hazardous chemicals.

Submersible Installations

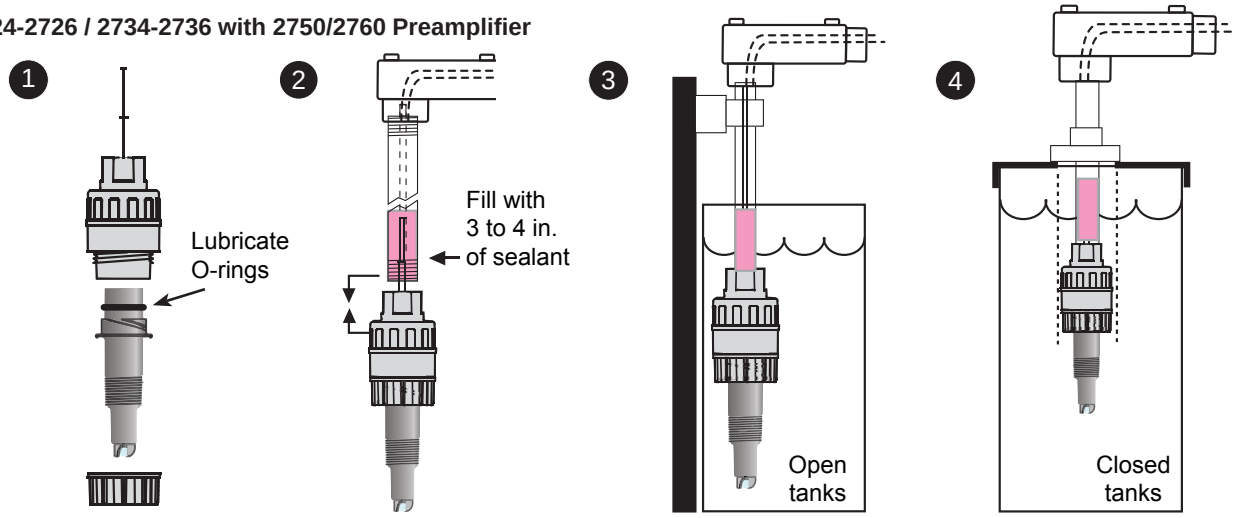
The user must supply the following hardware to complete a submersible installation:

- ¾ in. NPT threaded pipe or conduit
- Wiring junction box
- Pipe clamps (quick-release type recommended)
- Tank flange for closed tanks

Technical Note:

- Mount the electrode near tank outlets, away from reagent addition areas.
- Use the ¾ in. threads at the top of the preamplifier to run the cable inside pipe or conduit.
- Place the electrode tip in pH 4 buffer during system maintenance or storage to avoid dehydration.

2724-2726 / 2734-2736 with 2750/2760 Preamplifier



The Signet pH/ORP electrodes are designed to install in tanks by attaching conduit to the ¾ in. threads at the top of the accompanying preamplifier or sensor electronics:

1. The O-ring at the top of the electrode fits very tightly into the preamplifier. Use a small amount of non-petroleum based lubricant to assist the assembly.
2. To prevent moisture from migrating into the preamplifier, backfill the conduit with 3 in. to 4 in. of sealant.
3. Mount electrodes in a location with ample clearance to remove them for periodic cleaning and recalibration.
4. Choose a location that keeps the electrode glass completely submersed at all times.

pH System Calibration

There are two functions in a pH electrode that require the system to be calibrated:

Temperature

- The temperature output of the electrode (from a 3K Balco or PT1000 RTD) must be calibrated only once. When a new electrode is installed, it does not need to be repeated.
- Because the temperature measurement has a significant influence on the electrochemical measurement, the temperature output in new pH electrodes should always be calibrated before the pH/mV calibration.

NOTE: All Signet transmitters and controllers incorporate automatic temperature compensation.

Table 1

pH error due to temperature changes in fluid											
°C	**pH 2**	**pH 3**	**pH 4**	**pH 5**	**pH 6**	**pH 7**	**pH 8**	**pH 9**	**pH 10**	**pH 11**	**pH 12**
15	0.15	0.12	0.09	****0.06**	0.03	0	0.03	0.06	0.09	0.12	0.15
25	0	0	0	*** 0**	0	0	0	0	0	0	0
35	0.15	0.12	0.09	0.06	0.03	0	0.03	0.06	0.09	0.12	0.15
45	0.3	0.24	0.18	0.12	0.06	0	0.06	0.12	0.18	0.24	0.3
55	0.45	0.36	0.27	0.18	0.09	0	0.09	0.18	0.27	0.36	0.45

As the pH value moves away from neutral (7 pH) or the temperature moves away from 25 ºC, the electrochemical output is affected.

***** Example: At pH 5 the mV output of the electrode is not affected if the temperature is at 25 °C.

****** The electrode output will be shifted by 0.06 pH units if the temperature is reduced to 15 °C.

Electrochemical pH vs. mV Ratio

- The mV output from the electrode is created by the interaction of the electrode and the fluid.
- The electrode contains a gel that depletes over time, so the instrument must be readjusted periodically to maintain system accuracy.
- The need for recalibration varies with each application, but the life of the electrode is usually consistent.
- Keep a maintenance log to establish a depletion trend in new systems.
- The mV calibration is a two-point procedure.
- Signet offers pH buffer solutions prepared specifically for this purpose.
- pH buffer solutions can be used for calibrating more than one sensor within a day provided that the solutions are protected from debris and are not diluted by rinse water from the calibration procedure.
- Use clean water to rinse buffer solutions from the electrode.
- Dispose of all buffer solutions at the end of the day.
- If the pH sensor will not calibrate within acceptable limits, clean the electrode and recalibrate.
- If the calibration results remain outside of acceptable limits, the sensor is depleted and must be replaced.
- Follow the guidelines of local waste disposal regulations when discarding buffer solutions and spent electrodes.

Theoretical mV Values @ 25 °C	
pH	mV
2	+295.8
3	+236.64
4	+177.48
5	+118.32
6	+59.16
7	0
8	–59.16
9	–118.32
10	–177.48
11	–236.64
12	–295.8

Table 2

Electrode slope is the ratio of mV to pH units. At 25 °C the theoretical slope is 59.16 mV per pH.

ORP System Calibration

ORP electrodes do not incorporate a temperature sensor, so the only system calibration required is the electrochemical adjustment.

Electrochemical ORP vs. mV Ratio

- ORP measurements are relative values, and single-point adjustments are sufficient for most applications.
- Calibration should be done using ORP test solutions such as Zobell's solution, Light's solution, or in pH buffers that have been saturated with quinhydrone (Table 3). Quinhydrone is the oxidizer that is measured by the ORP electrode.
- Zobell's solution and Light's solution are not compatible with the AutoCal function in Signet pH instrumentation.
- A new ORP electrode measures the listed values ±15 mV.
- The ORP electrode is functional until the offset exceeds 50 mV.
- An electrode whose offset measures greater than 50 mV should be cleaned or replaced if necessary.
- ORP solutions made with quinhydrone are very unstable and may not read properly after being exposed to air for a prolonged time. These solutions must be discarded after a few hours.
- Dispose of all calibration solutions in accordance with local, state and federal guidelines.
- Use clean water to rinse buffer solutions from the sensors.

Table 3:
ORP test solutions

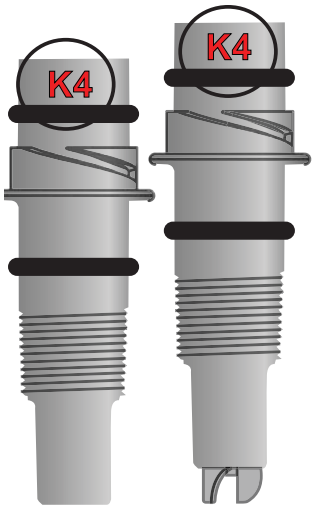
*Saturate 50 mL of pH 4 or pH 7 buffer with 1/8 g quinhydrone

	Zobell's solution	Light's solution	4 pH buffer w/quinhydrone*	7 pH buffer w/quinhydrone*
ORP at 20 °C			268 mV	92 mV
ORP at 25 °C	228 mV	469 mV	263 mV	86 mV
ORP at 30 °C			258 mV	79 mV

Electrode Date Code

- The electrode date code indicates the manufacturing date of the electrode.
- Electrodes should be put into service as soon as possible and should not remain in the box for more than two years.
- Over time, the storage solution (found in the "boot" covering the electrode tip) will evaporate or leak, allowing the delicate sensing tip and reference junction to dry.
- To rehydrate a dry electrode, soak it in pH 4 buffer for 24 to 48 hours.
- Electrodes more than 2 years old may still be functional, but will take longer to rehydrate.
- Restoration may not be effective for severely dehydrated electrodes.

Letter = Month
N = January
M = February
L = March
K = April
J = May
H = June
G = July
F = August
E = September
D = October
C = November
B = December



Numeral = Year
5 = 2010
6 = 2011
7 = 2012
8 = 2013
9 = 2014
0 = 2015
1 = 2016
2 = 2017
3 = 2018
4 = 2019
5 = 2020
6 = 2021

Example: K8 = manufactured in April 2013

Electrode Care and Application

pH/ORP electrodes are similar to batteries; they age with time and usage.
The following information will help maximize electrode life.

General Tips:

- To ensure uninterrupted operation of critical pH systems, replacement electrodes should be available.
- Store boxed electrodes flat or upright (electrode tip down) to maximize hydration of the glass surface.
- Keep the glass surface wet at all times.
- Soak the sensor tip in pH 4.0 buffer during system maintenance intervals.
- If the sensor dehydrates, soak the sensor tip in pH 4 buffer for 24 to 48 hours, then visually inspect the electrode for surface cracks, swelling, or discoloration.
- It may not be possible to restore severely dehydrated electrodes to normal operation.
- High temperatures, strong acids or caustics will increase electrochemical reactions and speed electrode aging.
- Coatings (e.g. grease) on the glass or junction surfaces cause extended response time and inaccurate measurement.
- Never store the electrode tip in deionized (DI) water. Use pH 4 buffer solution to keep the glass wet when out of the process.
- Never store the electrode at temperatures below 0 °C (32 °F) or allow it to dehydrate.
- Never scrape or sand the glass electrode surface.
- Treat glass electrode surfaces with care to prevent accidental breakage.

Cleaning

Problem	Suggested Solution
Hard Coatings	Use a dilute acid solution (HCl solution of 5% or less). If the electrode has been used in applications with a pH value higher than 7 pH, soak the electrode for 2 to 5 minutes.
	Use a dilute alkaline solution (NaOH solution at 5% or less) if the electrode has been used in applications with pH values less than 7 pH, soak the electrode for 2 to 5 minutes.
	Alternating immersion in acidic and alkaline solutions may be necessary for thorough cleaning.
Soft Coatings	Spray or vigorously stir the electrode with a mild detergent, such as dishwashing liquid. Chlorine bleach can also be used.
Oily or Organic Coatings	Spray or vigorously stir the electrode with a mild detergent or an appropriate solvent that will not attack the materials of construction. (isopropyl alcohol or similar)
ORP Platinum Coating	Gently wipe the electrode surfaces with a paper towel.
After Cleaning	Always rinse the electrode with water after cleaning.
	Soak the electrode in a pH 4 buffer (with KCl if available) for at least 10 minutes after cleaning.

Ordering Information

2724-2726 and 2734-2736 pH/ORP Electrodes

**Use with 2750 Sensor Electronics

Mfr. Part No.	Code	Description
3-2724-00	159 001 545	Electrode, pH, flat, PT1000, ¾ in. NPT
3-2724-01	159 001 546	Electrode, pH, flat, PT1000, ISO 7/1 R¾
3-2724-10	159 001 547	Electrode, pH, flat, 3K Balco, ¾ in. NPT
3-2724-11	159 001 548	Electrode, pH, flat, 3K Balco, ISO 7/1 R¾
3-2724-HF-10	159 001 771	Electrode, pH, HF resistant, flat, 3K Balco, ¾ in. NPT
3-2724-HF-11	159 001 772	Electrode, pH, HF resistant, flat, 3K Balco, ISO 7/1 R¾
3-2726-00	159 001 553	Electrode, pH, bulb, PT1000, ¾ in. NPT
3-2726-01	159 001 554	Electrode, pH, bulb, PT1000, ISO 7/1 R¾
3-2726-10	159 001 555	Electrode, pH, bulb, 3K Balco, ¾ in. NPT
3-2726-11	159 001 556	Electrode, pH, bulb, 3K Balco, ISO 7/1 R¾
3-2726-HF-00	159 001 549	Electrode, pH, HF resistant, bulb, PT1000, ¾ in. NPT
3-2726-HF-01	159 001 550	Electrode, pH, HF resistant, bulb, PT1000, ISO 7/1 R¾
3-2726-HF-10	159 001 551	Electrode, pH, HF resistant, bulb, 3K Balco, ¾ in. NPT
3-2726-HF-11	159 001 552	Electrode, pH, HF resistant, bulb, 3K Balco, ISO 7/1 R¾
3-2726-LC-00	159 001 557	Electrode, pH, bulb, Low Cond, PT1000, ¾ in. NPT
3-2726-LC-01	159 001 558	Electrode, pH, bulb, Low Cond, PT1000, ISO 7/1 R¾
3-2726-LC-10	159 001 559	Electrode, pH, bulb, Low Cond, 3K Balco, ¾ in. NPT
3-2726-LC-11	159 001 560	Electrode, pH, bulb, Low Cond, 3K Balco, ISO 7/1 R¾
3-2725-60	159 001 561	Electrode, ORP, flat, 10 KΩ ID, ¾ in. NPT
3-2725-61	159 001 562	Electrode, ORP, flat, 10 KΩ ID, ISO 7/1 R¾
3-2734-00	159 001 774	Electrode, pH, flat, PT1000, ¾ in. NPT **
3-2734-01	159 001 775	Electrode, pH, flat, PT1000, ISO 7/1 R¾ **
3-2734-HF-00	159 001 776	Electrode, pH, HF resistant, flat, PT1000, ¾ in. NPT **
3-2734-HF-01	159 001 777	Electrode, pH, HF resistant, flat, PT1000, ISO 7/1 R¾ **
3-2736-00	159 001 778	Electrode, pH, bulb, PT1000, ¾ in. NPT **
3-2736-01	159 001 779	Electrode, pH, bulb, PT1000, ISO 7/1 R¾ **
3-2736-HF-00	159 001 780	Electrode, pH, HF resistant, bulb, PT1000, ¾ in. NPT **
3-2736-HF-01	159 001 781	Electrode, pH, HF resistant, bulb, PT1000, ISO 7/1 R¾ **
3-2735-60	159 001 782	Electrode, ORP, flat, 10 KΩ ID, ¾ in. NPT
3-2735-61	159 001 783	Electrode, ORP, flat, 10 KΩ ID, ISO 7/1 R¾

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
3-2750-1	159 000 744	In-line Sensor Electronics w/Junction Box
3-2750-2	159 000 745	In-line Sensor Electronics w/Junction Box and EasyCal
3-2750-3	159 000 746	Submersible Sensor Electronics with 15 ft cable, ¾ in. NPT threads
3-2750-4	159 000 842	Submersible Sensor Electronics with 15 ft cable, ISO 7/1 R¾ threads
3-2750-7	159 001 671	pH Electronics, Digital (S^3L), 4.6 m (15 ft) cable
3-2760-1	159 000 939	Submersible Preamplifier with ¾ in. NPT threads and 4.6 m (15 ft) cable
3-2760-2	159 000 940	Submersible Preamplifier with ¾ in. ISO threads and 4.6 m (15 ft) cable
3-2760-3	159 000 941	Submersible Connector with 4.6 m (15 ft) cable and ¾ in. NPT threads
3-2760-4	159 000 942	Submersible Connector with 4.6 m (15 ft) cable and ISO 7/1 R¾ in. threads
3-2760-11	159 001 367	In-line Preamplifier with ¾ in. NPT threads and 4.6 m (15 ft) cable
3-2760-21	159 001 368	In-line Preamplifier with ¾ in. ISO threads and 4.6 m (15 ft) cable
3-2760-31	159 001 369	In-line Connector with 4.6 m (15 ft) cable and ¾ in. NPT threads
3-2760-41	159 001 370	In-line Connector with 4.6 m (15 ft) cable and ISO 7/1 R¾ threads
3-2759	159 000 762	pH/ORP System Tester (adapter cable sold separately)
3-2759.391	159 000 764	2759 DryLoc Adapter Cable (for use with 2750 and 2760)
3-0700.390	198 864 403	pH Buffer Kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 mL)
3822-7004	159 001 581	pH 4 buffer solution, pint (16 oz) (473 ml)
3822-7007	159 001 582	pH 7 buffer solution, pint (16 oz) (473 ml)
3822-7010	159 001 583	pH 10 buffer solution, pint (16 oz) (473 ml)
3822-7115	159 001 606	20 gram bottle Quinhydrone for ORP calibration
3-2700.395	159 001 605	Calibration kit: 3 Polypropylene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00
3-8050.390-1	159 001 702	Retaining Nut, Replacement, Valox®, K4530

+GF+

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For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090
For the most up-to-date information, please refer to our website at www.gfsignet.com

3-2724.090 Rev H 11/13 English
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Signet 2751 DryLoc® pH/ORP Smart Sensor Electronics

~~In-line~~
~~2751-1~~

In-line EasyCal
2751-2

~~Submersible~~
~~2751-3 or 2751-4~~

DryLoc® Electrodes sold separately

The Signet 2751 pH/ORP Smart Sensor Electronics featuring the DryLoc® connector, is the solution for field-free calibration, out of range glass impedance and broken glass detection, alerting the operator to probe failure or maintenance needs.

The 2751 features two different outputs: a two-wire 4 to 20 mA loop output with optional EasyCal function or a digital (S^3L) output which allows for longer cable lengths and is compatible with all Signet 8900, 9900 and 9950* instruments or in blind, 4 to 20 mA.

The Smart Sensor Electronics will allow for calibration of electrodes in a laboratory setting and installation of pre-calibrated probes in the field, reducing system downtime. Memory chip enabled electrodes will store operational data such as minimum and maximum pH/mV readings, runtime, minimum and maximum temperature (pH only), for troubleshooting and operational evaluation. To take full advantage of all features and benefits of the 2751, use with Signet 9900 (Generation IV or later), 9950 Transmitter or 0486 Profibus Concentrator.

The 2751 self-configures for pH or ORP operation via automatic recognition of the electrode type. The optional EasyCal feature allows simple push-button calibration and includes an LED indicator for visual feedback.

The 2751 submersible Smart Sensor Electronic can also be used in-line when used with the 3/4" or 1" threaded sensors including the 272X, 273X, 275X, 276X and 277X series of electrodes. The 2751 in-line sensor electronics can be used with Signet fittings up to DN100 (4 in.) and Wet-Tap assemblies.

Features

- **Probe health monitoring, glass impedance and broken glass detection**
- **Memory chip interface that allows for transferable calibration, runtime data, and manufacturing information**
- **In-line integral mount and submersible installation versions**
- **Automatic temperature compensation**
- **Auto configuration for pH or ORP operation**
- **Optional EasyCal calibration aid with automatic pH buffer recognition for 4, 7 and 10 pH and ORP solutions: quinhydrone saturated pH 4 or 7 buffers and Light's Solution +469 mV**
- **Junction boxes for convenient wiring**
- **Patented DryLoc® connector provides a quick and secure connection to the sensor****

Applications

- **Water and Wastewater Treatment**
- **Neutralization Systems**
- **Scrubber Control**
- **Effluent Monitoring**
- **Surface Finishing**
- **Flocculent Coagulation**
- **Heavy Metal Removal and Recovery**
- **Toxics Destruction**
- **Sanitization Systems**
- **Pool & Spa Control**
- **Aquatic Animal Life Support Systems**

*Users of 9950 Gen I and 9950 (Gen 2a) should update to 9950 (Gen 2b, available in Q4) to take full advantage of the 2751 features and benefits. Visit www.gfsignet.com for the latest software update.

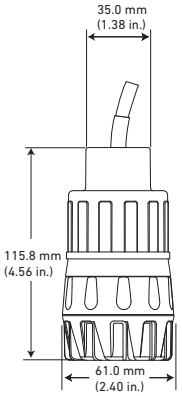
**U.S. Patent No.: 6,666,701

Specifications

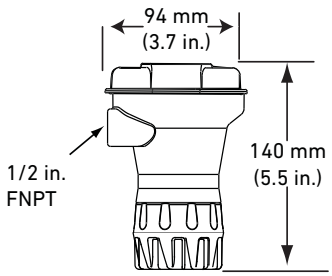
General				
Compatible Electrodes				
	Signet DryLoc® pH and ORP Electrodes, Models 2724-2726, 2734-2736, 2756-2757 Wet-Tap, 2764-2767, 2774-2777			
Operating Range	pH		-1 to 15 pH	
	ORP		±2000 mV	
Response Time	pH		< 6 sec. for 95% of change	
	ORP		Application dependent	
Materials	In-line		PBT (thermal plastic polyester) and polypropylene (retaining nut)	
	Submersible		CPVC	
Electrical				
Cable	4.6 m	15 ft	3-conductor shielded (3-2751-1 in-line and the 3-2751-3 or -4 submersible sensor electronics only)	
	22 AWG		For 9900, 9950 and 4 to 20 mA max. cable length is 300 m (1000 ft.). For 8900, please refer to the Cable Calculation Table of the Signet catalog for max. cable length.	
Power	12 to 24 VDC		±10%, regulated for 4 to 20 mA output	
	5 to 6.5 VDC		±5% regulated recommended, 3 mA max., for digital (S^3L) output	
Current Output	pH		Fixed 4 to 20 mA, isolated, = 0 to 14 pH (custom scaling available with 0252 tool)	
	ORP		Fixed 4 to 20 mA, isolated, = -1000 to +2000 mV (custom scaling available from ± 2000 mV with 0252 tool)	
Max Loop Resistance	100 Ω max. @ 12 V		325 Ω max. @ 18 V	600 Ω max. @ 24 V
Accuracy	±32 µA			
Resolution	±5 µA			
Update Rate	0.5 seconds			
Error Indication	3.6 mA, 22 mA, or none			
Digital (S^3L) Output	Serial ASCII, TTL level 9600 bps			
Accuracy	pH		± 0.02 pH @ 25 °C	± 0.02 pH @ 77 °F
	ORP		± 1.5 mV @ 25 ° C	± 1.5 mV @ 77 °F
	Temperature		≤ 0.4 °C	0.72 °F
Resolution	pH		≤ 0.01 pH	
	ORP		1.5 mV	
Update Rate	0.5 seconds			
Available Data	Raw mV, pH or ORP, Temperature (pH), Glass Impedance (pH), Minimum mV (pH), Maximum mV (pH), Minimum Temperature (pH), Maximum Temperature (pH), Model Number, Serial Number, Manufacturing Date, Runtime, Slope pH/mV, Measurement Offset, and Temperature			
Error Indication	Open input diagnostic, broken glass detection (pH), High Impedance			
Input Impedance, Z	$>10^{11}\Omega$			
Environmental				
Enclosure	3-2751-1 & -2		NEMA 4X/IP65 with electrode connected	
	3-2751-3 & -4		NEMA 6P/IP68 with electrode and watertight conduit and/or extension pipe connected	
Max. Temperature/Pressure Rating				
Operating Temperature				
Submersible	0 °C to 85 °C		32 °F to 185 °F	
In-line	0 °C to 85 °C		32 °F to 185 °F	
Storage Temperature	-20 °C to 85 °C		-4 °F to 185 °F	
Relative Humidity	0 to 95%, non-condensing (without electrode connected)			
Shipping Weight				
	2751-2		0.75 kg	1.65 lb
	2751-1, -3 & -4		0.64 kg	1.41 lb
Standards and Approvals				
	CE, FCC			
	RoHS compliant, China RoHS			
	Manufactured under ISO 9001 for Quality and ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety			

Dimensions

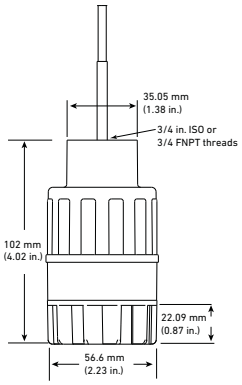
~~3-2751-1~~



3-2751-2

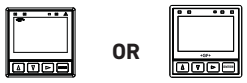
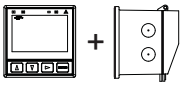
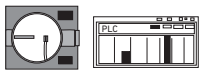
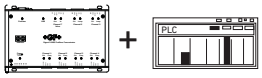
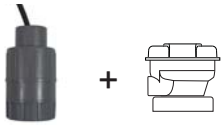
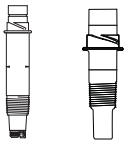


~~3-2751-3, -4~~

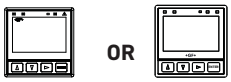
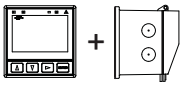
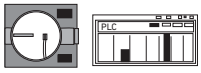
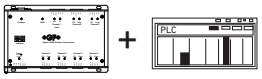
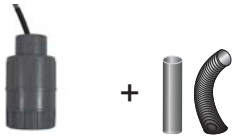
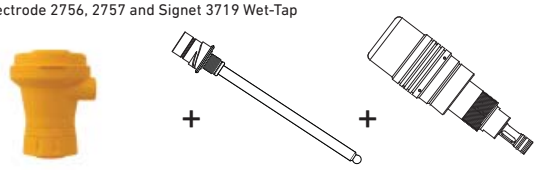
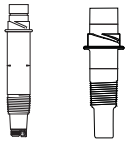
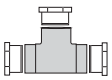


System Overview

In-Line Installation

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Input	Automation System
Signet Instruments 9900 9950 	Signet Instrument 9900 and Rear Enclosure 	3-2751 Smart Sensor Electronics and Customer Supplied Chart Recorder, Programmable Logic Controller, or Programmable Automation Controller 	3-0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or Programmable Automation Controller 
Signet 2751 Smart Sensor Electronics 	**Signet 2751 Smart Sensor Electronics** with Signet 3-8050-2 Universal Junction Box (EasyCal) 		**Signet 2751 Smart Sensor Electronics**
Signet Electrodes 2724-2726 ~~2734-2736~~ ~~2764-2767~~ ~~2774-2777~~ 			
2724-2726 and 2734-2736 DryLoc Electrodes: Use GF fittings* or customer supplied 3/4 in. NPT fittings 2764-2767 and 2774-2777 DryLoc Electrodes: Use customer supplied 3/4 in. or 1 in. NPT fittings			All sold separately

Submersible Installation

Panel Mount	Pipe, Tank, Wall	4 to 20 mA Input	Automation System
Signet Instruments 9900 9950 	Signet Instrument 9900 and Rear Enclosure 	2751 Smart Sensor Electronics and Customer Supplied Chart Recorder, Programmable Logic Controller , or Programmable Automation Controller 	0486 Profibus Concentrator and Customer Supplied Programmable Logic Controller or Programmable Automation Controller 
Signet 2751 Smart Sensor Electronics with customer supplied pipe extension or conduit, 3/4 in. NPT or ISO 7/1-R 3/4 threads** 	**Signet 2751 Smart Sensor Electronics** with Signet Wet-Tap Electrode 2756, 2757 and Signet 3719 Wet-Tap 		
Signet Electrodes 2724-2726 2734-2736 2764-2767 2774-2777 	GF Tees and Fittings see model 3719 for more info 		All sold separately

* See fittings section for more information.
**Refer to the Signet Submersion Kit brochure (3-0000.707) located on our website for installation suggestions and options.

2751 Product Selection Guide

1. Choose the Electrode

2724-2726, 2734-2736

Can use Any 3-272X or 273X series Electrode

2764-2767 Differential

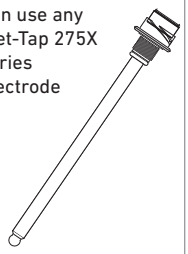
3-2764-1
3-2764-2
3-2766-1
3-2766-2

2774-2777
ORP electrodes must have 10K ID resistor use:
3-2775, 3-2777

pH Electrodes can be either the 1K or 3K use:
3-2774, 3-2774-1, 3-2776, 3-2776-1

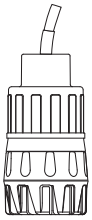
2756 and 2757 Wet-Tap

Can use any Wet-Tap 275X series electrode

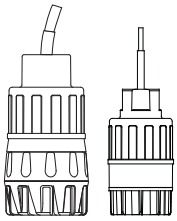


2. Determine the mounting style:

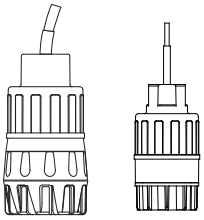
In-line



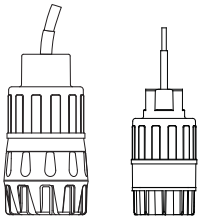
2751-1 or -2



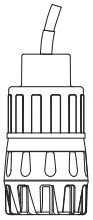
2751-1 or -2 | 2751-3 or -4



2751-1 or -2 | 2751-3 or -4



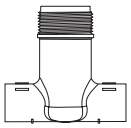
2751-1 or -2 | 2751-3 or -4



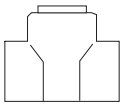
2751-1 or -2

And

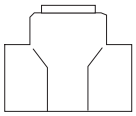
-In-line fitting



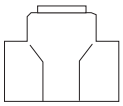
Signet fitting



¾" reducing tee



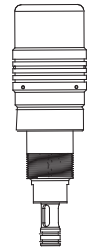
1" threaded tee



¾" reducing tee

Or

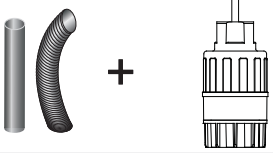
Submersible



3719 Wet-Tap Assembly

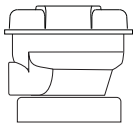
(Submersible not applicable with Wet-Tap assembly)

2751-3 or -4
and cable conduit (customer supplied) connected to ¾" sensor electronics



3. Junction Boxes

3-8050-1: Use when extending the submersible cable over long distance.
3-8050-2: Use with the submersible 2751-3 or -4 and the in-line 2751-1 for best calibration results with the EasyCal function when using the blind 4 to 20 mA output.

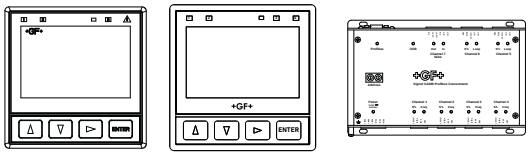


4. Choose the output instrument

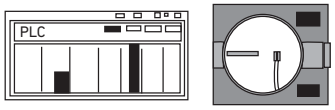
Digital (S^3L)

Or

4 to 20 mA



OR



9900 or 9950 Instruments, Profibus Concentrator

PLCs or Chart Recorders

Model 2751 Ordering Information

1) Model 2751 requires 12 to 24 VDC to function as a blind 4 to 20 mA output transmitter.

2) Order a 3-2751-2 or any other 2751 with a junction box 3-8050-2 if the EasyCal feature is desired.

3) Conduit and mounting brackets for submersion installation must always be used (customer supplied).

4) The 3-2759 System Tester must be ordered with the adapter cable 3-2759.391 for exclusive use with the 2751.

5) All sensor electronics, preamplifiers and connectors require a DryLoc electrode for full system installation.

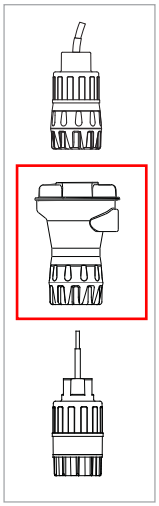
6) The 2751 Smart Sensor Electronics is compatible with all Signet 8900, 9900 and 9950 instruments. To take full advantage of the advanced features use the 9900 SmartPro Transmitters (Generation IV or greater), 9950 and 0486 Profibus Concentrator.

Application Tips

- The EasyCal feature automatically recognizes standard 4.0, 7.0, and 10.0 pH buffer or ORP quinhydrone solutions of +87 and +264 mV or Light's Solution, +469 mV, and simplifies calibration. For EasyCal ORP only single point calibration is used.

- Frequency of calibration of electrodes is dependent upon the application.

Ordering Information



Mfr. Part No.	Code	Description
In-line Smart Sensor Electronics (Yellow body)		
~~3-2751-1~~	~~**159 001 804**~~	~~with 4.6 m (15 ft) cable, recommended for 9900 or 9950 instruments~~
3-2751-2	**159 001 805**	with junction box and EasyCal, recommended for 4 to 20 mA use
Submersible Smart Sensor Electronics (Gray body)		
~~3-2751-3~~	~~**159 001 806**~~	~~with 4.6 m (15 ft) cable and ¾ in. NPT threads - when 4 to 20 mA is required use the 3-8050-2 junction box with EasyCal~~
~~3-2751-4~~	~~**159 001 807**~~	~~with 4.6 m (15 ft) cable and ISO 7/1-R 3/4 threads - when 4 to 20 mA is required use the 3-8050-2 junction box with EasyCal~~

Sensor Electronics with preamplified signal and Digital (S^3L) output (for use with the SmartPro Instruments) or 4 to 20 mA output - power supplied to unit dictates output type.

Note:
The 2751 Smart Sensor Electronics is compatible with 8900, 9900 and 9950 SmartPro Transmitters, and Signet 0486 Profibus Concentrator. To take full advantage of the 2751 features, use 9900 (Generation IV or later), 9950 or 0486 Profibus Concentrator.

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
Calibration		
3-2700.395	**159 001 605**	Calibration kit: includes 3 polyproplyene cups, box used as cup stand, 1 pint pH 4.01, 1 pint pH 7.00
3822-7115	**159 001 606**	20 gm bottle quinhydrone for ORP calibration (must use pH 4.01 and/or pH 7.00 buffer solutions)
3-2759	**159 000 762**	pH/ORP system tester (adapter cable sold separately)
3-2759.391	**159 000 764**	2759 adapter cable for use with 2751 DryLoc sensor electronics
3-0700.390	**198 864 403**	pH buffer kit (1 each 4, 7, 10 pH buffer in powder form, makes 50 ml of each)
3822-7004	**159 001 581**	pH 4 buffer solution, 1 pint (473 ml) bottle
3822-7007	**159 001 582**	pH 7 buffer solution, 1 pint (473 ml) bottle
3822-7010	**159 001 583**	pH 10 buffer solution, 1 pint (473 ml) bottle
Mounting		
3-8050.390-3	**159 310 116**	Retaining nut replacement kit, Black Polypropylene
3-8050-1	**159 000 753**	Universal mount junction box
3-8050-2	**159 000 754**	Universal mount junction box w/EasyCal (for submersible applications, use with 3-2751-3 and -4 where 4 to 20 mA is required)
3-9000.392-1	**159 000 839**	Liquid tight connector kit, NPT (1 connector)
3-9000.392-2	**159 000 841**	Liquid tight connector kit, PG 13.5 (1 connector)
Other		
5523-0322	**159 000 761**	Sensor cable (per ft), 3-cond. plus shield, 22 AWG, black/red/white (for use with 2751)
P31515-0P200	**159 000 630**	Universal Pipe Adapter PVC
P31515-0C200	**159 000 631**	Universal Pipe Adapter CPVC
P31515-0V200	**159 000 459**	Universal Pipe Adapter PVDF
7310-1024	**159 873 004**	24 VDC power supply, 10W, 0.42 A
7310-2024	**159 873 005**	24 VDC power supply, 24W, 1.0 A
7310-4024	**159 873 006**	24 VDC power supply, 40W, 1.7 A
7310-6024	**159 873 007**	24 VDC power supply, 60W, 2.5 A
7310-7024	**159 873 008**	24 VDC power supply, 96W, 4.0 A

3-2751.099 Rev A (07/17)
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CALL TOLL FREE 877-742-2878 FOR SALES AND SUPPORT
RETURN TO BurtProcess.com

+GF+

English

Signet 274X Series Differential DryLoc® pH and ORP Electrodes
Signet 275X Series Wet-Tap DryLoc® pH and ORP Electrodes
Signet 277X Series Threaded DryLoc® pH and ORP Electrodes

3-2744.090 Rev 1 02/20

Operating Instructions

274X

275X

277X

- English
- Deutsch
- Français
- Español
- 中文

California Prop. 65
WARNING:
Cancer and Reproductive Harm
www.p65warnings.ca.gov

Description

The Signet General Purpose 275X Wet-Tap and High Performance 274X and 277X series of pH and ORP electrodes are designed to minimize maintenance time and maximize performance longevity and value. All three family of pH and ORP electrodes are memory chip enabled to store Manufacturing, Calibration and Operational Data. For more flexibility and unique features, pair any pH or ORP electrode with a 2751 Smart Sensor Electronics and the 9900 Transmitter, 9950 Dual Channel Transmitter or the 0486 Profibus Concentrator.

The 275X Wet-Tap electrodes are all-purpose sensors ideal for applications where the probe can be removed for cleaning and maintenance without the system shutdown. They feature a unique foul-proof DryLoc® connector with gold-plated contacts, designed specifically for use with the Signet 2751 Smart Sensor Electronics, and 2760 Preamplifier. These dependable and highly responsive electrodes feature a large reference chamber and intelligent positioning of internal elements that combine to extend the service life. The electrodes are offered with a bulb sensing element that can be used for general purpose applications where a fast response is required even at low temperatures. The choice of a Pt1000 or 3 KΩ temperature sensor allows compatibility into all Signet pH/ORP instruments. The 3719 Wet-Tap assembly allows installation and removal of electrode even under process pressure without the need for process shutdown.

The Signet 274X Series Differential pH and ORP electrodes feature a Ryton® body and PTFE reference junction to resist fouling, clogging and chemical attack under harsh chemical applications. The glass in the pH differential electrodes is special formulation for high performance in media with high pH, elevated temperatures or high concentration of suspended solids. The Differential electrodes use a 3-electrode technique, measuring the pH and reference electrodes against a ground electrode for a more stable output signal. The solution ground eliminates noisy measurements by draining electrical current away from the reference electrode. The reference electrode is housed in a glass half-cell embedded in the reference chamber to protect it from poisioning or contamination. The electrolyte chamber is refillable and the salt bridge is field replaceable.

The Signet 277X Series pH and ORP electrodes are highly responsive electrodes featuring a PTFE double reference junction, potassium nitrate, KNO_3, in the front chamber (to block various poisoning ions such as copper (Cu^{2+}), lead (Pb^{2+}), mercury (Hg^{2+})) and a large reference chamber. The two chambers combine to extend the service-life of the electrode.

Both the 274X Series and the 277X Series feature a unique foul-proof DryLoc® connector with gold-plated contacts designed specifically for use with the Signet 2751 Smart Sensor Electronics and 2760 Preamplifier. They are available with either flat or bulb style sensing elements. The bulb protected style electrodes can be used for low temperature or low conductivity applications or where a fast response time is required. The flat versions allow sediment and particles to sweep past the measurement surface, minimizing risks of abrasion, breakage and coating. The temperature device in the pH electrodes is positioned at the tip of the measurement surface, resulting in a temperature response of less than 1 minute. Temperature devices available include 3 KΩ, or Pt1000 RTD.

Warranty Information

Refer to your local Georg Fischer Sales office for the most current warranty statement.

All warranty and non-warranty repairs being returned must include a fully completed Service Form and goods must be returned to your local GF Sales office or distributor. Product returned without a Service Form may not be warranty replaced or repaired.

Signet products with limited shelf-life (e.g. pH, ORP, chlorine electrodes, calibration solutions; e.g. pH buffers, turbidity standards or other solutions) are warranted out of box but not warranted against any damage, due to process or application failures (e.g. high temperature, chemical poisoning, dry-out) or mishandling (e.g. broken glass, damaged membrane, freezing and/or extreme temperatures).

Product Registration

Thank you for purchasing the Signet line of Georg Fischer measurement products.
If you would like to register your product(s), you can now register online in one of the following ways:

- Visit our website **www.gfsignet.com.**
  Under **Service and Support** click on
  Product Registration Form
- If this is a pdf manual (digital copy), **click here**

Safety Information

1. Use appropriate eye, face, hand, body and/or respiratory protection when using chemicals or solvents.
2. Prior to installation or removal:
   • Depressurize and vent system
   • Drain below sensor level.
3. Confirm chemical compatibility before use.
4. Do not exceed the max. temperature/pressure specifications.
5. Do not alter product construction.

If installing into a threaded connection:

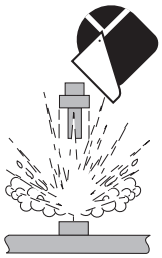
6. Inspect threads to ensure integrity. Do not install a sensor that has damaged threads.
7. Apply PTFE tape to the 3/4" M-NPT or ISO 7/1-R 3/4 process connection threads in accordance with industry practices.
8. **HAND TIGHTEN** the sensor into the process connection. **DO NOT USE TOOLS**.

	Caution / Warning / Danger Indicates a potential hazard. Failure to follow all warnings may lead to equipment damage, injury, or death
	Personal Protective Equipment (PPE) Always utilize the most appropriate PPE during installation and service of Signet products.
	Pressurized System Warning Sensor may be under pressure, take caution to vent system prior to installation or removal. Failure to do so may result in equipment damage and/or serious injury.
	Hand Tighten Only Overtightening may permanently damage product threads and lead to failure of the retaining nut.
	Do Not Use Tools Use of tool(s) may damage product beyond repair and potentially void product warranty.
	Note / Technical Notes Highlights additional information or detailed procedure.
	Do Not Freeze Products are temperature sensitive and may contain freezable liquids. Freezing damage to pH, ORP, and Chlorine electrodes voids product warranty.

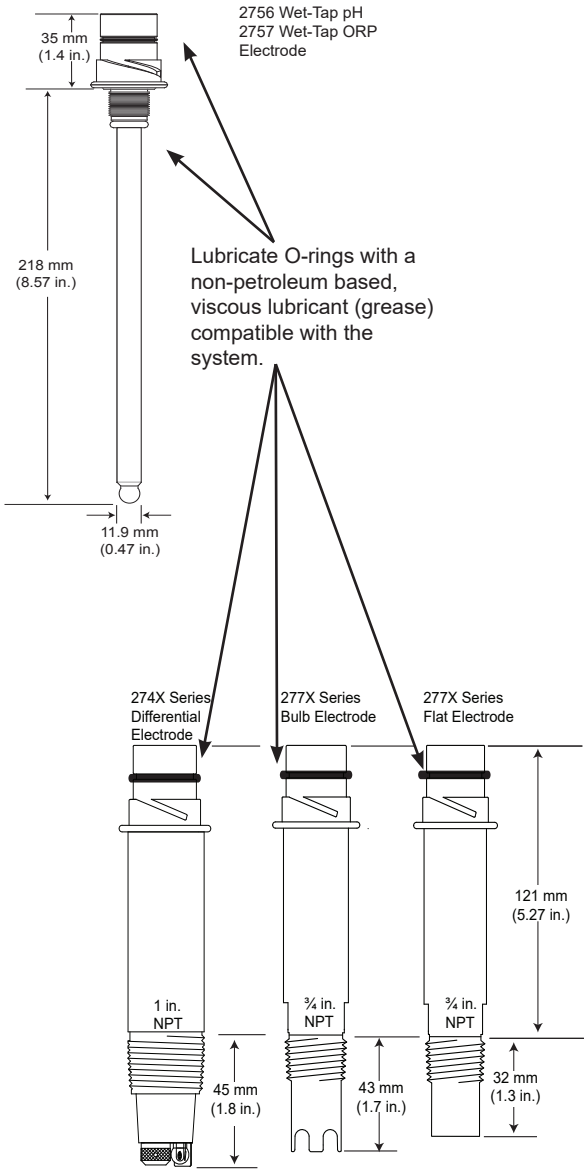
Chemical Compatibility

The retaining nuts of pH and ORP sensors are not designed for prolonged contact with aggressive substances.
Strong acids, caustic substances and solvents or their vapor may lead to failure of the retaining nut, ejection of the sensor and loss of the process fluid with possibly serious consequences, such as damage to equipment and serious personal injury. Retaining nuts that may have been in contact with such substances, e.g. due to leakage or spilling, must be replaced.

- The use of this product assumes operators are trained and familiar with this type of device.
- Operators should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators MUST follow all necessary safety procedures.



Dimensions



Specifications

274X Series Differential Electrodes
277X Series Threaded Electrodes
General

Compatibility ..... Signet 2751 and 2760
Shipping Weight ..... 0.25 kg (0.55 lbs.)
Operating Range
274X Series ..... 0 to 14 pH, ± 1500 mV ORP
277X Series ..... 0 to 14 pH, ± 2000 mV ORP

Reference Electrolyte

274X Series ..... Buffered KNO_3 solution
277X Series ..... KCl/AgCl gel with KNO_3 salt bridge

Reference Element

274X Series ..... pH glass electrode
277X Series ..... Ag/AgCl

Temperature Sensor

274X Series pH ..... 3 KΩ or Pt1000 RTD
277X Series pH ..... 3 KΩ or Pt1000 RTD
274X Series ORP ..... 10 KΩ ID for Signet instruments;
277X Series ORP ..... 10 KΩ ID for Signet instruments

Wetted Materials

Body ..... Ryton®
Reference junctions ..... PTFE
Sensing surface ..... Glass (pH), Platinum (ORP)
O-rings ..... FKM and EPDM
Solution ground ..... Carbon graphite (274X series only)

Operating Temperature

274X Series ..... 10 °C to 100 °C (50 °F to 212 °F)
277X Series ..... 0 °C to 85 °C (32 °F to 185 °F)
Storage Temperature ..... > 0 °C (32 °F)
Max Operating Pressure ..... 6.89 bar (100 psi)

275X Series Wet-Tap Electrodes
General

Compatibility ..... Signet 2751 and 2760
Shipping Weight ..... 0.25 kg (0.55 lbs.)
Operating Range ..... 0 to 14 pH, ± 1500 mV ORP
Reference Electrolyte ..... Polymerized Acrylamide Gel
Wet-Tap electrolyte ..... 3.5 M KCl
Reference Element ..... Ag/AgCl
pH Temp Sensor ..... Pt1000 RTD or 3 KΩ Balco
ORP Identification ..... 10 KΩ ID for Signet instruments

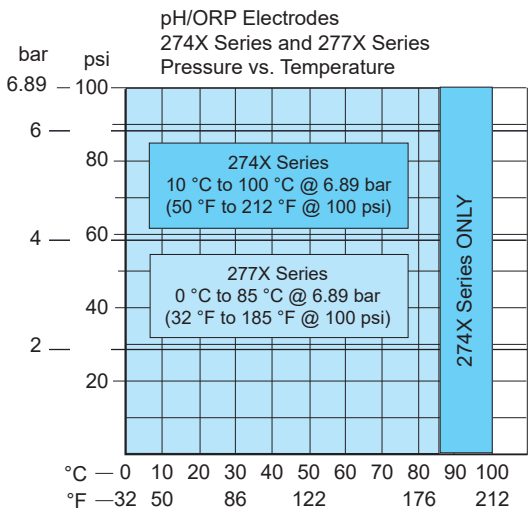
Wetted Materials

Wet-Tap body ..... PAS (Poly Aryl Sulphone)
Wet-Tap Junctions ..... Porous PTFE
Sensing surface ..... Glass (pH), Platinum (ORP)
O-rings ..... FKM

Temperatures

Operating Temperature ..... 0 °C to 85 °C (32 °F to 185 °F)
Storage Temperature ..... 0 °C to 85 °C (32 °F to 185 °F)
Maximum Temperature and Pressure rating
6.89 bar @ 0 °C to 65 °C (100 psi @ 32 °F to 149 °F)
4.00 bar @ 65 °C to 85 °C (58 psi @ 150 °F to 185 °F)

Ryton® is a registered trademark of Chevron Phillips Chemical



Standards and Approvals

- CE, WEEE, RoHS Compliant
- Manufactured under ISO 9001 for Quality, ISO 14001 for Environmental Management and OHSAS 18001 for Occupational Health and Safety.

China RoHS (Go to www.gfsignet.com for details)

Declaration of Conformity according to FCC Part 15
This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

REACH Information Obligation: in accordance with Article 33 of the European REACH Regulation (EC) No. 1907/2006, the substances Lead and Acrylamide are present in the glass matrix and as a polymerized gel respectively; in a concentration >0.1% (w/w). During normal use, the articles do not pose any risks and no additional information is required for safe use.

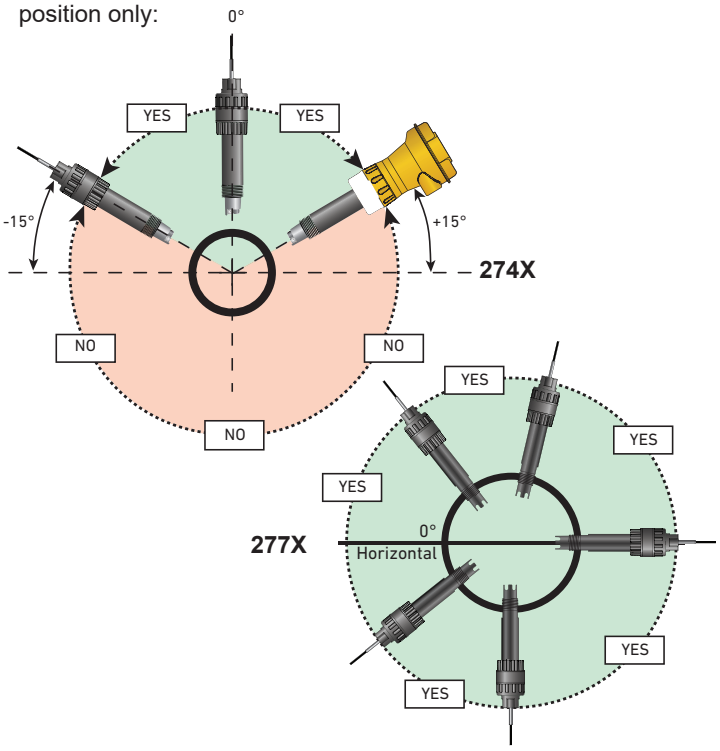
In-Line Installation

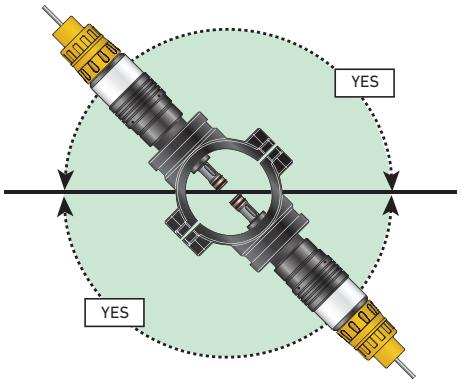
1. 2774 and 2775 electrodes can be mounted at any angle
2. Differential (274X series) electrodes must be mounted at a downward angle (> 15° from horizontal)
3. 275X Wet-Tap electrodes must be mounted in a 3719 Assembly at any angle
4. Avoid air pockets and sediments
5. Select a Signet installation fitting (0.5” to 4” size range) for convenience. Lightly lubricate o-ring with a non-petroleum based lubricate (grease) compatible with the system.
6. Use the ¾ in. M-NPT or ISO 7/1-R ¾ threads on the electrode body to install the electrode into reducing tee fittings.
7. Inspect threads to ensure integrity. Do not install an electrode with damaged threads.
8. Apply PTFE tape to the M-NPT or ISO 7/1-R ¾ process connection threads, in accordance with industry standards.
9. Use piping installation hardware with smooth, well-finished threads to facilitate the installation.
10. If necessary, the pipe should be plumbed with a depression (trap) so liquid is maintained around the electrode tip.
11. Hand-tighten the electrode into the process connection. Do not use any tools to install the electrode. The use of wrenches, pliers or similar may over-stress the sensor body and lead to breakage and subsequent spillage of the process liquid.

CAUTION:
A broken sensor may be ejected forcefully from the fitting and can cause severe injury.

12. The safety instructions have an adhesive label and should be placed near the sensor.

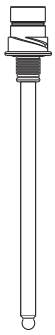
NOTE:
When mounting in a standard threaded fitting, the electrode must be mounted horizontal to 60 degrees below horizontal position only:





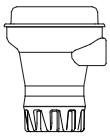
275X Wet-Tap with 2751 or 2760 and 3719 pH/ORP Wet-Tap Assembly

1) Choose sensor; 2) Choose preamplifier or sensor electronics; 3) Choose Wet-Tap assembly; 4) Choose customer supplied mounting option



1 Wet-Tap pH or ORP Sensor:
3-2756-WTP
3-2756-WTP-1
3-2757-WTP

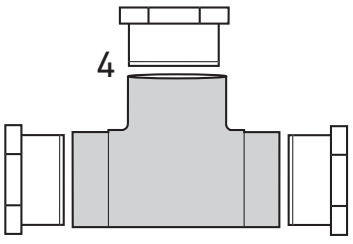
2 OR



2760 Preamplifier:
3-2760-11
3-2760-21

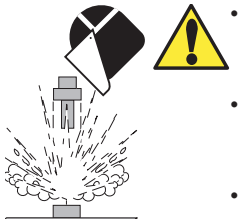
2751 Smart Sensor Electronics:
3-2751-1
3-2751-2

3 3719 Wet-Tap Assembly:
3-3719-11
3-3719-12
3-3719-21
3-3719-22



4 Customer supplied Tees and Fittings

Removing from In-Line Installation



- The use of this product assumes that operators are trained and are familiar with this type of device.
- They should be knowledgeable of the potential risks associated with pressurized piping systems.
- Operators MUST follow all necessary safety procedures.

In-line removal Instructions:

1. Wear safety goggles or face shield during removal. Use all appropriate eye, face, hand, body and/or respiratory protection when working with chemicals or solvents.
3. Depressurize and vent the piping system.
3. Drain the system to below sensor level.
4. Practice proper Lock Out/ Tag Out procedures when the sensor is removed for maintenance to prevent accidental opening and exposure to potentially hazardous chemicals.

Submersible Installations

The user must supply the following hardware to complete a submersible installation:

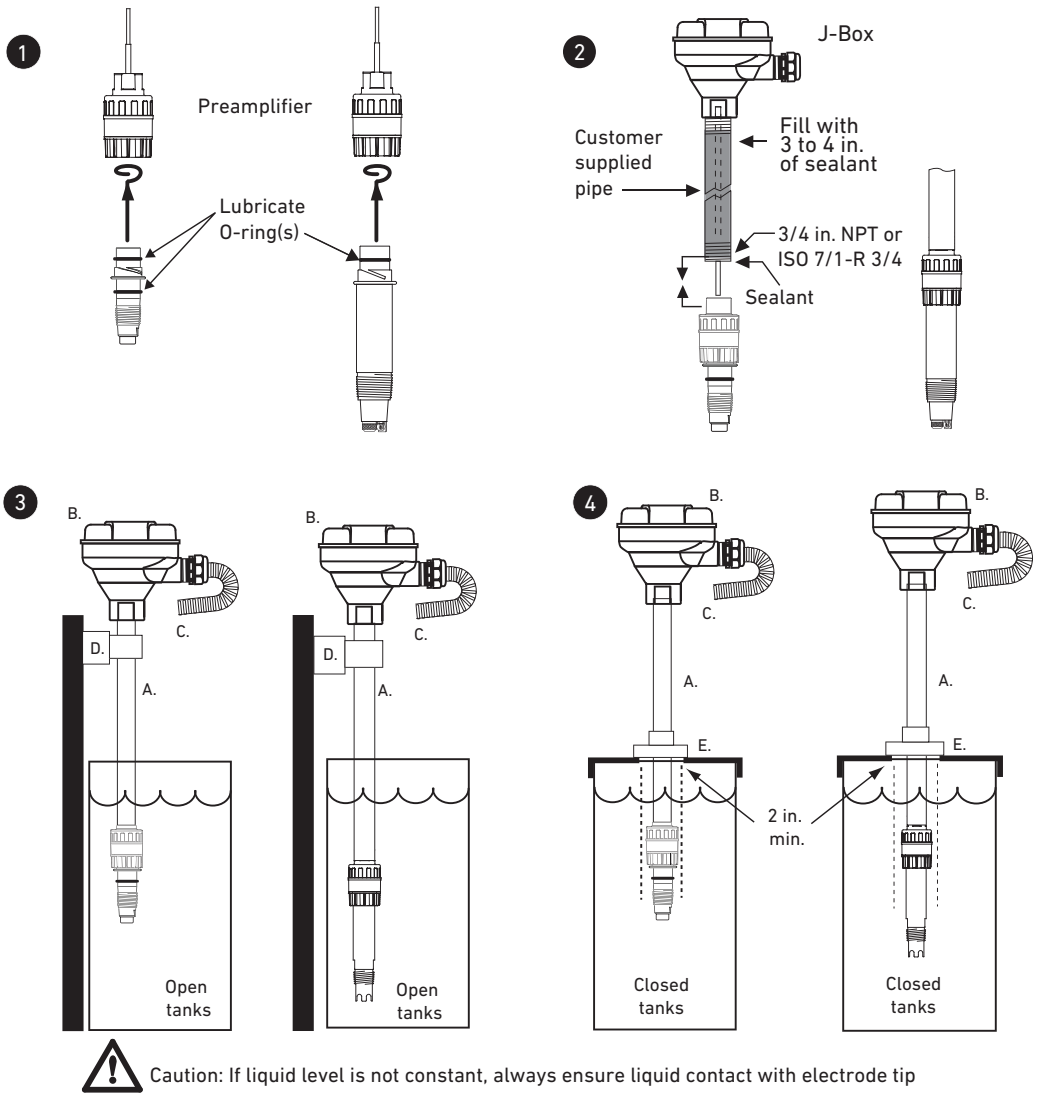
- ¾ in. Pipe, ¾ in. (DN 20) Male Adapter, Liquid Tight Connection at top of pipe assembly
- Wiring junction box
- Pipe clamps (quick-release type recommended)
- Tank flange for closed tanks
- Silicone Caulking Sealant & PTFE Tape

Technical Note:

- Mount the electrode near tank outlets, away from reagent addition areas.
- Use the ¾ in. (ISO 7/1-R ¾) threads at the top of the preamplifier to run the cable inside pipe or conduit.
- Place the electrode tip in 3.0M KCl solution or pH 4 Buffer for temporary storage during system maintenance to avoid dehydration. For long term storage place the electrode tip in 3.0M KCl solution.

The Signet pH/ORP electrodes are designed to install in tanks by attaching conduit to the ¾ in. (ISO 7/1-R ¾) threads at the top of the accompanying preamplifier or sensor electronics:

1. The O-ring at the top of the electrode fits very tightly into the preamplifier. Use a small amount of non-petroleum based lubricant to assist the assembly.
2. To prevent moisture from migrating into the preamplifier, backfill the conduit with 3 in. to 4 in. of sealant.
3. Mount electrodes in a location with ample clearance to remove them for periodic cleaning and recalibration.
4. Choose a location that keeps the electrode glass completely submersed at all times.



Caution: If liquid level is not constant, always ensure liquid contact with electrode tip

Electrode Date Code

- The electrode date code indicates the manufacturing date of the electrode.
- Electrodes should be put into service as soon as possible and should not remain in the box for more than two years.
- Over time, the storage solution (found in the "boot" covering the electrode tip) will evaporate or leak, allowing the delicate sensing tip and reference junction to dry.
- To rehydrate a dry electrode, soak the tip in 3.0 mol/L KCl solution for 24 to 48 hours. Preheating the KCl solution to <140 °F may speed up the re-hydration process.
- Electrodes more than 2 years old may still be functional, but will take longer to rehydrate.
- Restoration may not be effective for severely dehydrated electrodes.

Letter = Month
N = January
M = February
L = March
K = April
J = May
H = June
G = July
F = August
E = September
D = October
C = November
B = December

Numeral = Year
3 = 2018
4 = 2019
5 = 2020
6 = 2021
7 = 2022
8 = 2023
9 = 2024
0 = 2025
1 = 2026
2 = 2027
3 = 2028
4 = 2029

Example: K2 = manufactured in April 2027

Electrode Care

Depending on the type of application and the accuracy needed, pH and ORP electrodes will require routine maintenance. Contaminated/dirty electrodes should be swapped with properly cleaned conditioned and calibrated electrodes.

The solution used to clean an electrode varies depending on the type of coating:
Caution: Always wear appropriate safety gear and exercise proper safety practices when working with or near chemicals

- **General Cleaning –** Soak the electrode for 5 minutes in a mixture of warm tap water (< 140° F), and mild detergent such as liquid dish detergent. A soft brush, like a toothbrush may also be used to clean off particulates.
- **Biofilm and bacterial growth –** soak the electrode in a diluted household laundry bleach solution (pH electrodes only), 1part bleach to 10 parts water for 10 minutes.
- **Alkaline or Scale –** Lime/calcium and mineral buildup deposits may be removed by soaking the electrode in a solution of 2% to 5% hydrochloric acid (HCl) or vinegar for no more than 5 minutes.
- **Acidic contaminants –** may be removed by soaking the electrode in a weak caustic (less than 2% to 5% NaOH) for a few minutes only. Use the least harsh chemical which will remove the contaminant within 2-5 minutes of soaking without attacking the materials of construction.
- **Oily or organic coatings –** Soak the probe for 5 to 10 minutes in a solution of warm tap water < 140° F, and dish detergent. Alternatively, use an appropriate solvent (isopropyl alcohol or similar) that will not attack the materials of construction. If required gently clean junction and/or glass with a very soft tooth brush, and follow up with brief soaking (2-5 minutes) in 2% to 5% NaOH (sodium hydroxide). In the case of pH (not ORP) a difficult organic fouling can be treated with household bleach (4-6%) as a substitute for the dish detergent.
- **ORP Platinum Coating –** Gently wipe the electrode surface with a soft lint-free paper towel. If the various forms of chemical cleaning are not sufficient to achieve an accurate measurement and response time, a last resort would be to polish the platinum surface with a 0.3-1.0 micron alumina polishing slurry to remove any stubborn coatings.
- After cleaning, rinse pH/ORP electrode in distilled or tap water, then re-examine the electrode for damage that may have been hidden from view. Sensor may not initially behave properly; and have a temporary offset due to the cleaning chemistry. Proper conditioning is always recommended

Electrode Conditioning

Soak sensor tip (pH or ORP) in 3 mol/L KCl (potassium chloride), for at least 45 minutes to regenerate / condition.
The more aggressive the cleaning, the longer the soak in potassium chloride.
Failure to soak the electrode will cause the electrode to drift for a time after the cleaning procedure, and could adversely affect the calibration process/results.

If the cleaning and conditioning yield results within operational tolerance, the pH/ORP sensor is once again suitable for use.
However, if the results do not bring the readings of the pH/ORP sensor within tolerance, it is time to replace the sensor.

pH System Calibration

There are two functions in a pH electrode that require the system to be calibrated:

Temperature Calibration

- The temperature output of the electrode (measured by a 3KΩ Balco or Pt1000 RTD) must be calibrated only once. When a new electrode is installed, it does not need to be repeated.
- Because the temperature measurement has a significant influence on the electrochemical measurement, the temperature output in new pH electrodes should always be calibrated before the pH/mV calibration.

  NOTE: All Signet transmitters and controllers incorporate automatic temperature compensation.

pH error due to temperature changes in fluid											
°C	**pH 2**	**pH 3**	**pH 4**	**pH 5**	**pH 6**	**pH 7**	**pH 8**	**pH 9**	**pH 10**	**pH 11**	**pH 12**
15	0.15	0.12	0.09	****0.06**	0.03	0	0.03	0.06	0.09	0.12	0.15
25	0	0	0	*** 0**	0	0	0	0	0	0	0
35	0.15	0.12	0.09	0.06	0.03	0	0.03	0.06	0.09	0.12	0.15
45	0.3	0.24	0.18	0.12	0.06	0	0.06	0.12	0.18	0.24	0.3
55	0.45	0.36	0.27	0.18	0.09	0	0.09	0.18	0.27	0.36	0.45

Table 1

As the pH value moves away from neutral (7 pH) or the temperature moves away from 25 ºC, the electrochemical output is affected.

* Example: At pH 5 the mV output of the electrode is not affected if the temperature is at 25 °C.

** The electrode output will be shifted by 0.06 pH units if the temperature is reduced to 15 °C.

Offset and Slope Calibration

The pH electrode calibration is an important function that must be done routinely to standardize the electrode due to its ever-changing characteristics. The electrode contains a gel that depleates over time, so the instrument must be readjusted periodically to maintain system accuracy. There are many influences, including aging, temperature, coatings and chemicals used that will affect the probe characteristics. After cleaning and conditioning, Signet pH electrodes may be calibrated in two pH buffer solutions of different pH values (a two point calibration).

The pH electrode is calibrated by placing it in a buffer solution of known pH and measuring the cell potential. This is a linear function of pH in the range of pH 2-11, therefore two calibration points are needed. Most common calibration buffers are pH 4.01 and pH 7.00 (@ 25 °C). If the pH measurements are made in an acid to neutral range, we recommend using buffer pH 4.01 and buffer pH 7.00 for calibration. If an alkaline sample is measured, we recommend using buffer 7.00 and buffer 10.01 for calibration.

The response of the glass electrode is characterized by two parameters, offset and slope. The theoretical output of a pH electrode at pH 7 is 0 mV. The offset, or zero pH is the deviation of the pH from the nominal value. In the Signet transmitters, the offset calibration is performed under STANDARD.

The glass electrode slope is the mV developed per each pH unit (mV/pH). At 25 °C, the theoretical slope is 59.16 mV/pH. So, at pH 4.01, +177 mV will be generated, while at pH 10.01 (with a lower H+ concentration), a potential of -177 mV will be generated, (see Table 2). A new electrode however, will generate 0 ± 15 mV in pH 7.00 and will have a slope efficiency between 93.2 and 103%. In the Signet transmitters, manual slope calibration is performed under SLOPE.

Theoretical mV Values @ 25 °C	
pH	mV
2	+295.8
3	+236.64
4	+177.48
5	+118.32
6	+59.16
7	0
8	–59.16
9	–118.32
10	–177.48
11	–236.64
12	–295.8

Table 2

pH System Calibration cont.

How to calculate a pH electrode slope efficiency

Two pH buffers are selected to check the pH probe performance, pH 4.01 and pH 7.00. The ratio of the measured potentials (E2-E1) to the difference of pH (7.00 – 4.01) gives the slope of the straight line.

1. Read the mV potential generated by the electrode in two calibration buffers
2. Determine the slope (the mV potential generated per pH unit)
3. Divide this number by the theoretical slope, 59.16 mV/pH @ 25 °C and multiply by 100.

Example 1
pH electrode generates -12 mV in pH 7.00 buffer
and +162 mV in pH 4.01 buffer.
160 mV - (-12 mV) = 172 mV
172 mV/ 3 = 57.33 mV/pH unit
57.33/59.16 x 100 = 96.9 % slope efficiency

Example 2
pH electrode generates -45 mV in pH 7.00 buffer
and +115 mV in pH 4.01 buffer.
115 mV - (-45 mV) = 160 mV
160 mV/3 = 53.33 mV/pH unit
53.33/59.16 x 100 = 90.1%

In Example 2, slope efficiency of 90.1% is acceptable but the offset of -45 mV is not.
An offset shift can be the result of the reference electrode being contaminated or poisoned.
A slope shift can be the result of the glass being etched or coated with a hard build-up.

As the electrode ages, the slope decreases gradually, generally a slope between 85% and 105% is acceptable. If the offset value (pH 7.00) is > +/- 45 mV, electrode should be replaced. When a great accuracy is required from the electrode, the offset and the slope values need to be as close as possible to the theoretical values.

Refer to the Calibration Procedure section of the instrument manual for a 2 point pH calibration. If the sensor is used in a 4 to 20 mA 'blind application' refer to the Calibration section of the 2751 Smart Sensor Electronics for a 2-point EasyCal pH calibration.

ORP System Calibration

ORP electrodes do not incorporate a temperature sensor, so the only system calibration required is the electrochemical adjustment.

ORP electrodes should need less frequent calibration than a typical pH sensor, the redox potential is a characteristic of the interaction between the platinum measuring electrode and the redox species in solution.

ORP measurement is only an indicator of the process solution reducing or oxidizing potential. Always perform a single point calibration (standardization). Using the 9900 or 9950 transmitter, this can be performed under STANDARD. Disregard the SLOPE calibration.
If calibrating the ORP electrode under EasyCal (9900 Transmitters, Gen IV or later), one point calibration will be your only option.

A new ORP electrode measures the listed value +/- 20 mV. A two-point calibration will not increase the accuracy of the measurement given the +/- 20 mV repeatability of the sensor itself. On top of that, the ORP is not temperature compensated, so if the measurement is not done at 25 °C, any benefit gained will be lost. A true two-point calibration is possible in very few applications where only one redox couple is present in solution and its chemistry is known.

Calibration should be done using ORP premade standard solutions such as Zobell's solution and Light's solution, or solutions made using the standard pH 4.01 buffer and pH 7.00 buffer with quinhydrone powder mixed in until saturation is reached (Table 3). If all the quinhydrone does dissolve, continue to add small amounts and stir until a small amount of quinhydrone remains un-dissolved after mixing. Quinhydrone is the oxidizer that is measured by the ORP electrode. Please note that Zobell's solution is not compatible with the AutoCal function in Signet ORP instrumentation.

Pre-packaged or mixed Quinhydrone solutions are strong and may have a long lasting effect on the electrode, therefore after calibration it's recommended to properly condition the electrode before returning to the process. It is also possible to calibrate the ORP electronics based upon a known grab sample confirmed with a lab meter.

Pick a solution with a mV value closest to the process value and if possible adjust the temperature of the solution to the process temperature to minimize the offset.

The ORP electrode is functional until the offset exceeds 50 mV.
When the offset measures greater than 50 mV, the electrode should replaced.

Table 3:
ORP test solutions

*Saturate 50 mL of pH 4 or pH 7 buffer with 1/8 g quinhydrone

	Zobell's solution	Light's solution	4 pH buffer w/quinhydrone*	7 pH buffer w/quinhydrone*
ORP at 20 °C			268 mV	92 mV
ORP at 25 °C	228 mV	469 mV	263 mV	86 mV
ORP at 30 °C			258 mV	79 mV

Buffer Solutions

Proper handling, storage and use of buffers is very important on the pH and ORP measurement accuracy. If the buffers are contaminated or used improperly, the calibration will be inaccurate and all subsequent measurements will be wrong.

- When calibrating pH electrodes, always use pH buffers in the range of your sample.
- To achieve an accurate calibration make sure the electrode and the buffer are at the same temperature.
- Buffers have limited shelf life. Do not use a buffer if the expiration date has passed.
- Never return used buffers to the buffer bottle. Discard it.
- Do not leave the buffer bottle open (exposed to air).
  The atmospheric carbon dioxide lowers the pH of the alkaline buffers (10.01 pH).
- To avoid contamination, rinse the electrode with distilled or tap water before placing it in the buffer. If necessary, the electrode might be blotted dry using a lint-free paper towel (e.g. Kimwipes) to remove excess water. Be extra careful not to touch or rub the surface of the glass. The wiping of the glass can produce a static charge that will interfere with the voltage reading of the electrode. In addition to this, the hydration gel layer is interrupted.
- Store buffers at room temperature.
- Signet offers the following pH buffer solutions, pH 4.01, pH 7.00 and pH 10.01.
- Make fresh buffer solutions just before using. ORP solutions made with quinhydrone are very unstable and may not read properly after being exposed to air for a prolonged time. These solutions must be discarded after a few hours.
- Dispose of all calibration solutions in accordance with local guidelines and regulations.

Electrode Storage

Proper electrode storage maximizes electrode performance and extends electrode life.

Prior to storage - add 3 mol/L KCl to the electrode storage cap (about half full), and carefully secure the cap onto the electrode tip.

- Store boxed electrodes wet, flat or upright (electrode tip down) to maximize hydration of the glass surface.
- Store electrodes in stable temperature environment, avoiding freezing conditions (below 0 °C (<33° F) and heat above 100° F).
- Never store the electrode in deionized (DI) water. Use 3 mol/L KCl solution to keep the glass wet when out of the process.

Short term storage (up to 24 hours) - soak the electrode tip in either pH 4.01 buffer or 3 mol/L KCl solution.

- Drying out of the pH sensitive glass and the junction must be avoided (or damage to the electrode will occur).
- Prior to electrode installation, make sure there's a light film of synthetic grease (such as silicone-free grease) applied to the upper electrode O-ring. If the electrode will be installed into a GF Signet Installation Fitting, then also apply a thin film of synthetic grease to the lower O-ring.

Long term storage (longer than 24 hrs) - add 3 mol/L KCl solution to the storage cap (about half full) and carefully secure the cap onto the electrode tip. This will ensure probes are always ready to use.

Response Time/Stability

Response time and stability are affected by the condition of the pH glass measuring surface (for an ORP electrode, the platinum surface),the reference junction and the reference solution. Electrodes may sometimes be restored to acceptable levels by cleaning the measuring surface and reference junction.

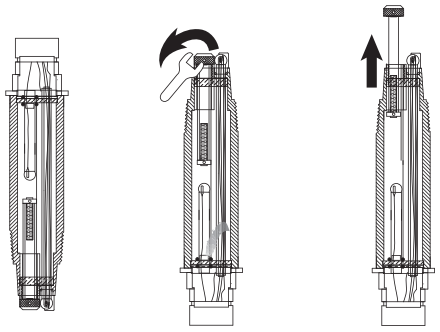
Electrode mV values should remain stable ± 3 mV. Conditions that may cause fluctuations are:

- Electrode coating
- Clogged reference junction
- Ground fault: If proper operation is observed in the beaker, but readings are unstable in the application, a ground fault may exist.
  - Using instrumentation with isolated inputs and outputs may restore stable operation.
  - Solution grounding may also restore stable operation.

Maintenance and Cleaning

274X Series Differential Electrodes

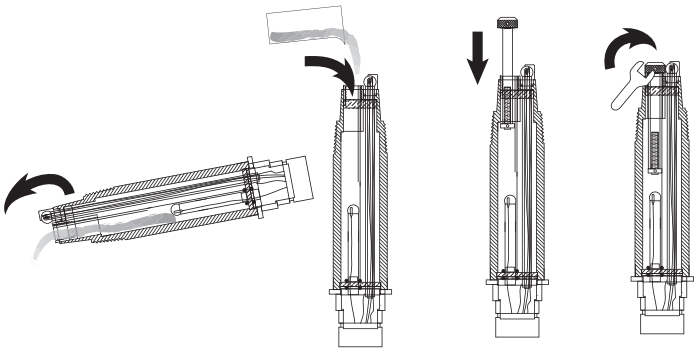
Differential electrodes have a replaceable salt bridge and the electrolyte chamber can be refilled. The electrolyte chamber should be full. If any fluid is audible when shaken, the chamber should be refilled. Refill the electrolyte chamber when the electrode offset exceeds 40-45 mV. Replace the salt bridge when performance becomes sluggish or if the output is erratic or inaccurate.



Replacing the Salt Bridge

Parts Required: Salt Bridge (order number 3800-4340) and Differential Reference Solution (order number 3864-0002)

Tools Required: Small pliers



Procedure:

1. Remove sensor from mounting.
2. Hold upside down and unscrew salt bridge using a pair of small pliers. Be careful not to damage the glass bulb!
3. Drain the depleted reference solution and dispose of properly.
4. Fill reference chamber with fresh reference solution (approx. 30 ml).
5. Replace salt bridge and screw finger tight. Solution will drip out while screwing in salt bridge.
   Use pliers to turn approximately ¼ turn past finger-tight.
6. Perform calibration (standard and slope) before returning the system to service.

NOTE:
The refillable electrolyte chamber in 274X series differential electrodes may leak during storage and shipping. Check the fluid and refill before installation if necessary.

WARNING!
Wear appropriate eye, face, hand, body, and respiratory protection when using chemicals or solvents.

Ordering Information

Mfr. Part No.	Code	Description
Signet 275X Series Wet-Tap DryLoc pH and ORP Electrodes		
pH Electrode		
3-2756-WTP	159 001 390	Bulb pH electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, Pt1000 RTD for connection to the 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics
3-2756-WTP-1	159 001 384	Bulb pH electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, 3 KΩ Balco RTD
ORP Electrode		
3-2757-WTP	159 001 391	ORP electrode, plastic body, DryLoc connector, use with the 3719 Wet-Tap Assembly only, to use with 2751 Smart Sensor Electronics or 2760 Preamplifier
Signet 274X Series Differential DryLoc pH and ORP Electrodes		
pH Electrode		
3-2744-1	159 001 944	Flat surface pH differential electrode, DryLoc connector, 3 KΩ Balco RTD
3-2744-2	159 001 910	Flat surface pH differential electrode, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics
3-2746-1	159 001 911	Bulb pH differential electrode with bulb protection, DryLoc connector, 3 KΩ Balco RTD
3-2746-2	159 001 912	Bulb pH differential electrode with bulb protection, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics
ORP Electrode		
3-2745-1	159 001 913	Flat surface ORP differential electrode, DryLoc connector, 10 KΩ ID resistor for connection to 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics
3-2747-1	159 001 914	Bulb ORP differential electrode with bulb protection, DryLoc connector, 10 KΩ ID resistor for connection to 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics
Signet 277X Series Threaded DryLoc pH and ORP Electrodes		
pH Electrode		
3-2774	159 000 955	Flat surface pH electrode, DryLoc connector, 3 KΩ Balco RTD
3-2774-1	159 000 956	Flat surface pH electrode, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics
3-2774-HT	159 001 796	Flat surface pH electrode, DryLoc connector, 3KΩ Balco RTD, High Temperature (110 °C, 230 °F), in-line install only.
3-2774-HT-C	159 001 795	Flat surface pH electrode, DryLoc connector, BNC connector, 3KΩ Balco RTD, NPT, High Temperature (110 °C, 230 °F), NPT, 15 ft cable, no memory chip, for submersible installations, can only be connected to the 2751 or 2760 sensor electronics if used with the 3-2722 BNC adapter.
3-2774-HT-ISO	159 001 794	Flat surface pH electrode, DryLoc connector, 3 KΩ Balco RTD, High Temperature (110 °C, 230 °F), 3/4" ISO, 3KΩ Balco RTD, in-line install only.
3-2776	159 000 959	Bulb pH electrode with bulb protection, DryLoc connector, 3 KΩ Balco RTD
3-2776-1	159 000 960	Bulb pH electrode with bulb protection, DryLoc connector, Pt1000 RTD for connection to 8900, 9900 and 9950 instruments when used with the 2751 Smart Sensor Electronics
Signet 277X Series Threaded DryLoc pH and ORP Electrodes		
ORP Electrode		
3-2775	159 000 957	Flat surface ORP electrode, DryLoc connector, 10 KΩ ID resistor for connection to the 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics
3-2777	159 000 961	Bulb ORP electrode with bulb protection, DryLoc connector, 10 KΩ ID resistor for connection to the 8900, 9900 or 9950 when used with the 2751 Smart Sensor Electronics

Ordering Information cont.

Special Order Options - Please consult the factory

Mfr. Part No.	Code	Description
Electrode		
3-2774-HF	Special Order	Flat glass pH electrode for hydrofluoric acid applications <2%, DryLoc connector, in-line sensor, NPT
3-2775-HT	Special Order	Flat surface ORP electrode, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ RTD, in-line install only
3-2775-AU	Special Order	Flat surface ORP electrode, gold measuring electrode, DryLoc connector, NPT, in-line sensor
3-2776-HT	Special Order	Bulb glass pH electrode with protection, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ RTD, in-line install only
3-2776-HF	Special Order	Bulb glass pH electrode with protection, hydrofluoric acid applications <2%, DryLoc connector, in-line sensor, NPT
3-2777-HT	Special Order	Bulb ORP electrode with protection, high temperature (110 °C, 230 °F), DryLoc connector, ¾" NPT, 3KΩ TRD, in-line install only
3-2777-AU	Special Order	Bulb ORP electrode with protection, gold measuring electrode, DryLoc connector, in-line sensor, NPT

Accessories and Replacement Parts

Mfr. Part No.	Code	Description
Calibration		
3-2759	159 000 762	pH/ORP System Tester
3-2759.391	159 000 764	Adapter Cable for use with 2751, 2760
3-0700.390	198 864 403	pH Buffer Kit (includes 4.0, 7.0, and 10.0 buffer powder)
3-2700.395	159 001 605	Calibration Kit: includes 3 PP cups, cups stand, 1 pint pH 4.01, 1 pint pH 7.00
3822-7115	157 001 606	20 g bottle Quinhydrone for ORP calibration (must use pH 4.01 and/or pH 7.00 buffer solutions)
3822-7004	159 001 581	pH 4 buffer solution, 1 pint (473 ml) bottle
3822-7007	159 001 582	pH 7 buffer solution, 1 pint (473 ml) bottle
3822-7010	159 001 583	pH 10 buffer solution, 1 pint (473 ml) bottle
3800-5000	159 838 107	3.0M KCl storage solution for pH and ORP, 1 pint (473 ml) bottle
3-2700.398	159 001 886	O-ring lubricant kit (5 packs of Super Lube, 1cc each)
1224-0205	159 000 836	O-ring, EPR (EPDM)
3800-4340	159 001 948	Replacement salt bridge in black (2744-2747)
3864-0001	159 001 007	Replacement salt bridge in gray (2764-2767)
3864-0002	159 001 008	Replacement reference electrolyte solution, 500 ml
2120-0015	159 001 009	CPVC adapter: 1½ in. to 1 in.
2122-0015	159 001 010	PVDF adapter: 1½ in. to 1 in.

+GF+

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3 Inch Totalizing Water Meter with Pulse Output

PRMFiltration

Cast Iron Flanged Water Meters for indicating flow totalization of water with pulse output. Woltmann Helix style water meter for industrial use. Designed for long service life and maintenance-free operation, even under harsh conditions.

Features:

- Pulse Output Components
- All Meters have Hydrocarbon Resistant Seals and will not be damaged by dissolved amounts of free product
- Sealed Dry Dial for Clear Readings

Specifications:

- Woltmann Helix Style Water Meter
- 150# Flange
- Pulse Rate: 100 gal/pulse
- Accuracy Class: B
  Transitional Flow: ± 5%
  Nominal Flow: ± 2%
- 6 Digit Mechanical Roller Counter
- Maximum Water Temperature: 86°F
- Maximum Water Pressure: 150 psi
- Mounting Orientation: Horizontal

Materials:

- Body: Cast Iron Body, Epoxy Coated
- Measuring Components: Polyethylene
- Seals: Viton

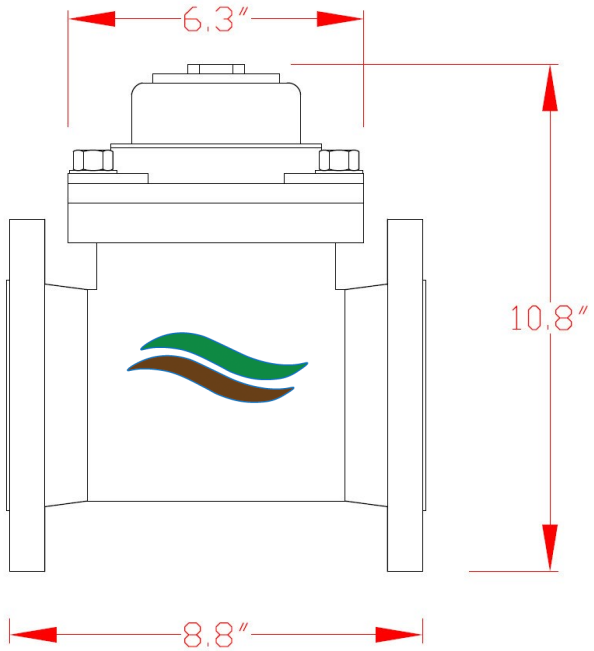
PRM meters are ideal for Environmental and Industrial companies to measure process water for environmental treatment, manufacturing, or irrigation. These meters are for any application that does not require potable water measurement and are excluded from federal Lead Free Standards for drinking water.

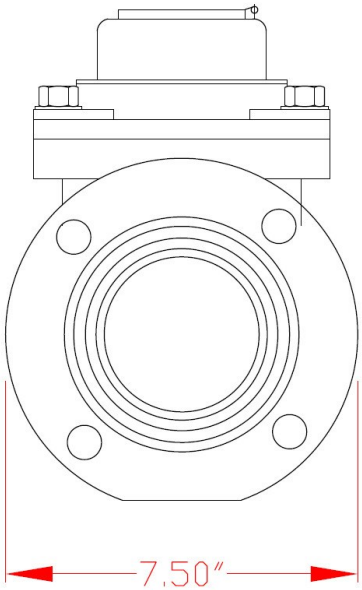
PRM Part Number:

WM300PVX: 3” Flanged Multi-Jet Water Meter

3 Inch Totalizing Water Meter with Pulse Output

Information in this drawing is provided for reference only.





WM300PVX:

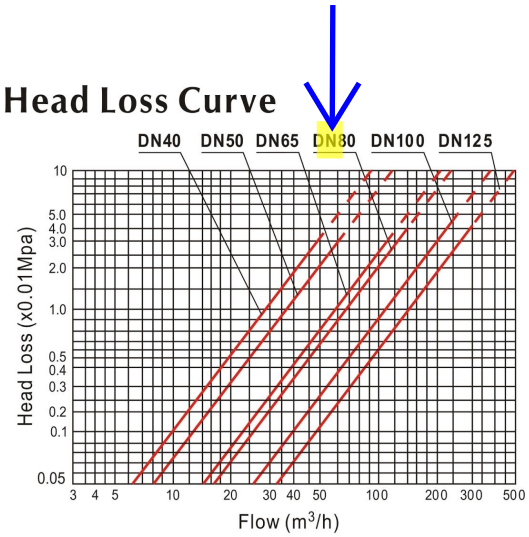
Materials:
Body: Cast Iron
Measuring Chamber: Polyethylene
Paint: Epoxy Coated
Seal: Viton
Mounting Orientation: Horizontal

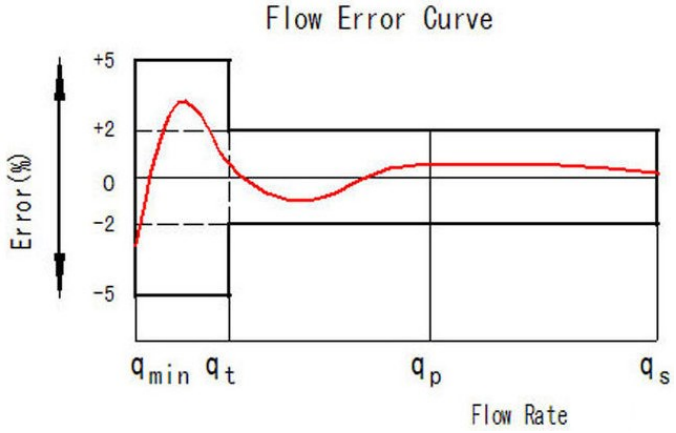
Not for use with Potable Water

Connection: 3 Inch 150# Flange
Pulse Rate: 100 gallons/pulse

Height: 10.8 Inches
Length: 8.8 Inches
Weight: 31 lbs.

Flow Specifications:
Qmin: 5.3 GPM
Qt: 35 GPM
Qp: 176 GPM
Qmax: 352 GPM





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PRMFiltration

Water Meter Manual

The PRM Multi-Jet Water Meter is ideal for commercial and industrial applications. PRM water meters are based on a vertical axis turbine. The water enters the meter body and is directed to a chamber around the measuring insert. The water then flows to the turbine via multiple passages spaced at intervals around the circumference of the insert. These passages form the “multiple” jets of water that act to rotate the turbine. This rotation is transferred to the counter dials via the counter gearing. The multi-jet design allows for simplicity and accuracy with wide flow ranges, even in low flow applications. The hermetically sealed register will not leak or fog and is completely separated from the water. These water meters are designed for long service life and maintenance-free operation. Brass water meters not for potable water use.

Specifications:

Brass Cold Water Meters: (Blue)
Wetted Materials: Body: Brass, polyethylene; Couplings: Brass; Measuring Chamber: Polyethylene.
O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal (pulse output units only): Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon; 1” to 2” 1 pulse per 10 gallons
Mounting Orientation: Horizontal with register facing up.

Stainless Steel Cold Water Meters: (Silver)
Wetted Materials: Body: 304 Stainless Steel, polyethylene; Couplings: 304 Stainless Steel;
Measuring Chamber: Polyethylene; O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal (pulse output units only): Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon; 1” to 2” 1 pulse per 10 gallons
Mounting Orientation: Horizontal with register facing up.

Brass Hot Water Meters: (Red)
Wetted Materials: Body: Brass, heat resistant polymer; Couplings: Brass;
Measuring Chamber: Heat resistant polymer;O-Rings: FKM (Viton)
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 194°F (40°C).
Pressure Limit: 150 psi (10 bar).
Output Signal: Pulse output with frequency proportional to flow rate.
Pulse: ½” and ¾” 1 pulse per gallon
Mounting Orientation: Horizontal with register facing up.

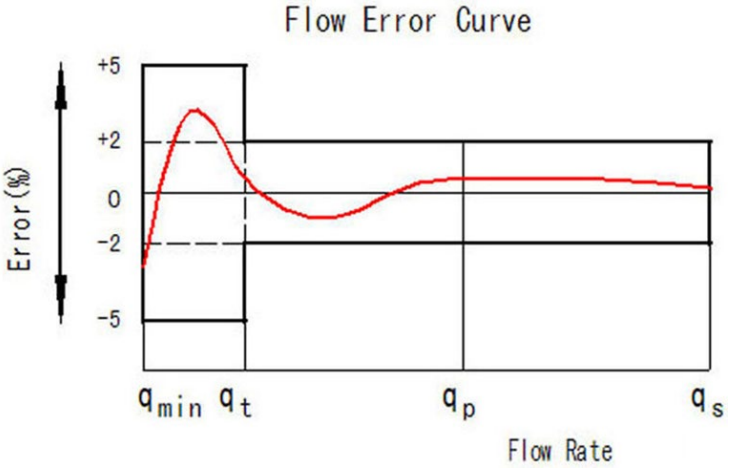
Nylon Cold Water Meters: (Black)
Wetted Materials: Body: Nylon 66; Couplings: Nylon 66; Measuring Chamber: ABS Plastic.
Accuracy: Transitional Flow: ±5%; Nominal Flow: ±2%.
Temperature Limit: 104°F (40°C).
Pressure Limit: 150 psi (10 bar).
Mounting Orientation: Horizontal with register facing up.

Water Meter Classification and Accuracy

Water meters are primarily classified by size, or the nominal diameter of the water meter is matched to the size of the pipe to which it is being connected. However, it should always be confirmed that the expected flow rates through the meter fall within the accurate flow range of the meter. The meters flow range is defined as follows:

Nominal flow rate	Qp	The designation flow rate of the meter. This is the ideal amount of water flow through the meter.
Maximum flow rate	Qmax	The highest flow rate at which the meter accuracy will be within the Maximum permitted error
Minimum flow rate	Qmin	The lowest flow at which the meter accuracy will be within the maximum permitted error.
Transitional flow Rate	Qt	The flow rate at which the maximum permitted error of the meter changes from +/-5% to +/-2%.

Max. permitted error from Qmin to Qt: +/-5%
Max. permitted error from Qt to Qmax: +/-2%



PRM Meters are Class B meters and conform to AWWA Standards.

Nominal Diameter	Qmin (GPM)	Qt (GPM)	Qp (GPM)	Qmax (GPM)
0.5 Inch	0.25	1	5	10
0.75 Inch	0.5	2	10	20
1 Inch	0.75	3	15	30
1.25 Inch	0.75	3	25	50
1.5 Inch	1.5	5	40	75
2 Inch	2	8	65	130

PRM Woltmann Style Flanged Meters

Nominal Diameter	Qmin (GPM)	Qt (GPM)	Qp (GPM)	Qmax (GPM)
3 Inch	5	35	176	352
4 Inch	8	53	264	528
6 Inch	20	132	660	1320

Water Meter Reading
Turbine type meters use a combination of inline digits and clock dials to show the volume of water that has been measured. The inline digits are in black and show the whole gallons. The clock dials have pointers that indicate the fractions of the gallons. On the larger meters this may change as often there is a x100 multiplier on the counter so the dial will show the whole gallons to give you an accurate reading.

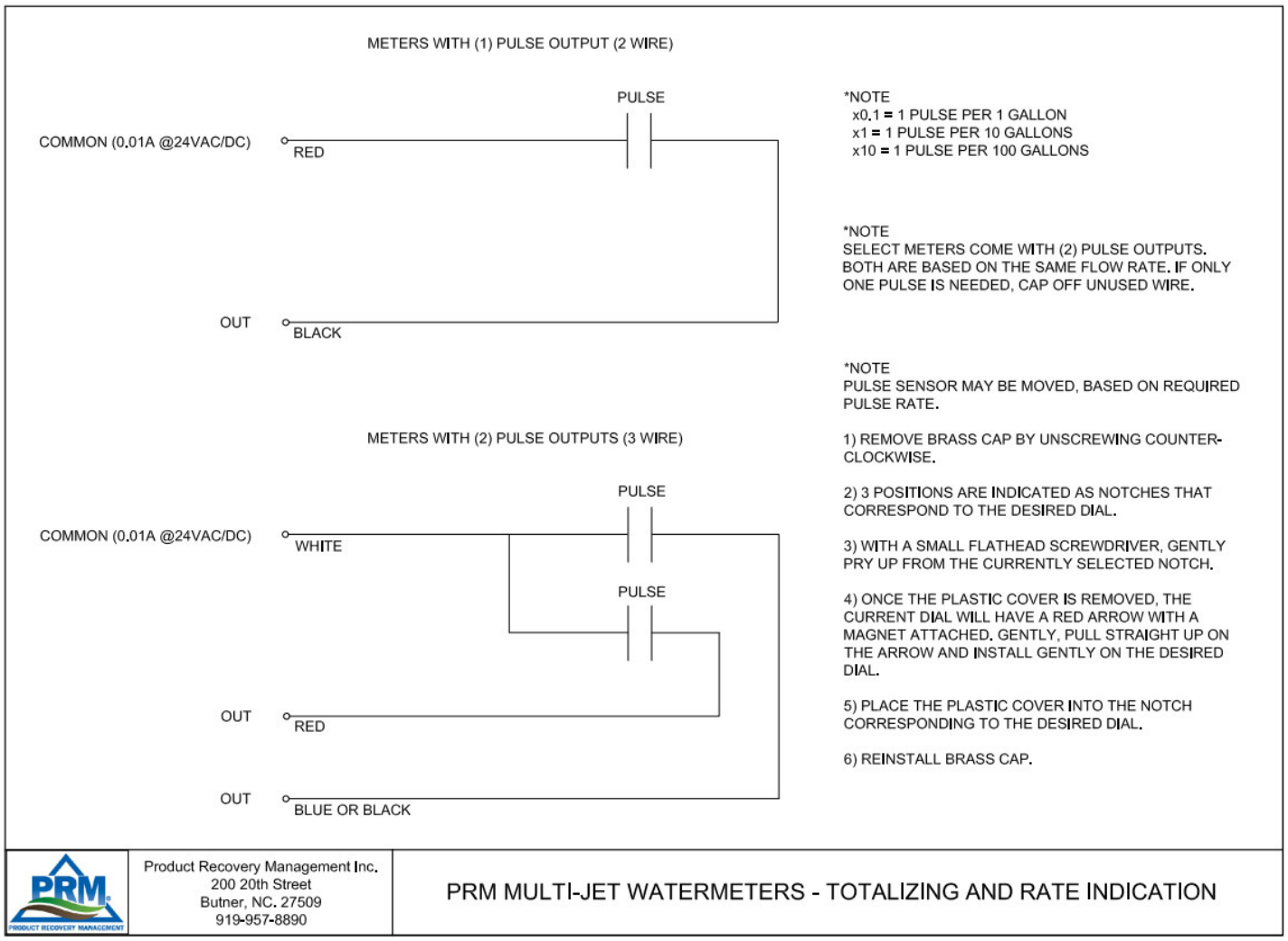
Maintenance/Repair
Preventative maintenance consists of periodic inspections and cleaning procedures.
The procedures should be performed at regular intervals, and any defects discovered should be corrected before further operation of the meter.
All water meters with registers should be protected from weather and not be exposed to direct sunlight.
Visually inspect the meter for missing hardware, broken resistor glass, or other signs of wear or deterioration.
Verify proper flow rate and pressure for meter. A loss in pressure, with the resulting flow rate decrease, may indicate the meter screen is clogged and requires cleaning.
Clean the strainer yearly, or as required, depending on water condition. Pull out the strainer or back flush the meter to loosen trapped particulates.

Installation Instructions

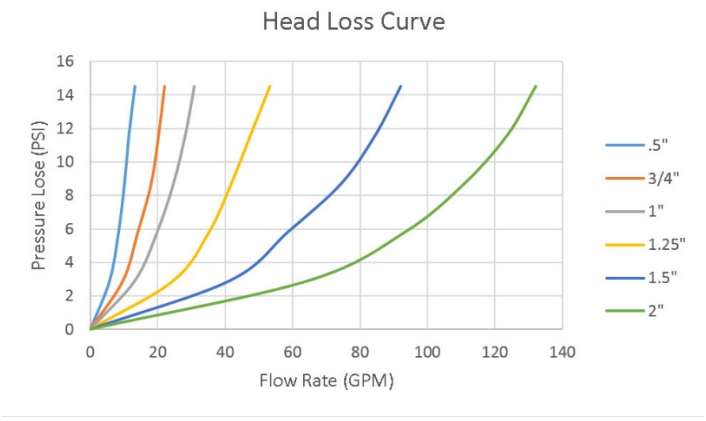
1. Thoroughly flush the service line upstream of the meter to remove dirt and debris.
2. Remove meter thread protectors. Note: To protect meter spud threads, store the meter with thread protectors in place. Attach included NPT adapters for easy connection to piping.
3. Set the meter in the line. Install in a horizontal plane, with the register upright, in a location accessible for reading, service and inspection. Arrows on the side of the meter and above the outlet indicate the direction of flow.

4. For accurate measurement, the tap height should be higher than the meter.
5. Do not over-tighten connections; tighten only as required to seal.
6. With upstream shut-off valve only: Open shut-off valve slowly to remove air from meter and service line. Open a valve slowly to allow entrapped air to escape. Close the valve.
7. With both upstream and downstream shut-off valves installed, test the installation for leaks: Close the outlet (downstream) shutoff valve. Open the inlet (upstream) shut-off slowly until meter is full of water. Open the outlet (downstream) valve slowly until air is out of the meter and service line. Open valve slowly to allow entrapped air to escape. Close the valve.

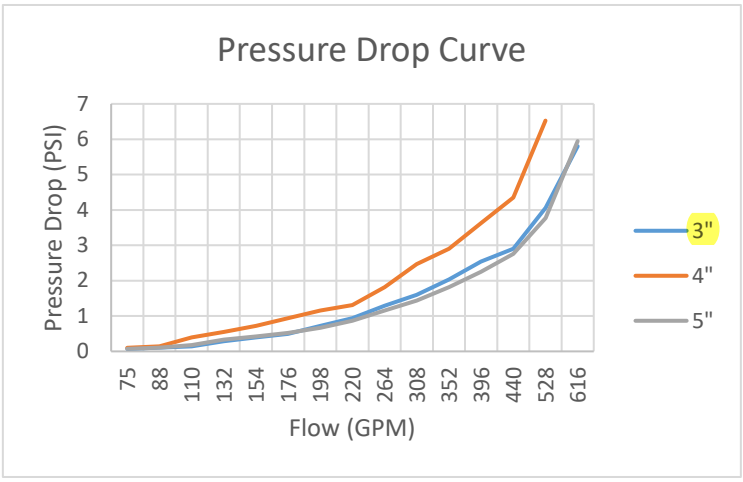
Wiring Diagram (Pulse Units)



Head Loss Curves



½ Inch to 2 Inch Multi Jet Meters



3, 4, and 6 inch Flanged Meters

EQ Tank Float Switches (Qty. 3)

FLOAT SWITCH

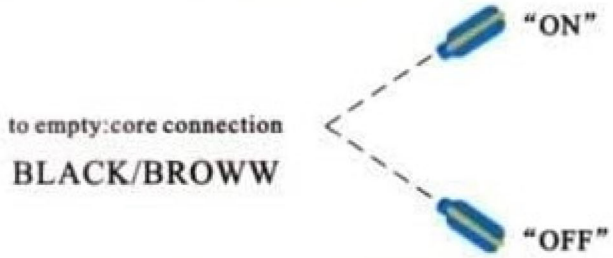
AUTOMATIC ADJUSTABLE
EASYTOINSTALL
RELIABLE
MAINTENANCE FREE
ENVIRONMENTALPROTECTION

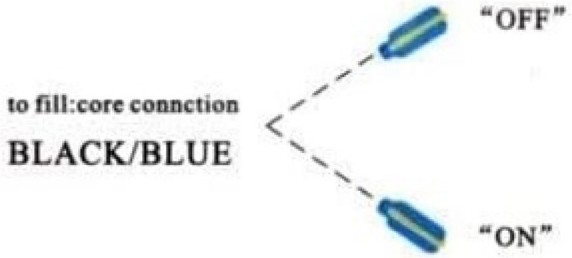
WIRING CONNECTION

Blue=the "ON" switch action below is to fill

Black

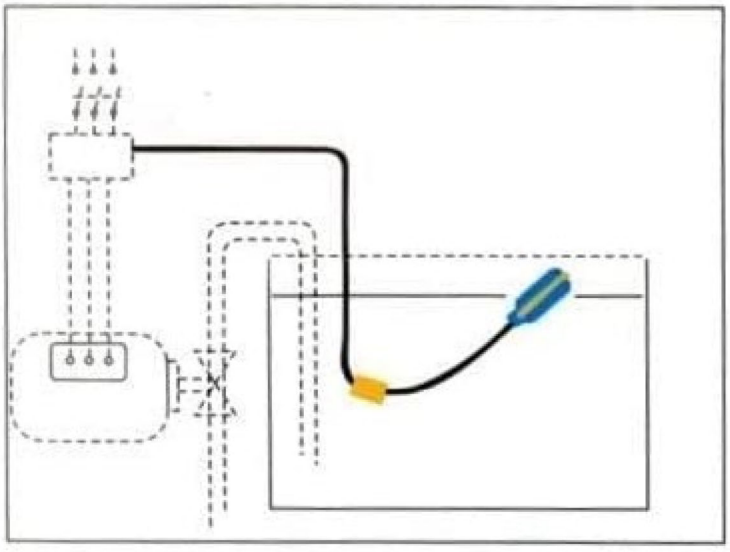
brown=the "ON" switch on high is to empty

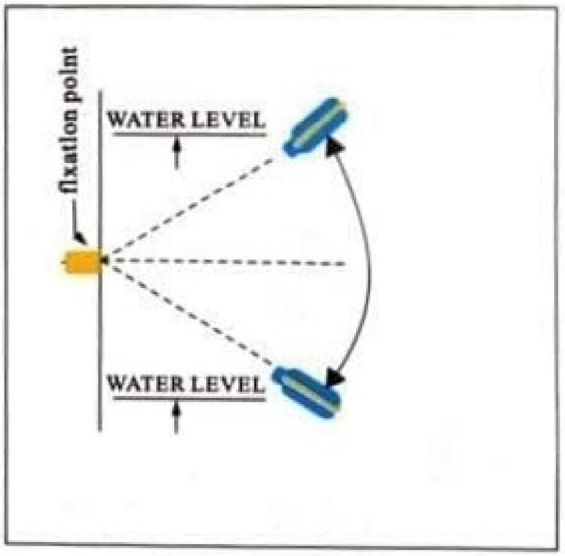




TECHNICALCALDATES

Microswitch:	10(8)A250V~10（4）A380V
Switch currency:	⊣⊢
	≥50 000 switch workings
Protective connection:	▣T70U" ⑧
Protection:	Waterproof"
Max.temperature:	70℃
Working pressure:	max.1bar
Circuitbreaking capacity:	directly 2KW with 250V





EASY OPERATION

The desired "ON"or"OFF"differential is obtained by simply lengthening or shortening the free cord fixation point. "ON"and"OFF"switch action may be adjusted to any desired liquid level by moving the cord fixation in up or down direction.

APPLICATION

The float switch "HUTO"is a switch which regulates fluid level in the tank or well etc, The float switch is resistant to water(sewage water),it is relative capable of being used for oil,most acids and alkalis.The float switch is not exploaion proof.

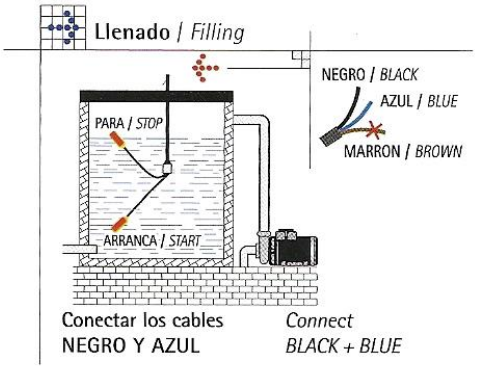
CustomerService@SumpAlarm.Com
Call us at: 314-787-8059
www.SumpAlarm.Com

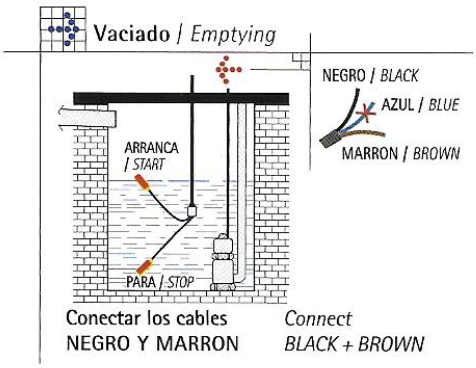
Thank you for your float switch purchase!

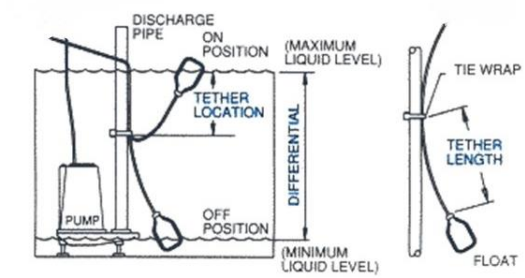
Always remember to disconnect all power and have your float switch installed by a licensed electrician.

This float switch is rated to directly control motors of up to ½ Horsepower (or 13 Amps) at 120 or 220 Volts AC for non-continuous pump operations, and up to 13 Amps DC for motor loads. Please feel free to contact us for other applications. For higher horsepower motors, a contactor or relay will be required. Your float switch has a three wire configuration, which can be used to make connections for either filling or emptying.

- For "Normally Full" Operation, where the desire to activate a pump to Fill a tank, sump, or vessel, use the **Black** and **Blue** Wires for connection, and cap the **Brown** wire.
- For "Normally Empty" Operation, where the desire to activate a pump to Empty a tank, sump, or vessel, use the **Black** and **Brown** Wires for connection, and cap the **Blue** wire.





Installation #1 **Without Counterweight**		The above diagrams demonstrate a float switch utilizing the counterweight included in the package. A counterweight may not be necessary in your particular installation. In submersible pump applications, a float switch can be mounted as shown at left using only a wire tie. The *Tether Length* illustrated in the Figure can be minimized to 3 inches from the float switch ribbing.

(OVER TO NEXT PAGE)

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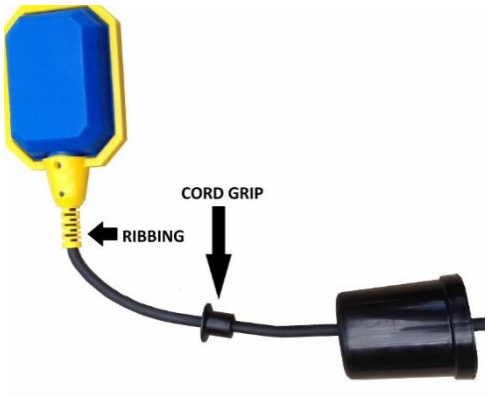
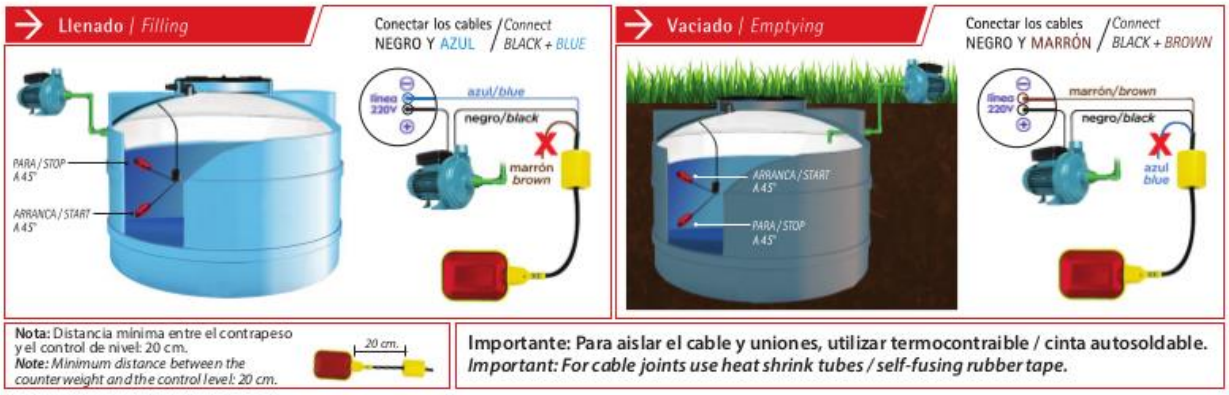
Call us at: 314-787-8059
www.SumpAlarm.Com

Instalation #2 **With Counterweight**		Alternatively, if the float switch is installed with the counterweight, it will be necessary to slide the cord grip down the length of the cable. This can be accomplished by opening the cord grip with a screwdriver and passing it down the length of the cable. After the cord grip is in position, the counterweight can be slid down the cable and locked to the cord grip.

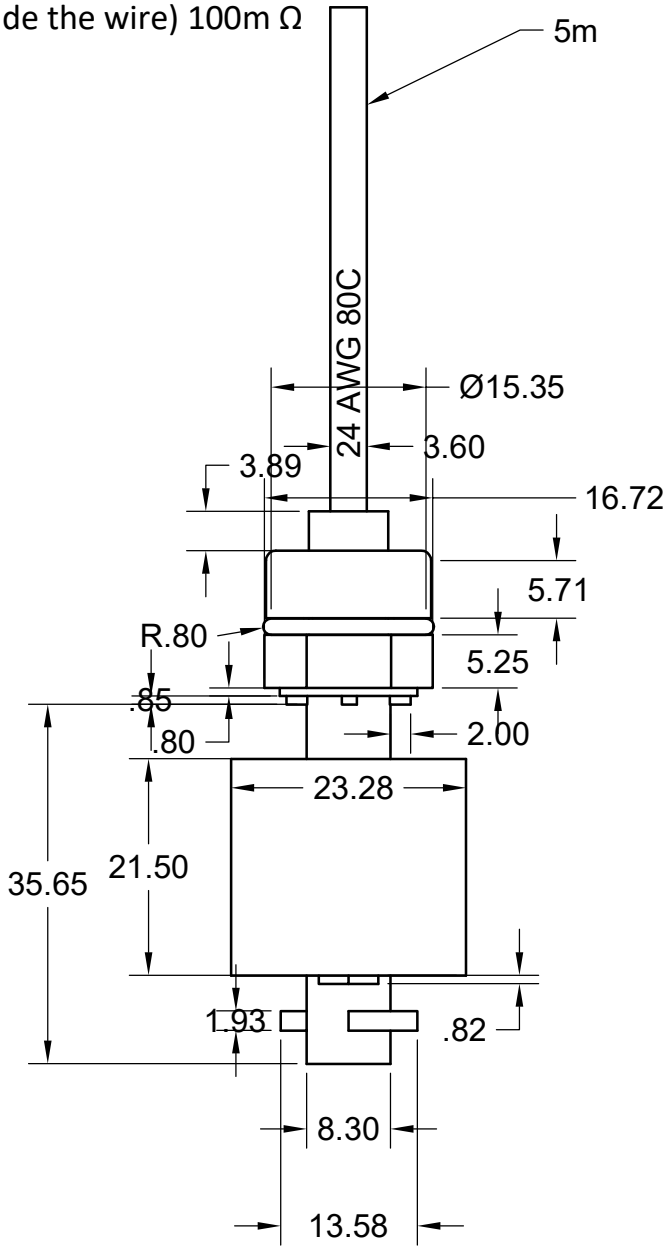
Other Float Switch Ratings and Specifications:

- Your float switch is warranted in the field for two years.
- Temperature ratings from 32F to 140F, and rated to IP68, with CE approvals
- Stainless steel ball and Honeywell micro switch
- Casing made of Polypropylene for non-corrosive and non-combustible fluids
- It can be used in water tanks, low density oils and sewage water
- Not rated for hazardous or explosive applications.
- IEC 60730-1 (08-2003) + IEC 60730-2-16 (08-2001)
- The enclosed package has instructions in English and Spanish



Our contact information is above. Se hablamos Español.

- Max. Contact Rating: 50W
- Max. Switching Voltage: 100VDC
- Max. Switching Current: 1.5A
- Max. Initial Contact Resistance: (Do not include the wire) 100m Ω
- Temperature Rating: -10 ~ +85 ℃
- Float Ball Material: PP
- Float Body Material: PP+GF
- Screw Nut Material: PP+GF
- E-Ring Material: PP



Sump Alarm

PROJECT

LS-FLOAT-SWITCH

TITLE

Magnetic Float Switch
Sump Alarm Inc

APPROVED		SJS	SIZE	CODE	DWG NO	REV
CHECKED	SJS	3/12/2018	A		LS-FLOAT-SWITCH	A
DRAWN	Sean D	3/1/2018	SCALE 2:1.5	WEIGHT 87 GRAMS	SHEET 1/1	

LS-2600 Leak Sensors

Level Sense LS2600 Surface Liquid Sensor connects to a control device accepting an analog or digital input.

- Size: L64*W15.6*H12.7mm
- Housing: ABS, white
- Working Voltage: 5Vdc-12Vdc
- Max. Voltage: 24Vdc
- Max. Working Current: 0.5 Amp
- Temperature: 14°F +150°F / (-10°C +65°C)
- 6 Feet of Cable
- Red wire to Positive, white wire to Negative (ground)
- Perfect for Arduio, Rasberry Pi, and home electronics projects.

If you are using this in home electronics projects, please take note of the following:

- This device is not providing a “contact closure” it is providing a trickle current between the two contacts when water with some ionic content is present.
- The Leak sensor behaves as an open circuit when no water is present, and behaves as a (roughly) 1.4MΩ resistor when water is present. The resistance of it *depends on your water.*
- To confirm if the device is working, place the ohmmeter probes directly into water approximately 1.5” inches apart and take a reading. Then place the sensor in water and connect the ohmmeter to the red and white wires. The two readings should be similar.
- To get the best circuit design, put the sensor feet in water and measure the resistance with an ohmmeter. Use this resistance in your circuit design.
- In the unlikely event you have “non-conductive” water, it can be easily rectified by sprinkling some salt around the sensor location. The water will absorb the salt, the salt will ionize the water, and allow it to conduct.
- If you are using this sensor as an input to an Arduino or raspberry Pi, it is recommended to use either an Analog input, or a “PULL UP” input where the sensor is taking an input to ground.

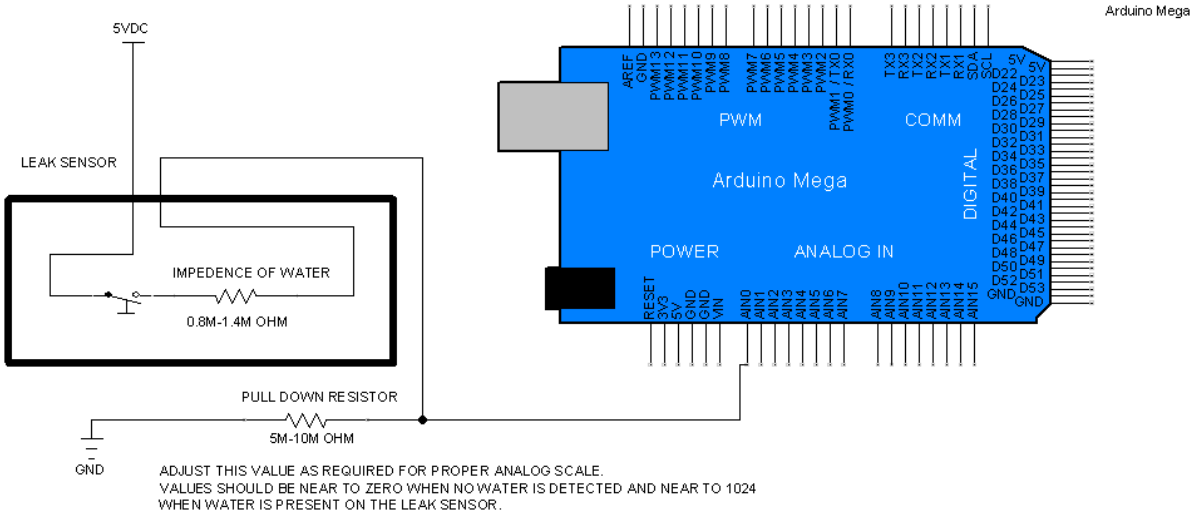
Application	Red Wire Connection	White Wire Connection
Arduino / RP Analog Input	+5VDC	Input, with 5MΩ Pull Down Resistor
Arduino Discrete Input (pinmode=PULL UP)	Input	Ground
Solid State Relay **Control** (with 3-32VDC Coil) and 12-24VDC+ Power Source	Coil -	Ground
Control a mechanical relay or contactor	DC Source	Transistor Base going into a “Darlington Pair”

For help or assistance, call our support line at 314-787-8059 ext 2.

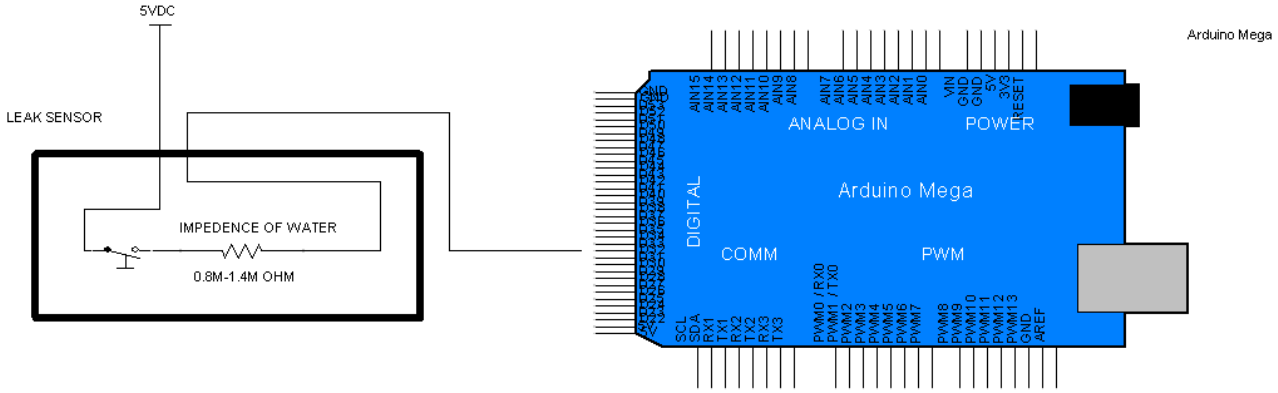
LS-2600 Leak Sensors

SumpAlarm

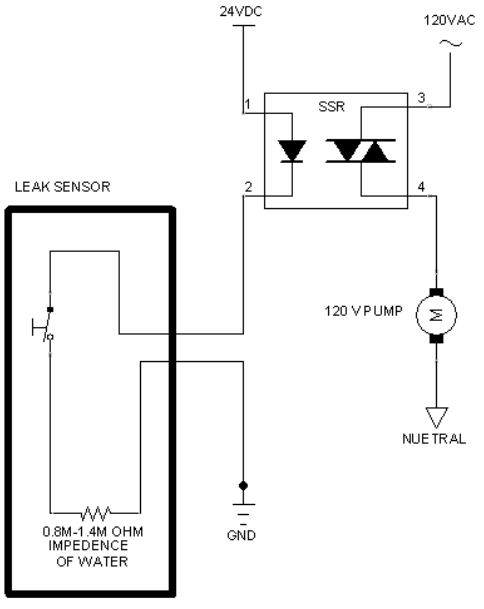
LS-2600 WITH MICROCONTROLLER ANALOG INPUT



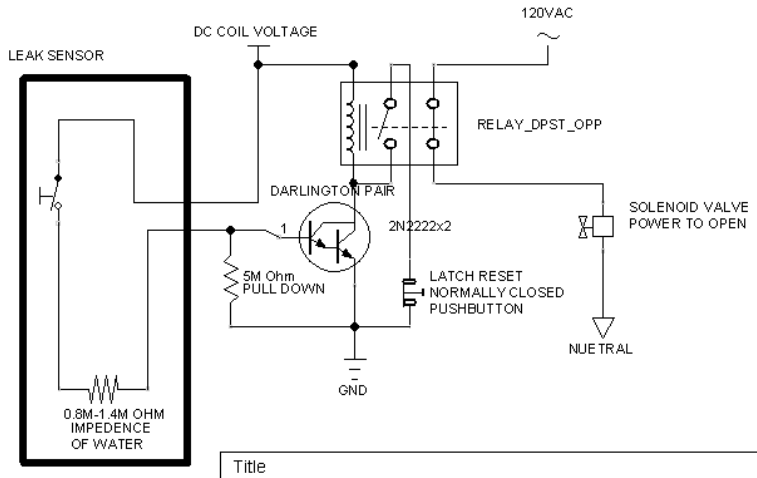
LS-2600 WITH MICROCONTROLLER DIGITAL *PULL UP* INPUT



ACTIVATING SOLID STATE RELAY WITH THE LS-2600 TO POWER A 120VAC PUMP (OR SOLENOID)



ACTIVATING A MECHANICAL RELAY WITH THE LS-2600 TO POWER A 120VAC SOLENOID (OR PUMP) CIRCUIT LATCHES ON WATER CONTACT



Title LS-2600 EXAMPLE CIRUITS		
Author LEVEL SENSE BY SUMPALARM SUMP ALARM		
File S:\TechnicalData\Lev ... ls-2600 circuits.dsn		Document LS-2600
Revision 1.0	Date 02/19/2018	Sheets 1 of 1

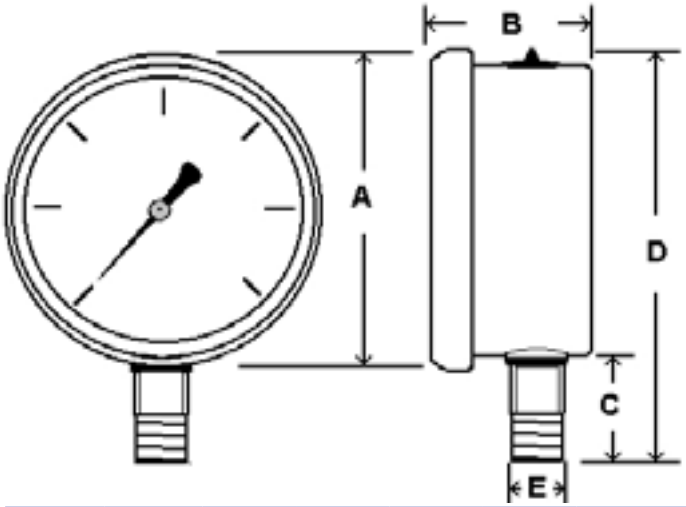
201L LIQUID FILLED LOWER MOUNT

Glycerine filled for added durability in applications where vibration or pulsation is present
Stainless steel case and bezel, copper alloy internals

SPECIFICATIONS

Dial	1 ½" (40 mm), 2" (50 mm), 2 ½" (63 mm), 4" (100 mm)
Case	Stainless steel, glycerine filled
Wetted Parts	Copper alloy
Bezel	Stainless steel, fixed
Lens	Polycarbonate
Pointer	Black aluminum
Connection	Lower mount 1 ½" dial = ⅛" NPT 2" dial = ⅛" or ¼" NPT 2 ½" dial = ¼" NPT 4" dial = ¼" or ½" NPT
Scale	Standard: psi/BAR (x 100 = kPa) Single scale psi available from stock
Accuracy	3-2-3% of span 1 ½" & 2" ASME B40.1 Grade B 2-1-2% of span 2 ½" & 4" ASME B40.1 Grade A
Ambient Temp	Glycerine Filled = 30° F to 160° F Dry = -30° F to 180° F

Design meets or exceeds ASME B40.100 pressure gauge standard.



Dial	Unit	A	B	C	D	E
1 ½"	In.	1.85"	1.00"	0.67"	2.28"	⅛" NPT
	mm	47	25	17	58	
2"	In.	2.27"	1.20"	0.91"	2.95"	⅛" or ¼" NPT
	mm	58	31	23	75	
2 ½"	In.	2.80"	1.40"	1.07"	3.55"	¼" NPT
	mm	71	36	27	90	
4"	In.	4.29"	1.75"	1.17"	5.21"	¼" or ½" NPT
	mm	109	45	30	132	

AVAILABLE OPTIONS*

- Certificate of Accuracy, NIST traceable
- Custom Dial
- Liquid Fill Options, see page 176
- Anti-Vibration Movement, see page 109
- Glass Lens
- Dry, Fillable Case
- Cleaned for Oxygen Service (dry only)
- Special Connection Size
- Protective Rubber Cover, see page 121
- Max/Min Pointer, see page 122

*Lead times/minimums may apply

APPROXIMATE SHIPPING WEIGHTS/ BOX QUANTITIES

Dial Size	Est. Unit Weight	Box Qty
1 ½"	0.20 lbs (0.10 kg)	100
2"	0.40 lbs (0.18 kg)	100
2 ½"	0.55 lbs (0.24 kg)	50
4"	1.5 lbs (0.68 kg)	30

4. HEATING

Please read and save these instructions. ***Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.***

Dayton® Heavy-Duty Electric Unit Heaters

Description

Dayton Heavy-Duty Electric Heaters are designed for continuous or intermittent use in factories, warehouses, public buildings, stock rooms, service stations, any large or exposed areas, or additions. Can be installed for use in downflow or horizontal applications.

FEATURES

- Units 5 thru 15 kW are field convertible from single to three phase
- 24 volt low voltage control circuit is standard except on 3 kW, 208V, 240/208V, and 277V units which have line voltage control
- Heavy-duty totally enclosed motors
- Aluminum finned, copper clad, steel sheath heating elementl
- Advanced inlet louver design draws cool air across heating element for more efficient operation
- Automatic reset linear thermal protector
- Venturi outlet with large dynamically balanced fan blade
- Heavy gauge die-formed steel housing
- Optional vertical and horizontal brackets available

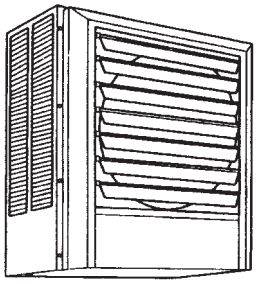


Figure 1

Unpacking

Remove the heater from the box and inspect it for any damage. If it appears to be damaged, immediately return.

Check the contents of the box to make sure it contains one heating unit.

Specifications

Model	kW Rating	BTU/HR (1,000's)	Heater/ Motor Voltage	Phase	Control Voltage	Amps Per Phase	Fan Motor HP	Fan Motor RPM	CFM at Outlet	FPM at Outlet	Air Temp. Rise (°F)	Air Throw (Horiz)
2YU58*	3.0/2.2	10.2/7.5	240/208	1	240/208	12.5/11.0	1/100	1600	350	800	27	12'
2YU59	3.0	10.2	480	3	24	3.6	1/100	1600	350	800	27	12
2YU60*	3.0	10.2	277	1	277	11.0	1/100	1600	350	800	27	12
2YU61*	3.0	10.2	208	1	208	14.5	1/100	1600	350	800	27	12
2YU62*	5.0/3.7	17.0/12.6	240/208	1-3	240/208	21.0/18.0	1/100	1600	350	800	45	12
2YU63	5.0	17.0	480	3	24	6.0	1/100	1600	350	800	45	12
2YU64*	5.0	17.0	277	1	277	18.0	1/100	1600	350	800	45	12
2YU65*	5.0	17.0	208	1-3	208	24.0	1/100	1600	350	800	45	12
2YU66	7.5/5.6	25.6/19.1	240/208	1-3	24	31.3/27.0	1/30	1600	650	970	37	18
2YU67	7.5	25.6	480	3	24	9.0	1/30	1600	650	970	37	18
2YU68	7.5	25.6	208	1-3	24	36.0	1/30	1600	650	970	37	18
2YU69	10.0/7.5	34.1/25.6	240/208	1-3	24	42.0/36.0	1/30	1600	650	970	49	18
2YU70	10.0	34.1	480	3	24	12.0	1/30	1600	650	970	49	18
2YU71	10.0	34.1	208	1-3	24	48.0	1/30	1600	650	970	49	18
2YU72	15.0/11.2	51.2/38.2	240/208	3	24	36.1/33.3	1/20	1530	910	1640	52	35
2YU73	15.0	51.2	480	3	24	18.0	1/20	1530	910	1640	52	35
2YU74	15.0	51.2	208	1-3	24	72.0	1/20	1530	910	1640	52	35
2YU75	20.0/15.0	68.2/51.2	240/208	3	24	48.0/41.2	1/10	1500	1320	2060	48	41
2YU76	20.0	68.2	480	3	24	24.0	1/10	1500	1320	2060	48	41
3END3	25	85.2	480	3	24	30	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU77	30.0/22.5	102/77	240/208	3	24	72.0/63.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU78	30.0	102.3	480	3	24	36.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
2YU79	30.0	102.3	208	3	24	84.0	1/4	1600/1375	2100/1800	2100/2030	45/53	50
3END4	40	136.4	480	3	24	48	1/2	1524/1420	3000/2600	3260/2900	49/42	60
2YU80	50.0/37.5	170/127	240/208	3	24	120.4/104.2	1/2	1525/1420	3000/2600	3260/2900	53/61	60
2YU81	50.0	170.5	480	3	24	60.2	1/2	1525/1420	3000/2600	3260/2900	53/61	60

(*) These models are wired for direct line voltage control.

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Dayton® Heavy-Duty Electric Unit Heaters

ENGLISH

IMPORTANT INSTRUCTIONS

⚠ WARNING ***When using electric appliances, basic precautions should always be followed to reduce the risk of fire, electric shock, and injury to persons, including the following:***

1. Read all instructions before installing or using this heater.
2. This heater is a commercial/industrial product not intended for use in a residential setting.
3. This heater is hot when in use. To avoid burns, do not let bare skin touch hot surfaces. Keep combustible materials, such as furniture, pillows, bedding, papers, clothes, etc. and curtains at least 3 feet (0.9 m) from the front of the heater.
4. Extreme caution is necessary when any heater is used by or near children or invalids and whenever the heater is left operating and unattended.
5. This heater has hot and arcing or sparking parts inside and is not intended for use in hazardous atmospheres where flammable vapors, gases, liquids or other combustible atmospheres as defined in the National Electrical Code are used or stored. Failure to comply can result in explosion or fire.
6. Do not operate any heater after it malfunctions. Disconnect power at main service panel and have heater inspected by a reputable electrician before using.
7. Do not use outdoors.
8. To disconnect heater, turn controls to off, and turn off power to heater circuit at main service panel.
9. Do not insert or allow foreign objects to enter any ventilation or exhaust opening as this may cause an electric shock, fire, or damage to the heater.
10. To prevent a possible fire, do not block air intake or exhaust in any manner.
11. Use this heater only as described in this manual. Any other use not recommended by the manufacturer may cause fire, electric shock, or injury to persons.
12. This heater is not intended for use in special environments. Do not use in damp or wet locations such as marine or greenhouse or in areas where corrosive or chemical agents are present.
13. When installing, see INSTALLATION INSTRUCTIONS for additional warnings and precautions.
14. For safe and efficient operation, and to extend the life of your heater, keep your heater clean. See MAINTENANCE INSTRUCTIONS.

Installation Instructions

⚠ WARNING ***To prevent a possible fire, injury to persons or damage to the heater, adhere to the following:***

1. Disconnect all power coming to heater at main service panel before wiring or servicing.

IMPORTANT NOTE: This heater must be installed by a qualified person.

2. All wiring procedures and connections must be in accordance with the National and Local Codes having jurisdiction and the heater must be grounded.
3. Verify the power supply voltage coming to heater matches the ratings as shown on the heater nameplate.

⚠ CAUTION ***Energizing heater at a voltage greater than the voltage printed on the nameplate will damage the heater and void the warranty and could cause a fire.***

4. To reduce the risk of fire, do not store or use gasoline or other flammable vapors and liquids in the vicinity of the heater.
5. The ceiling or wall mounting structure and the anchoring provisions must be of sufficient strength to support the combined weight of the heater and mounting bracket.
6. All built-in thermostats: If the heater is used to prevent piping or liquids from freezing, and if the thermostat is set below 45°F (7°C), the fan must run continuously.
7. The heater must be mounted at least 7’ (2134 mm) above the floor to avoid accidental contact with the fan blade which could cause injury.
8. Keep at least 5’ clearance in front of the heater. Refer to Table 1 for side, top and back clearance requirements.
9. Do not mount mercury type thermostat directly on unit. Vibration could cause heater to malfunction.

HEATER LOCATION

1. Arrange units so their discharge air streams are subjected to a minimum of interference from columns and partitions.
2. Direct air stream away from room occupants in comfort heating.
3. Air streams should wipe exposed wall without blowing directly at them.

Models 2YU58 thru 2YU81, 3END3 and 3END4

Installation Instructions (Continued)

4. Direct air stream along the windward side of a room when installed in a building exposed to a prevailing wind.
5. If using a remote thermostat, locate thermostat approximately 5 feet above the floor on the interior partition walls or posts away from cold drafts, internal heat sources, and away from heater discharge air streams.
6. Large rooms require multi-unit installations. Arrange units to provide perimeter air circulation where each unit supports the air stream from another.

MOUNTING

GENERAL (See Table 3, page 4, for Mounting Accessories)

1. Position the heater so access door can be opened to provide access to the wiring and control compartment. If the heater is to be mounted with the access door facing a wall, the heater must be mounted far enough from that wall to allow full opening of the access door (approximately equal to the depth of the heater). Refer to Table 1.
2. Heater may be mounted for vertical or horizontal discharge by the use of threaded rods. Refer to Table 2.
3. Optional mounting brackets permit horizontal pivoting of heater.
4. Louvers may be positioned to direct heated air in desired direction. For horizontal discharge, louvers should direct air either straight ahead or downward.

Table 1 – Wall and Ceiling Clearance, inches (mm) / Mounting Brackets

Unit	Discharge	Ceiling	Side Wall	Back Wall	Optional Mounting Brackets
3 & 5 kW	Horiz.	2 (50.8)	6 (152.4)	9 (228.6)	2YV16
	Vert.	6 (152.4)	18 (457.2)	18 (457.2)	2YU84
7.5 to 10 kW	Horiz.	6 (152.4)	6 (152.4)	13 (330.2)	2YV16
	Vert.	6 (152.4)	24 (609.6)	24 (609.6)	2YU84
15 to 20 kW	Horiz.	6 (152.4)	9 (228.6)	12 1/2 (317.5)	2YV17
	Vert	6 (152.4)	24 (609.6)	24 (609.6)	2YU84
25 to 50 kW	Horiz.	16 (406.4)	12 (304.8)	18 1/2 (470.0)	2YU91 & 92
	Vert.	12 (304.8)	36 (914.4)	36 (914.4)	2YU85

Table 2 – Mounting Rod Spacing

Unit	Rod Thread Type	(Figure 2) Horizontal A	B	C	D	(Figure 3) Vertical E	F	G	H
3 - 5kW	5/16″-18	6 1/16″	6″	4 1/16″	3/4″	6″	9 3/4″	2″	4 3/16″
7.5 - 10	5/16-18	6 1/16	8 7/8	5 1/8	3/4	8 7/8	14 5/8	2	5 1/8
15 - 20	5/16-18	11 3/8	8 7/8	5 1/8	3/4	8 7/8	14 7/8	2	5 1/8
25 - 30	3/8-16	10 9/16	14 1/2	6 3/16	5/8	14 1/2	21 1/4	2 3/16	6 3/16
40 - 50	3/8-16	15 15/16	14 1/2	6 3/16	5/8	—	—	—	—

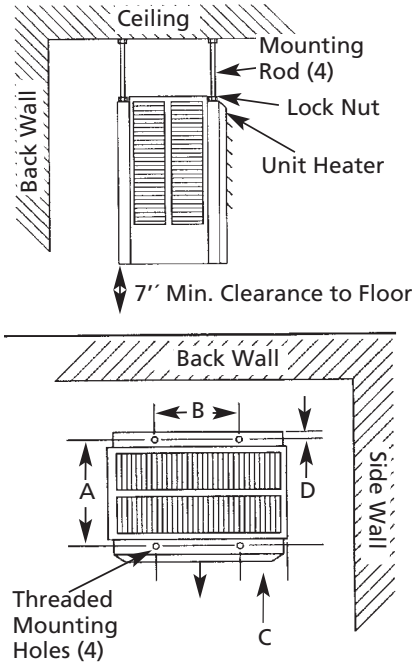

Figure 2 – Horizontal Discharge Mounting and Spacing

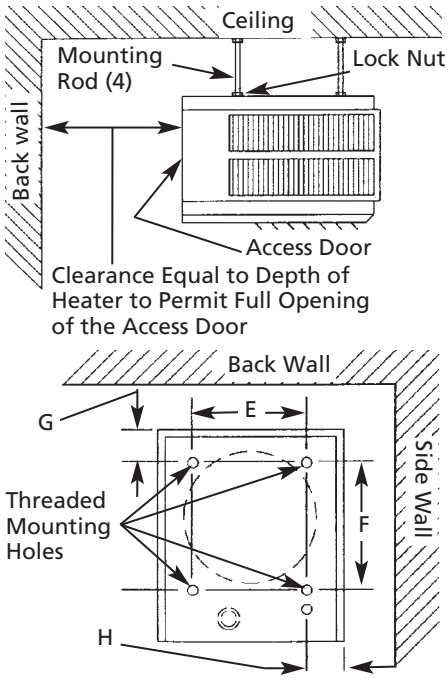

Figure 3 – Vertical Discharge Mounting and Rod Spacing

Dayton® Heavy-Duty Electric Unit Heaters

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Installation Instructions (Continued)

ROD MOUNTING

HORIZONTAL DISCHARGE

1. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts. (See Table 2.)
2. Securely attach the four mounting rods to the ceiling. (Refer to Table 1 for wall and ceiling clearances, and Table 2 for mounting rod spacing.)

VERTICAL DISCHARGE

1. Remove bolts from the threaded holes in the back of the heaters.
2. Install four threaded mounting rods in the threaded holes and secure in place using lock nuts.
3. Securely attach the four mounting rods to the ceiling. (Refer to Table 1 for wall and ceiling clearances, and Table 2 for mounting rod spacing dimensions.)

WIRING

BRANCH CIRCUIT (POWER)

1. Connect heater only to the voltage, amperage and frequency specified on the nameplate.
2. Field wiring must be properly sized to carry the amperage in accordance with the NEC.
3. The access door is hinged. There are either one or two screws accessible from the bottom that must be removed to gain access.

Table 3 – Optional Accessories

Electrical Accessory	Description	Product Compatability Notes
2YU33	Single pole internal thermostat Temp range 40°F - 85°F	All Dayton Unit heaters
2YU95	Two stage internal thermostat Temp range 40°F - 85°F	Can only be used on 2YU58, 2YU60, 2YU61, 2YU74, 2YU77, 2YU79, 2YU80, and 2YU81
2YU82	Internal summer fan switch	All Dayton Unit heaters
2YU90	Internal heat recovery thermostat with relay (24 V coil - single pole normally open)	All Dayton Unit heaters except 2YU58, 2YU60, 2YU61, and 2YU64
2YU93	25 amp 3 pole power disconnect switch rated 25 amps resistive @ 600 volts	Use only on 2YU58, 2YU59, 2YU60, 2YU61, 2YU62, 2YU63, 2YU64, 2YU65, 2YU67, 2YU70, 2YU73, 2YU76
2YU94	60 amp 3 pole power disconnect switch rated 60 amps resistive @ 600 volts	Use only on 2YU74 (when wired for 3 phase), 2YU66, 2YU69, 2YU72, 2YU76, 2YU78, 3END3, and 3END4

Mechanical Accessory	Description	Product Compatability Notes
2YU34	Radial Diffuser Kit	Use only on 7.5 thru 20kW heaters (2YU66 thru 2YU76)
2YU83	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 3 and 5kW heaters (2YU58 thru 2YU65)
2YU84	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 7.5 thru 20kW heaters (2YU66 thru 2YU76)
2YU85	Vertical Discharge Ceiling Mounting Bracket Kit	Use only on 25 thru 50kW heaters (2YU77 thru 2YU81, 3END3 and 3END4)
2YV16	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 3 thru 10kW heaters (2YU58 thru 2YU71)
2YV17	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 15 and 20kW heaters (2YU72 thru 2YU76)
2YU91	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 25kW and 30kW heaters (3END3, 2YU77, 2YU78, and 2YU79)
2YU92	Universal Wall and Ceiling Mounting Bracket Kit	Use only on 40kW and 50kW heaters (3END4, 2YU80 and 2YU81)

Models 2YU58 thru 2YU81, 3END3 and 3END4

Installation Instructions (Continued)

4. A knockout is provided in the back of the heater close to the power terminal board. The control terminal board knockout is 1/2 inch conduit size. The power terminal block knockout is multiple diameter. Use the diameter that fits the required conduit size.
5. A ground terminal is provided near the power terminal board. The ground wire should be connected before other connections are made.
6. The power terminal board is equipped with box terminals sized to accept the correct size power supply wire. Wire rated at 600V and 60°C is satisfactory for the heater branch circuit. Either aluminum or copper wire is satisfactory for connection to the heater power terminal board box terminal. Copper wire is recommended.
7. Each heater has a wiring diagram affixed to the inside of the access door. Consult this diagram before making any field connections.

IMPORTANT NOTE: Installation Screw Lug Torque – during transportation it is possible screw lug connections can loosen. After installation, before power is turned on to the heater, check all screw lug connections for tightness to a recommended minimum torque of 35 in-lbs. (3.9 N-m).

8. Single or three-phase connections may be used with heater models 2YU62, 2YU65, 2YU66, 2YU68, 2YU69, 2YU71, and 2YU74. These units are factory wired for single phase operation. If these heaters are for use with three-phase power, reconnect the wires as indicated in the wiring diagram attached to the heater.
   a. Additional information can be found by looking at the wiring illustrations in Figures 4a and 4b and following the directions under "Control Wiring".
   b. On Models 2YU62, 2YU65, 2YU66, 2YU68, 2YU69, and 2YU71 (Figure 4a), move only the two wires marked "A1" and "B1"; do not move or change any other wiring. The element lead wire marked "B1" which is factory connected to the power terminal block (terminal located closest to the elements) must be moved to terminal "B" on the three-phase terminal block.

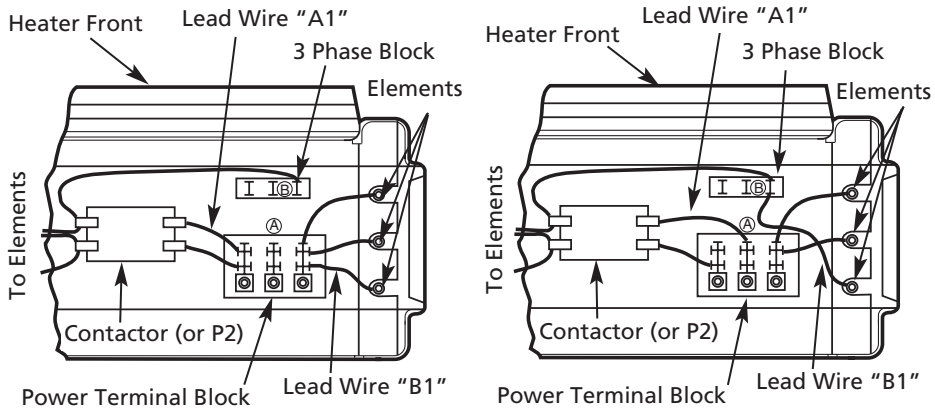

Figure 4a – Wiring Connections for Single-Phase and Three-Phase Power (2YU62, 2YU65, 2YU66, 2YU68, 2YU69 and 2YU71)

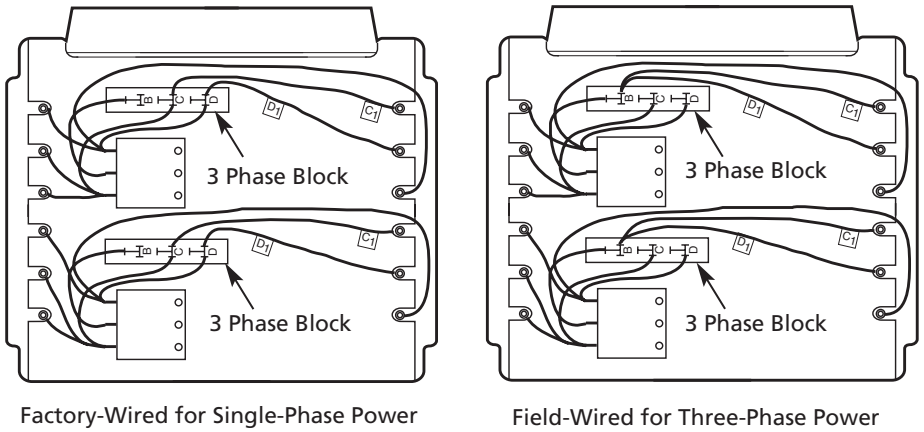

Figure 4b – Wiring Connections for Single-Phase and Three-Phase Power (2YU74)

Dayton® Heavy-Duty Electric Unit Heaters

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Installation Instructions (Continued)

c. The relay (contactor lead wire "A1") must be moved from the end terminal of the power terminal block (terminal closest to the contactor or control terminal board) to the "A" terminal of the lower terminal block (center terminal).

d. Model 2YU74 (Figure 4b) has two three-phase terminal blocks located adjacent to the relays (contactors). Move only the two wires marked "C1" and "D1" on each of these two three-phase terminal blocks to terminal "B". Do not move or change any other wires.

9. Electrical Accessories, either kits or factory-installed options, are shown connected by a dashed line on the heater wiring diagram.

10. 208/240 VOLT HEATER. The heaters are wired for 240V from factory. When heater is to be connected to 208V supply, the transformer leads have to be interchanged. For model 2YU80, interchange ORANGE and RED primary leads. The black colored lead is the COMMON for the 50VA transformer provided with this model. For the other models, interchange BLACK and RED primary leads. The WHITE colored lead is the COMMON for the 40VA control transformer provided with these heaters. Always refer to the wiring diagram on the cover of the heater before making this reconnection of transformer primary leads.

CONTROL WIRING

⚠ WARNING ***Line voltage is present on some of the terminals on the control terminal board. Always disconnect the power from the heater before making any connections to the control board to prevent hazard.***

1. Use min. 600 volt, NEC Class 1 insulated wire for all control circuit wiring.
2. Use a crimp-on type fork terminal on the wire ends that attach to the control terminal board if more than one connection is to be made under the terminal screw.
3. On units not provided with internal contactor (3 kW), refer to Figure 5, page 8, for wiring diagram.

NOTE: Thermostat and control circuit wiring must be suitable to handle the full load of the heater (example 2YU61 is rated 24 amps).

4. On units provided with internal contactor (units rated 5 kW and higher) refer to Figure 6, page 8, for wiring diagram. Control wiring must be rated minimum 18 AWG.

Operation Instructions

1. Heater must be properly installed before operation.
2. Turn power supply to heater "ON" at main service panel.
3. Where applicable, refer to control accessory instructions regarding proper operation of any controls or accessories used with the heater.

HOW TO RESET OVER-TEMPERATURE SAFETY CONTROL (FACTORY INSTALLED OPTION ONLY)

The limit switch is located internally on the rear of the heater. On the 3kW and 5kW models, the access to the reset button is on the right side (when facing rear of heater); on all other models it is near the top rear of the heater.

The manual reset limit is in series with the automatic recycling protector (limit). The manual reset limit will not reset until the heater has cooled and the button is pushed in.

⚠ WARNING ***Do not tamper with or bypass any safety limits inside heater.***

⚠ CAUTION ***Do not continue to attempt to use the heater if the safety control repeatedly operates after being reset. To do so could permanently damage the heater or create a fire or safety hazard.***

Models 2YU58 thru 2YU81, 3END3 and 3END4

Operation Instructions (Continued)

It is important to keep this heater clean. Your heater will give you years of service and comfort with only minimum care. To assure efficient operation follow the simple instructions below.

⚠ WARNING ***All servicing beyond simple cleaning that requires disassembly should be performed by qualified service personnel.***

⚠ WARNING ***To reduce the risk of fire and electric shock or injury, disconnect all power coming to heater at main service panel and check that the element is cool before servicing or performing maintenance.***

USER CLEANING INSTRUCTIONS

1. After the heater has cooled, a vacuum cleaner with brush attachment may be used to remove dust and lint from exterior surfaces of the heater including the grille openings.
2. With a damp cloth, wipe dust and lint from grille and exterior surfaces.
3. Return power to heater and check to make sure it is operating properly.

MAINTENANCE CLEANING INSTRUCTIONS

(To be performed only by Qualified Service Personnel)

At least annually, the heater should be cleaned and serviced by a qualified service person to assure safe and efficient operation. This should include the removal of the grille and, as necessary the heater from the back box to clean residue from the unit. After completing the cleaning and servicing, the heater should be fully reassembled and checked for proper operation.

Maintenance Instructions

It is important to keep this heater clean. Your heater will give you years of service and comfort with only minimum care. To assure efficient operation follow the simple instructions below.

⚠ WARNING ***All servicing beyond simple cleaning that requires disassembly should be performed by qualified service personnel.***

⚠ WARNING ***To reduce the risk of fire and electric shock or injury, disconnect all power coming to heater at main service panel and check that the element is cool before servicing or performing maintenance.***

USER CLEANING INSTRUCTIONS

1. After the heater has cooled, a vacuum cleaner with brush attachment may be used to remove dust and lint from exterior surfaces of the heater including the grille openings.
2. With a damp cloth, wipe dust and lint from grille and exterior surfaces.
3. Return power to heater and check to make sure it is operating properly.

MAINTENANCE CLEANING INSTRUCTIONS

(To be performed only by Qualified Service Personnel)

At least annually, the heater should be cleaned and serviced by a qualified service person to assure safe and efficient operation. This should include the removal of the grille and, as necessary the heater from the back box to clean residue from the unit. After completing the cleaning and servicing, the heater should be fully reassembled and checked for proper operation.

Dayton® Heavy-Duty Electric Unit Heaters

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Wiring Accessories

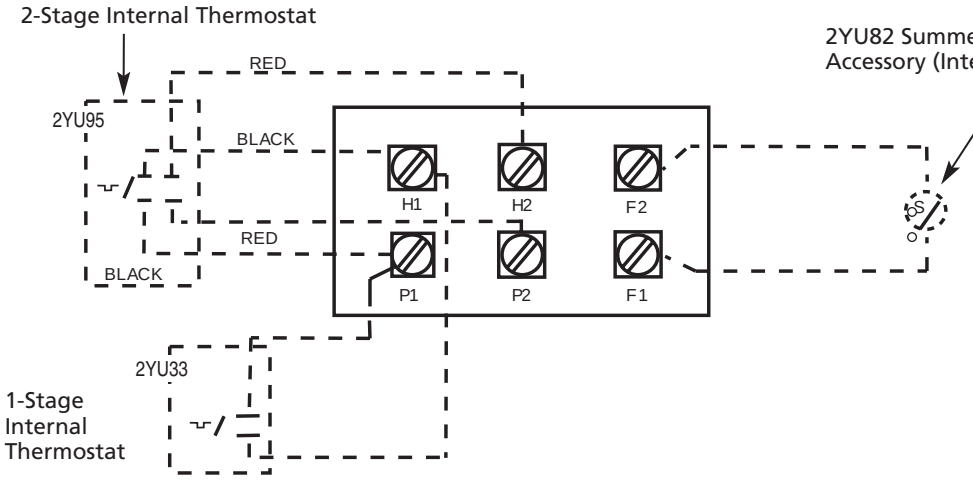


Figure 5 – Control Terminal Board (for Heaters without Contactors)

NOTES: (See Table 3, page 4, for Electrical Accessories)

1. This style control terminal board used with models 2YU58, 2YU60, 2YU61 and 2YU64.
2. When unit is wired for single phase, place jumper H1 to H2. If single pole thermostat is used with single phase unit, connect thermostat leads to P1 and H1.
3. External line voltage thermostats should be treated as single stage only.

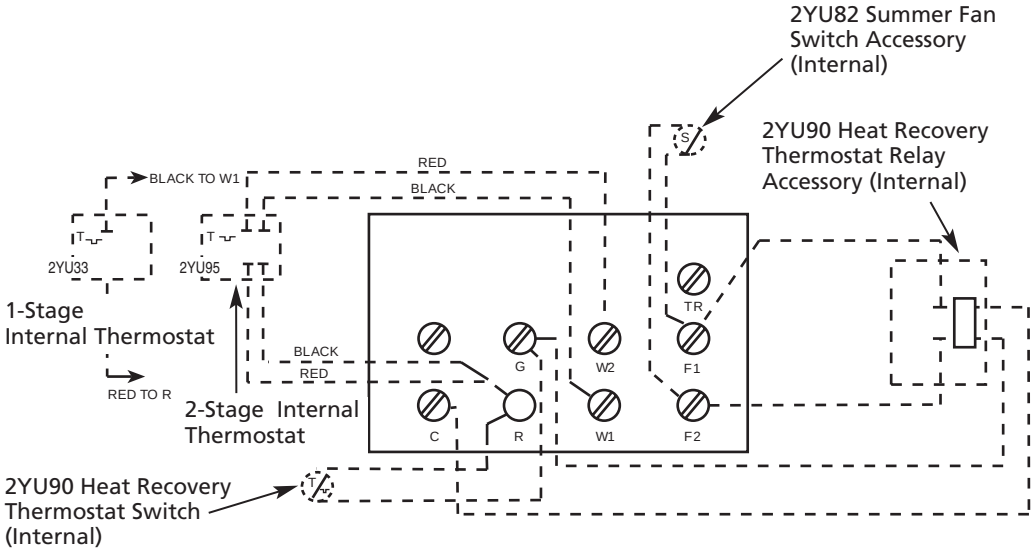


Figure 6 – Control Terminal Board (for Heaters with Contactors)

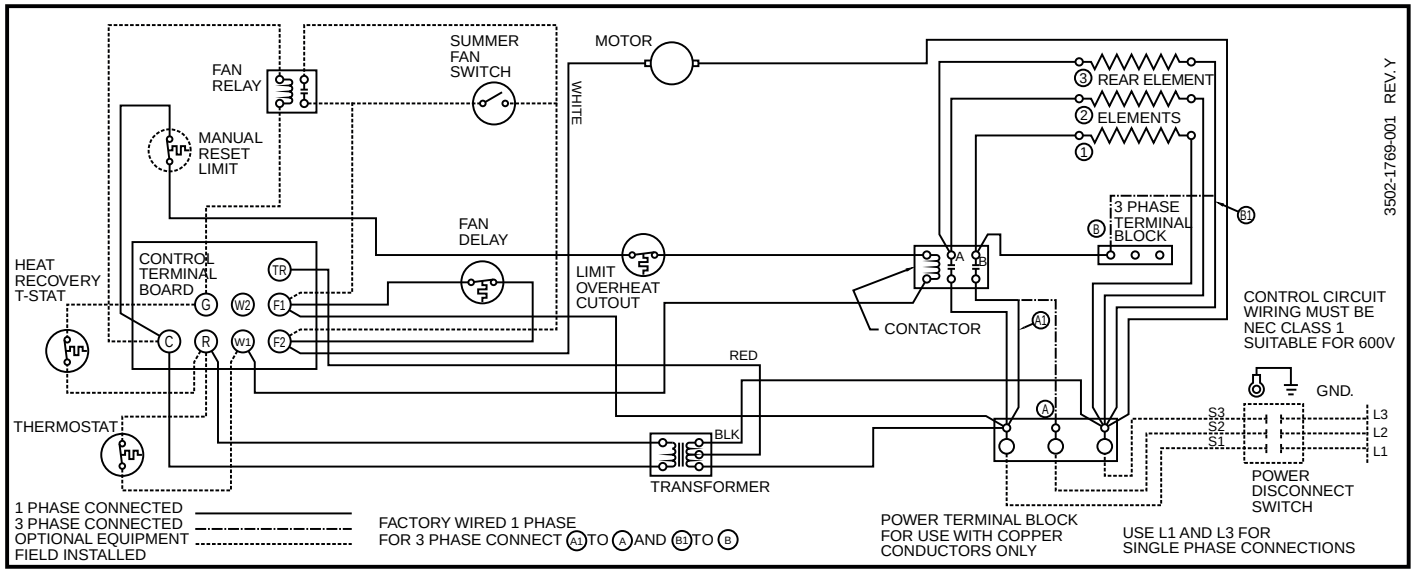
NOTES: (See Table 3, page 4, for Electrical Accessories)

1. This style control terminal board used with models except 2YU58, 2YU60 and 2YU61.
2. Remove jumper W1 to W2 when 2-stage thermostat is used.
3. Only one fan switch and one thermostat accessory may be installed in a single heater.
4. External line voltage thermostats should be treated as single stage only.

Models 2YU58 thru 2YU81, 3END3 and 3END4

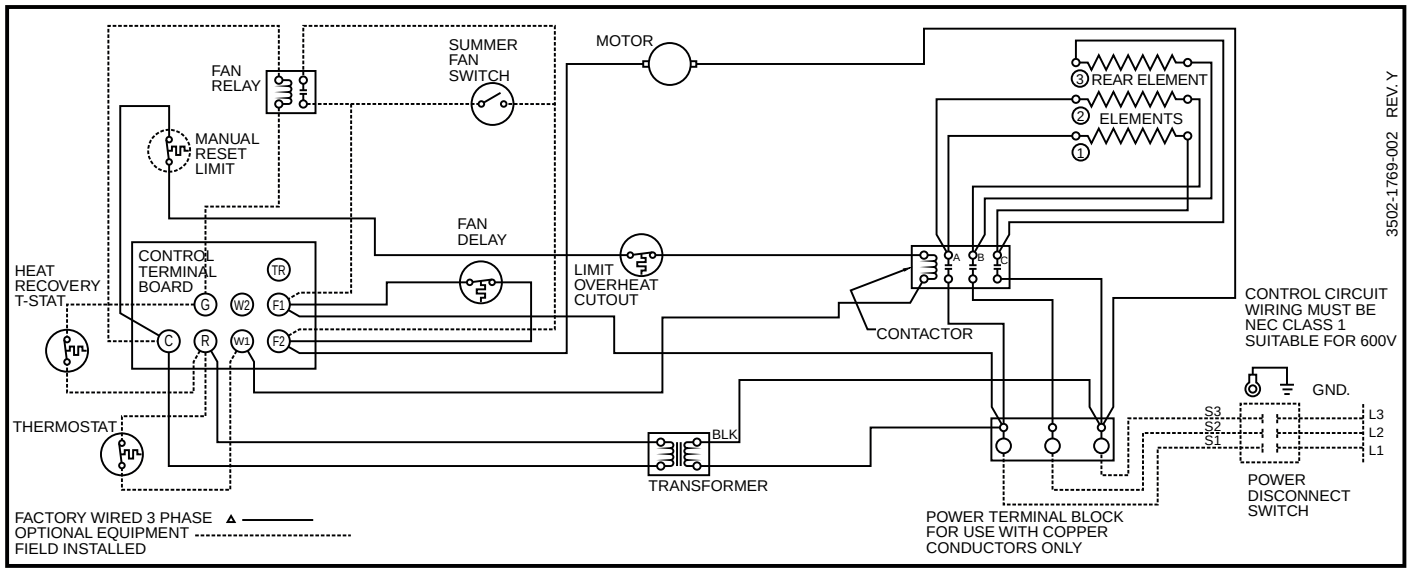
Wiring Diagrams

Diagram 1



3 Element, Single and Three Phase (Models 2YU66 and 2YU69)

Diagram 2



3 Element, Three Phase (Models 2YU59, 2YU63, 2YU67 and 2YU70)

Dayton® Heavy-Duty Electric Unit Heaters

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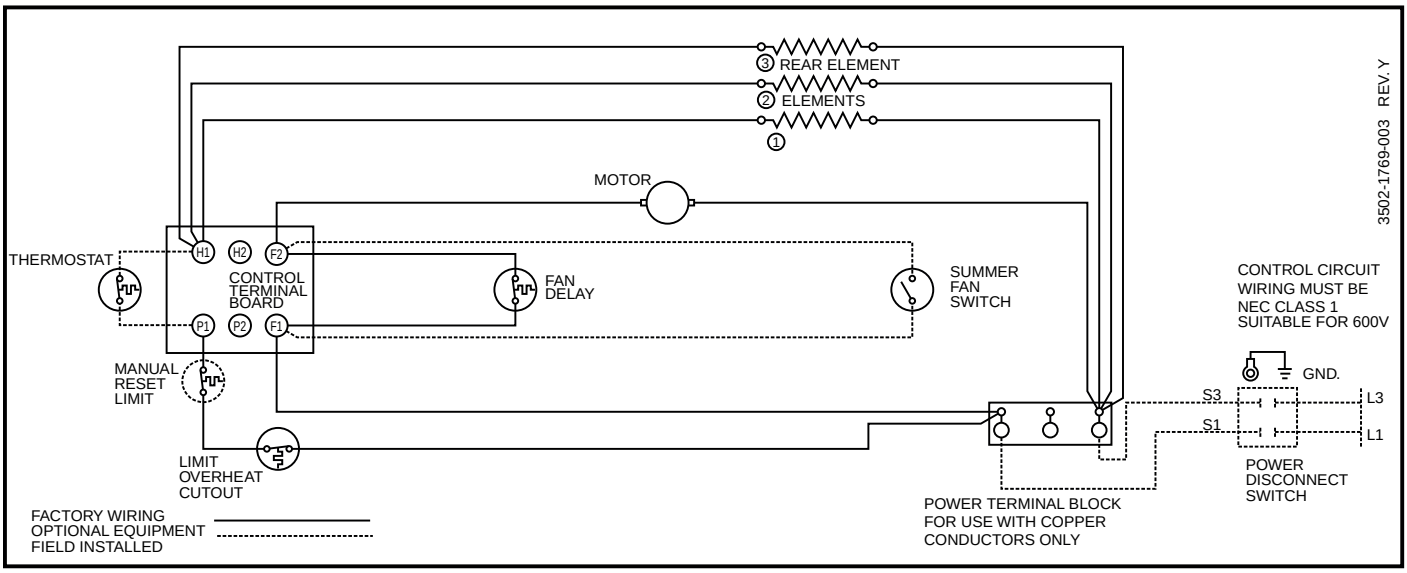
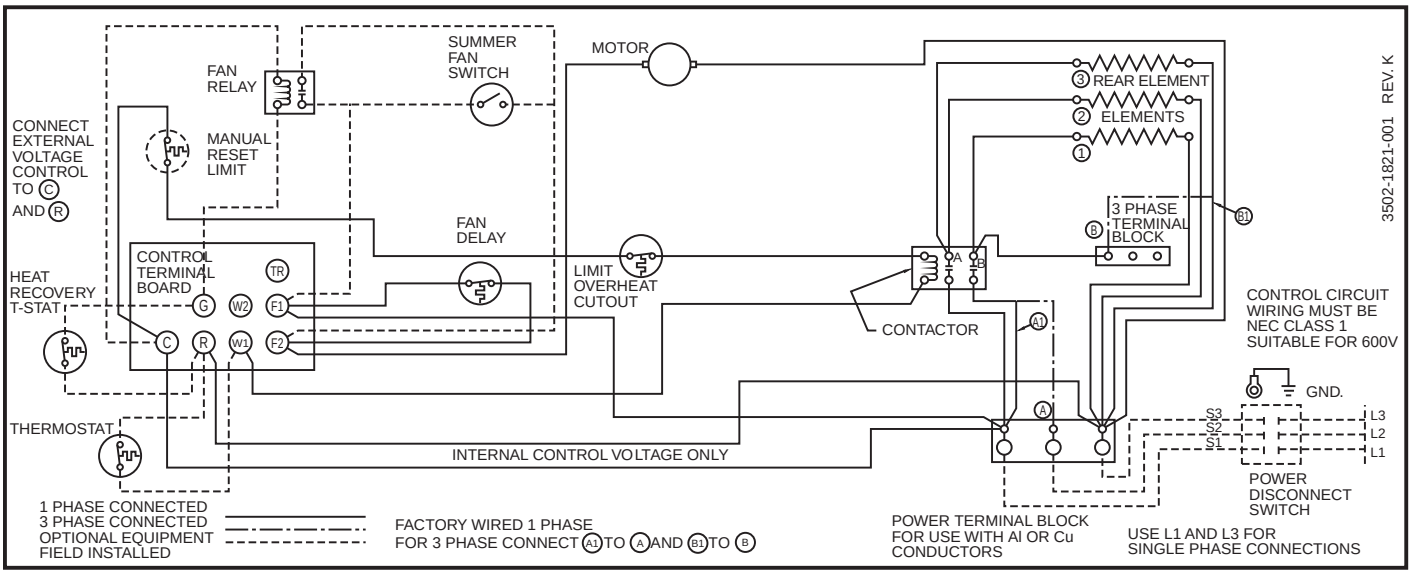
Wiring Diagrams (Continued)

Diagram 3



3 Element, Single Phase (Models 2YU58, 2YU60, 2YU61 and 2YU64)

Diagram 4

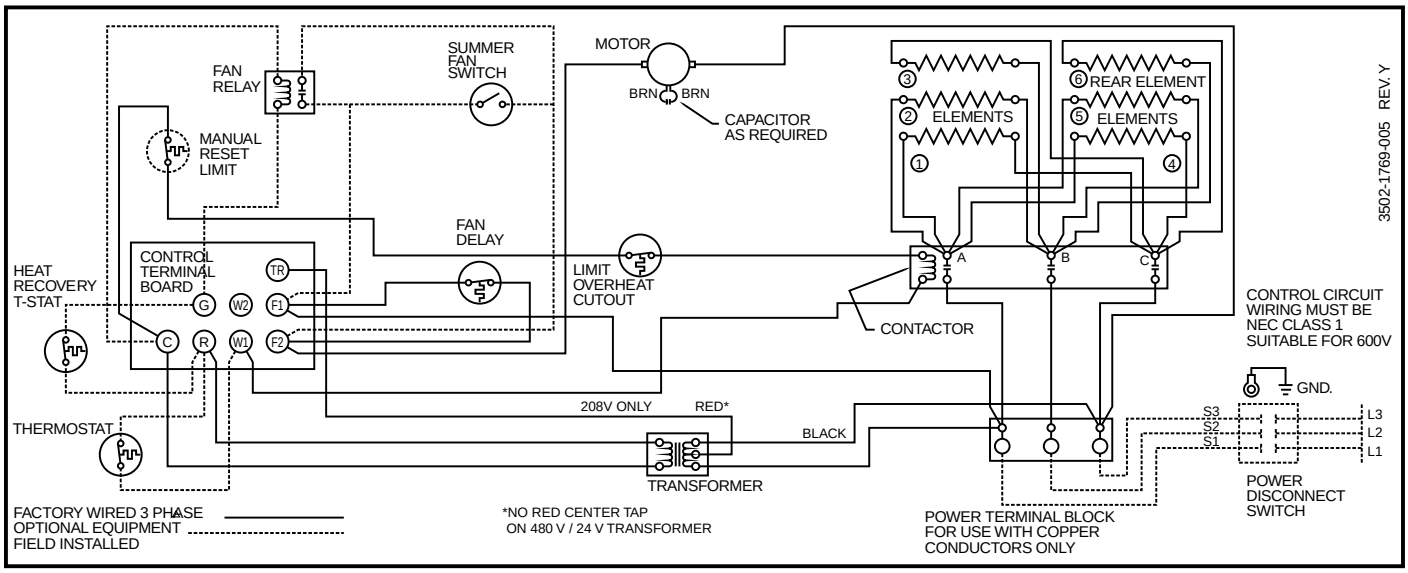


3 Element, Single and Three Phase (Models 2YU62 and 2YU65)

Models 2YU58 thru 2YU81, 3END3 and 3END4

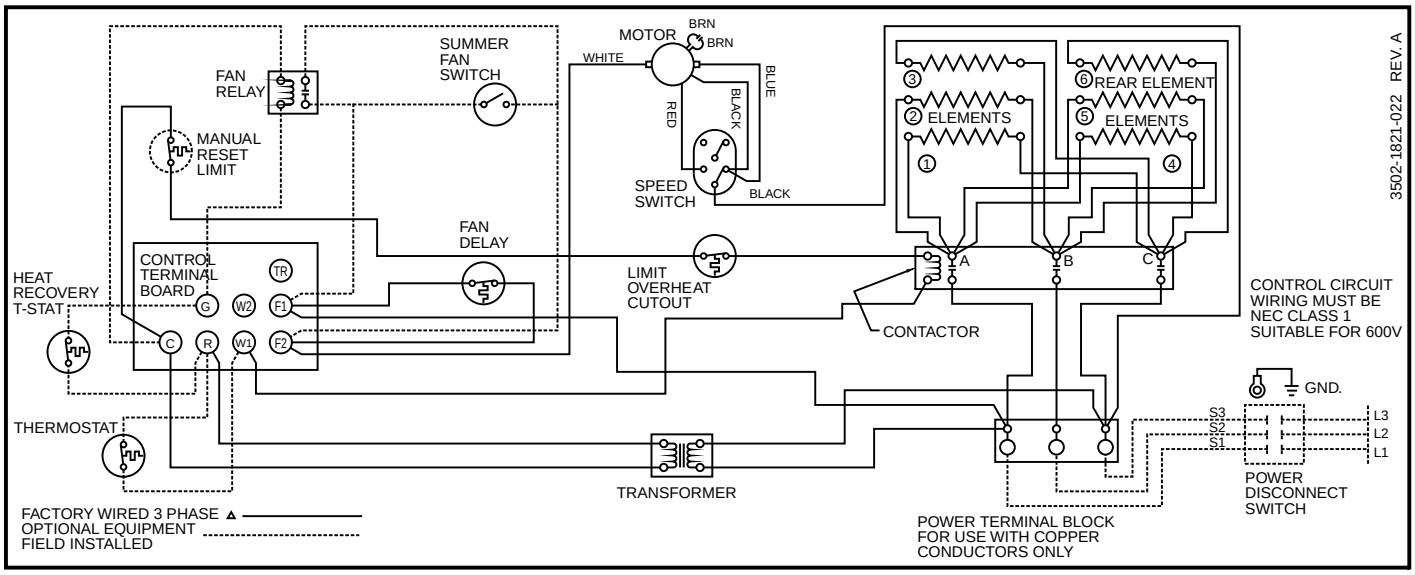
Wiring Diagrams (Continued)

Diagram 5



6 Element, Three Phase (Models 2YU72, 2YU73, 2YU75 and 2YU76)

Diagram 6



6 Element, Three Phase (Model 3END3 and 2YU78)

Dayton® Heavy-Duty Electric Unit Heaters

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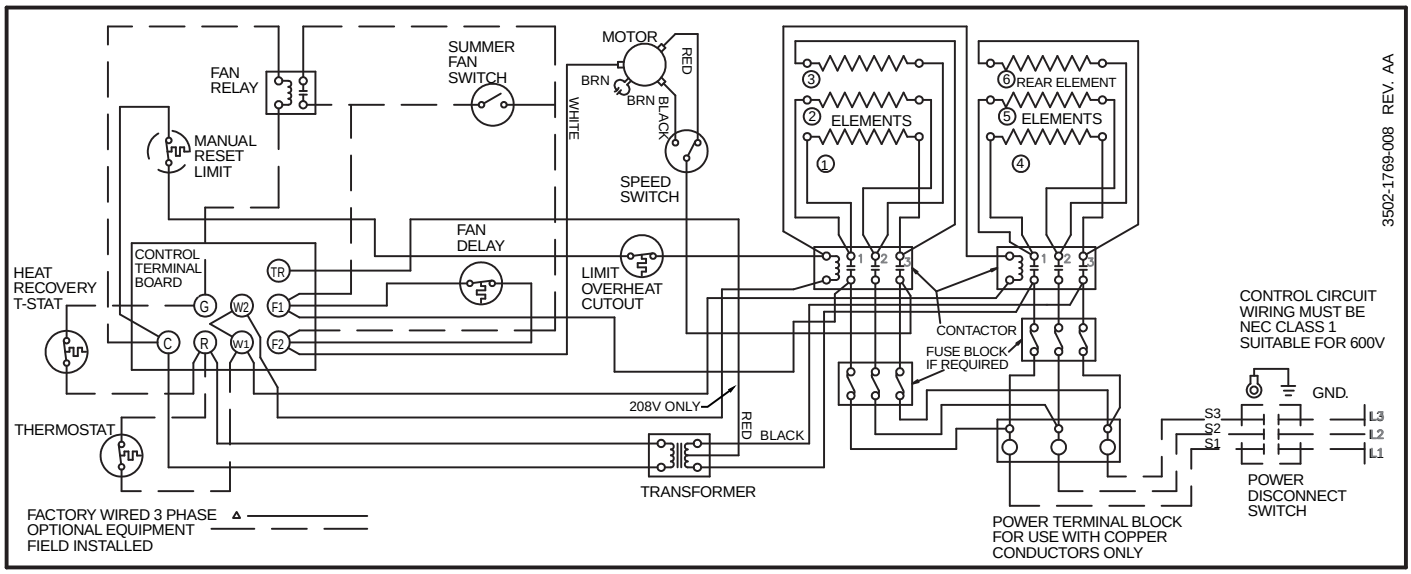
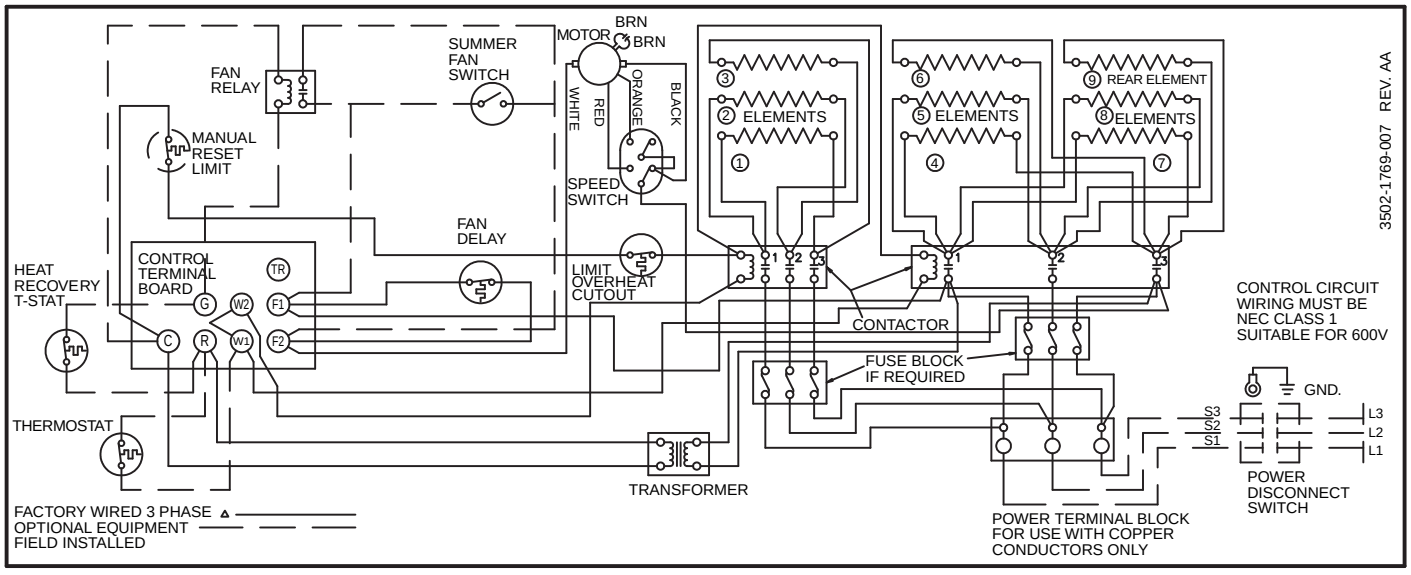
Wiring Diagrams (Continued)

Diagram 7



6 Element, 2 Contactor, Three Phase (Model 2YU77)

Diagram 8

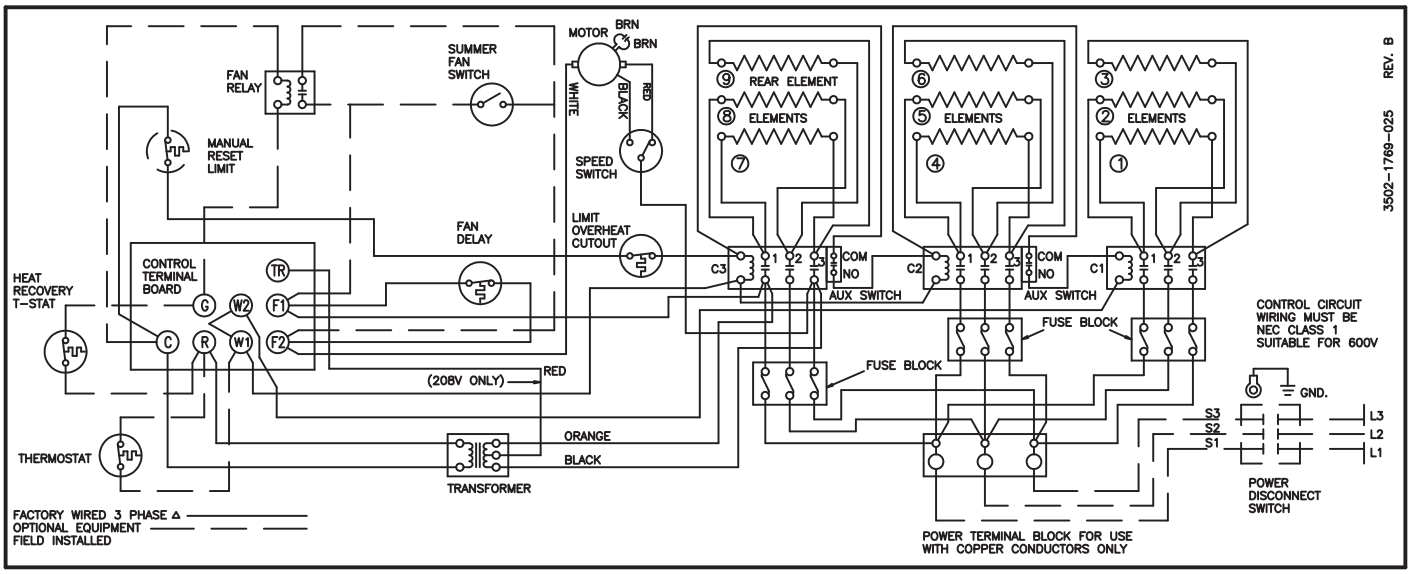


9 Element, 2 Contactor, Three Phase (Model 3END4 and 2YU81)

Models 2YU58 thru 2YU81, 3END3 and 3END4

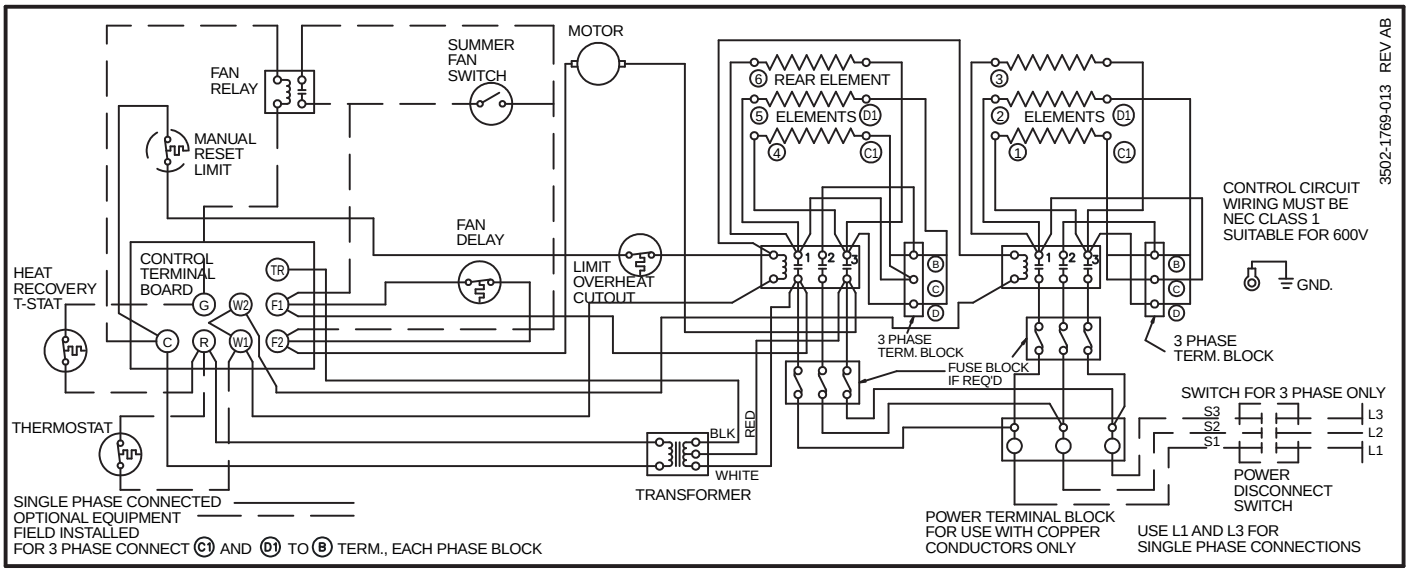
Wiring Diagrams (Continued)

Diagram 9



9 Element, 3 Contactor, Three Phase (Model 2YU80)

Diagram 10



6 Element, 2 Contactor, Single and Three Phase (Model 2YU74)

Dayton® Heavy-Duty Electric Unit Heaters

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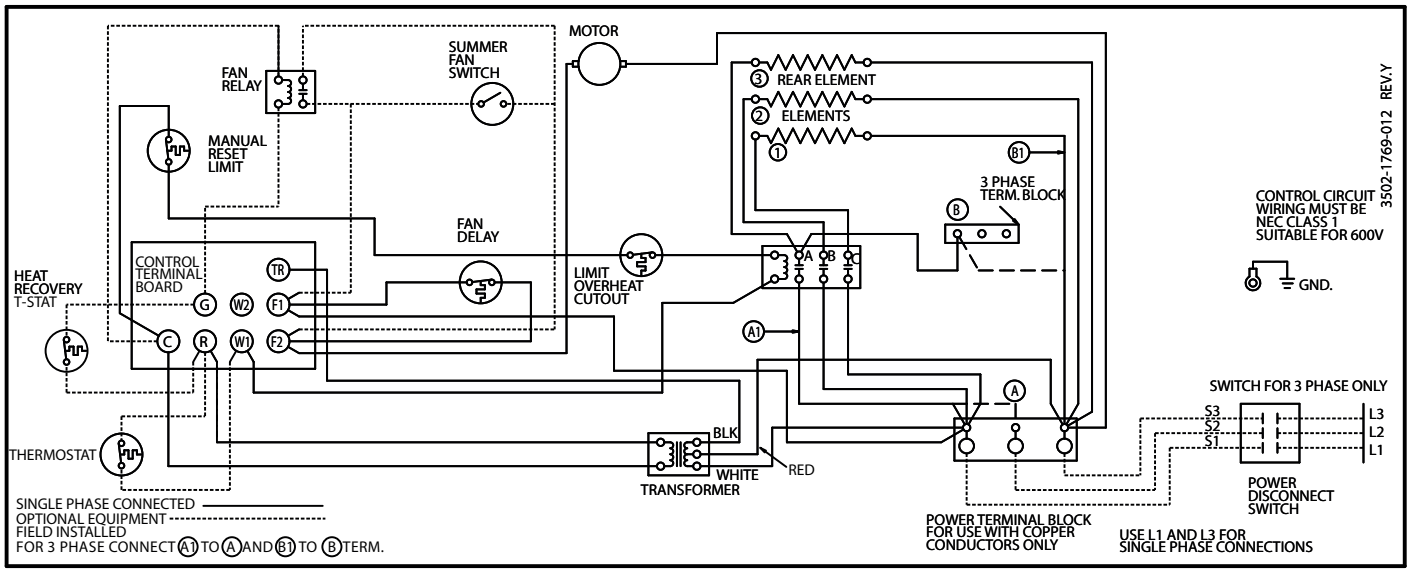
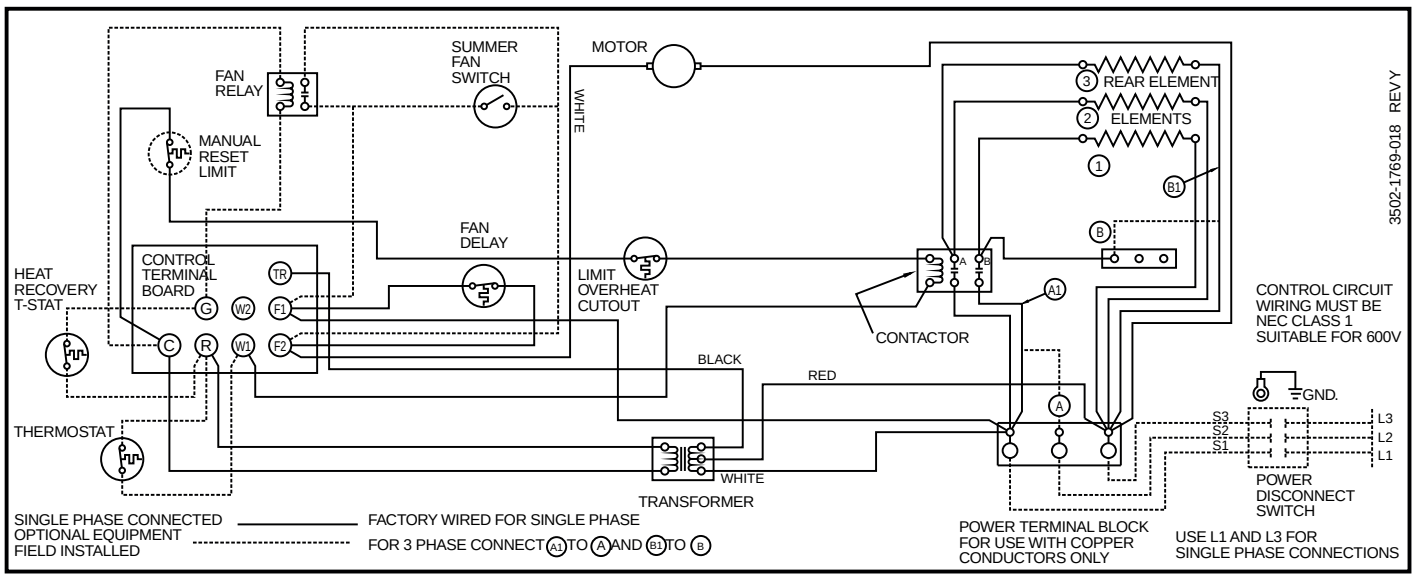
Wiring Diagrams (Continued)

Diagram 11



3 Element, Single and Three Phase (Model 2YU71)

Diagram 12

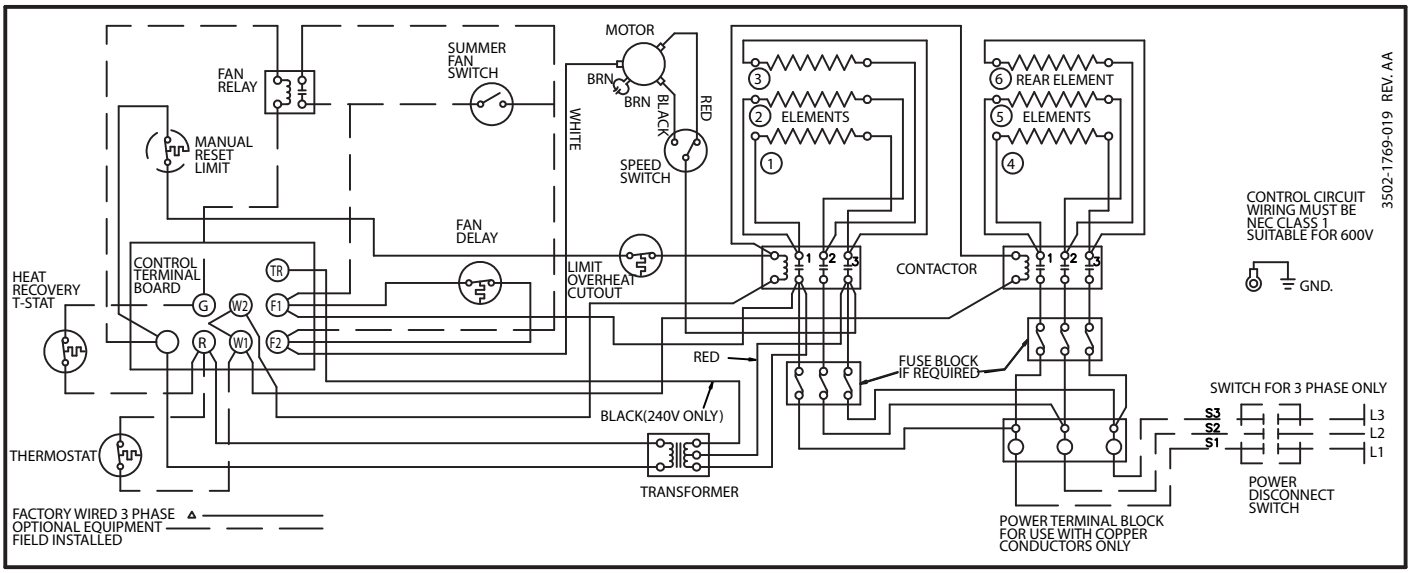


3 Element, Single and Three Phase (Model 2YU68)

Models 2YU58 thru 2YU81, 3END3 and 3END4

Wiring Diagrams (Continued)

Diagram 13



6 Element, 2 Contactor, Three Phase (Model 2YU79)

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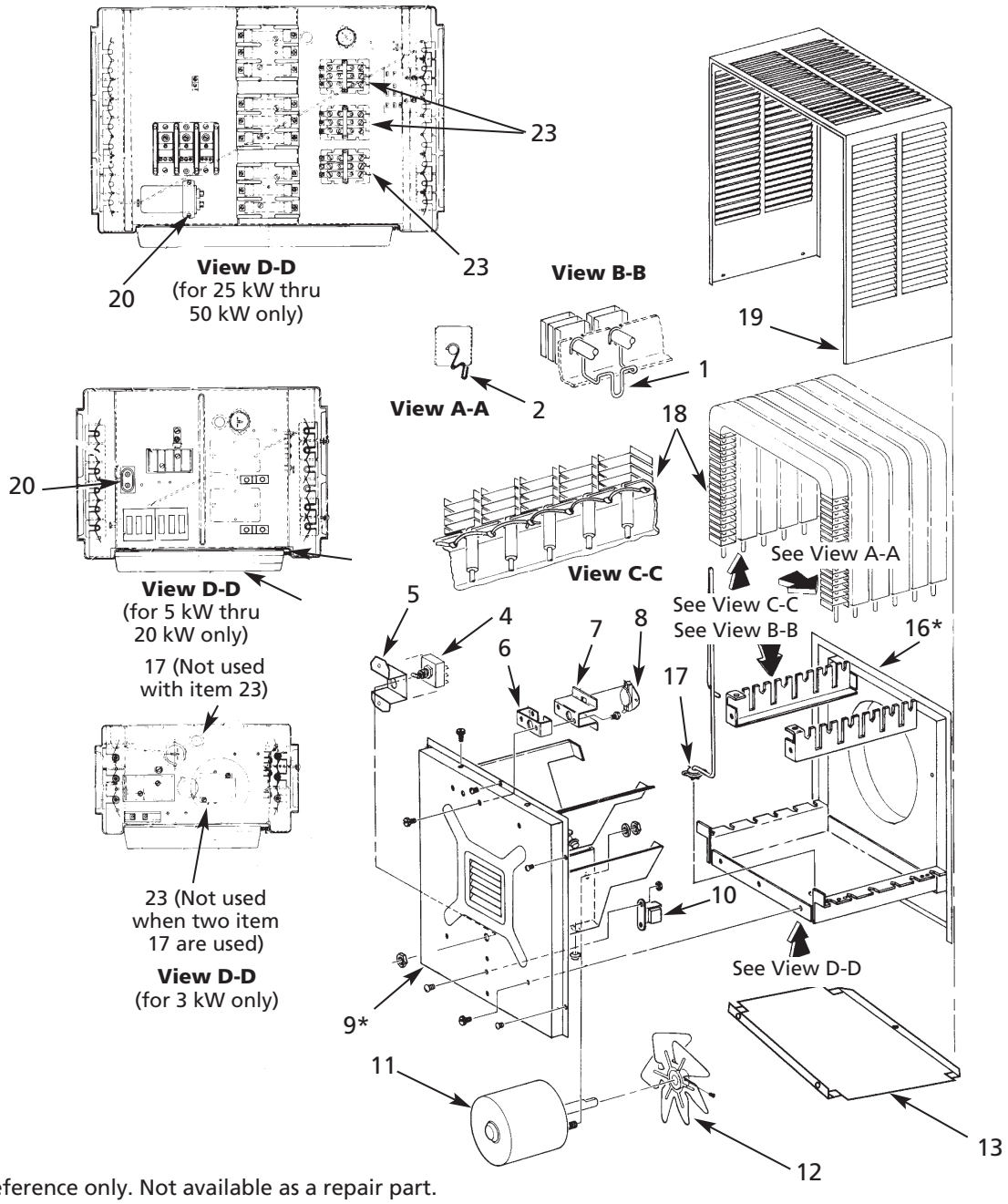
For Repair Parts, call 1-800-Grainger

24 hours a day – 365 days a year

Please provide following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list



(*) Reference only. Not available as a repair part.

Figure 7 – Repair Parts Illustration for Heavy-Duty Electric Unit Heaters

Models 2YU58 thru 2YU81, 3END3 and 3END4

Repair Parts List for Heavy-Duty Electric Unit Heaters

Model	Ref. 1 Element Spring	Ref. 2 Capillary Tube Spring	Ref. 3 Element Retainer Spring	Ref. 4 Switch	Ref. 5 Mounting Bracket	Ref. 6 Bracket Extension	Ref. 7 Switch Bracket	Ref. 8 Fan Delay
2YU58	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU59	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU60	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU61	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU62	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU63	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU64	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU65	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU66	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	—	4520 0010 000
2YU67	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000
2YU68	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000
2YU69	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000
2YU70	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000
2YU71	5208 0073 000	5208 0072 000	5208 0074 000	—	—	—	1215 0256 000	4520 0010 000
2YU72	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000
2YU73	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000
2YU74	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000
2YU75	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000
2YU76	5208 0073 000	5208 0072 000	5208 0074 000	—	—	1215 0282 000	1215 0256 000	4520 0010 000
2YU77	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000
3END3	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000
2YU78	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000
2YU79	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	—	1215 0256 000	4520 0010 000
3END4	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000
2YU80	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000
2YU81	5208 0073 001	5208 0072 000	5208 0074 000	5216 2053 000	1215 2258 000	1215 0282 000	1215 0256 000	4520 0010 000

Model	Ref. 10 Transformer	Ref. 11 Motor	Ref. 12 Fan Blade	Ref. 13 Cover	Ref. 17 Linear Limit Protector	Ref. 18 Element Assy.	Ref. 19 Element Guard	Ref. 20 Clamp
2YU58	—	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 000	1402 2163 001	—
2YU59	5814 0003 002	3900 2005 000	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 002	1402 2163 001	—
2YU60	—	3900 2002 007	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 001	1402 2163 001	—
2YU61	—	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 024	1402 2163 001	—
2YU62	—	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 003	1402 2163 001	—
2YU63	5814 0003 002	3900 2005 000	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 005	1402 2163 001	—
2YU64	—	3900 2002 007	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 004	1402 2163 001	—
2YU65	—	3900 2002 006	1210 2000 000	1402 2166 001	4520 0011 000	1802 0087 025	1402 2163 001	—
2YU66	5814 0003 000	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 006	1402 2164 002	—
2YU67	5814 0003 002	3900 0347 005	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 008	1402 2164 002	—
2YU68	5814 0003 000	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 031	1402 2164 002	—
2YU69	5814 0003 000	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 031	1402 2164 002	—
2YU70	5814 0003 002	3900 0347 005	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 011	1402 2164 002	—
2YU71	5814 0003 000	3900 2014 004	1210 0090 000	1402 2167 002	4520 0011 001	1802 0087 036	1402 2164 002	—
2YU72	5814 0003 000	3900 0361 000	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 012	1402 2164 003	—
2YU73	5814 0003 002	3900 0361 001	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 013	1402 2164 003	—
2YU74	5814 0003 000	3900 0361 000	1210 0090 001	1402 2167 003	4520 0011 001	1802 0087 037	1402 2164 003	—
2YU75	5814 0003 000	3900 0362 000	1210 0096 000	1402 2167 003	4520 0011 001	1802 0087 037	1402 2164 003	1417 5004 000
2YU76	5814 0003 002	3900 0362 001	1210 0096 000	1402 2167 003	4520 0011 001	1802 0087 015	1402 2164 003	1417 5004 000
2YU77	5814 0003 000	3900 0364 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 018	1402 2165 002	1417 5004 000
3END3	5814 0003 002	3900 2065 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 017	1402 2165 002	1417 5004 000
2YU78	5814 0003 002	3900 2065 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 019	1402 2165 002	1417 5004 000
2YU79	5814 0003 000	3900 0364 000	1210 0098 000	1402 2168 002	4520 0011 002	1802 0087 028	1402 2165 002	1417 5004 000
3END4	5814 0003 002	3900 0350 001	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 021	1402 2165 003	1417 5004 000
2YU80	5814 2021 001	3900 0350 000	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 022	1402 2165 003	1417 5004 000
2YU81	5814 0003 002	3900 0350 001	1210 0097 000	1402 2168 003	4520 0011 002	1802 0087 023	1402 2165 003	1417 5004 000

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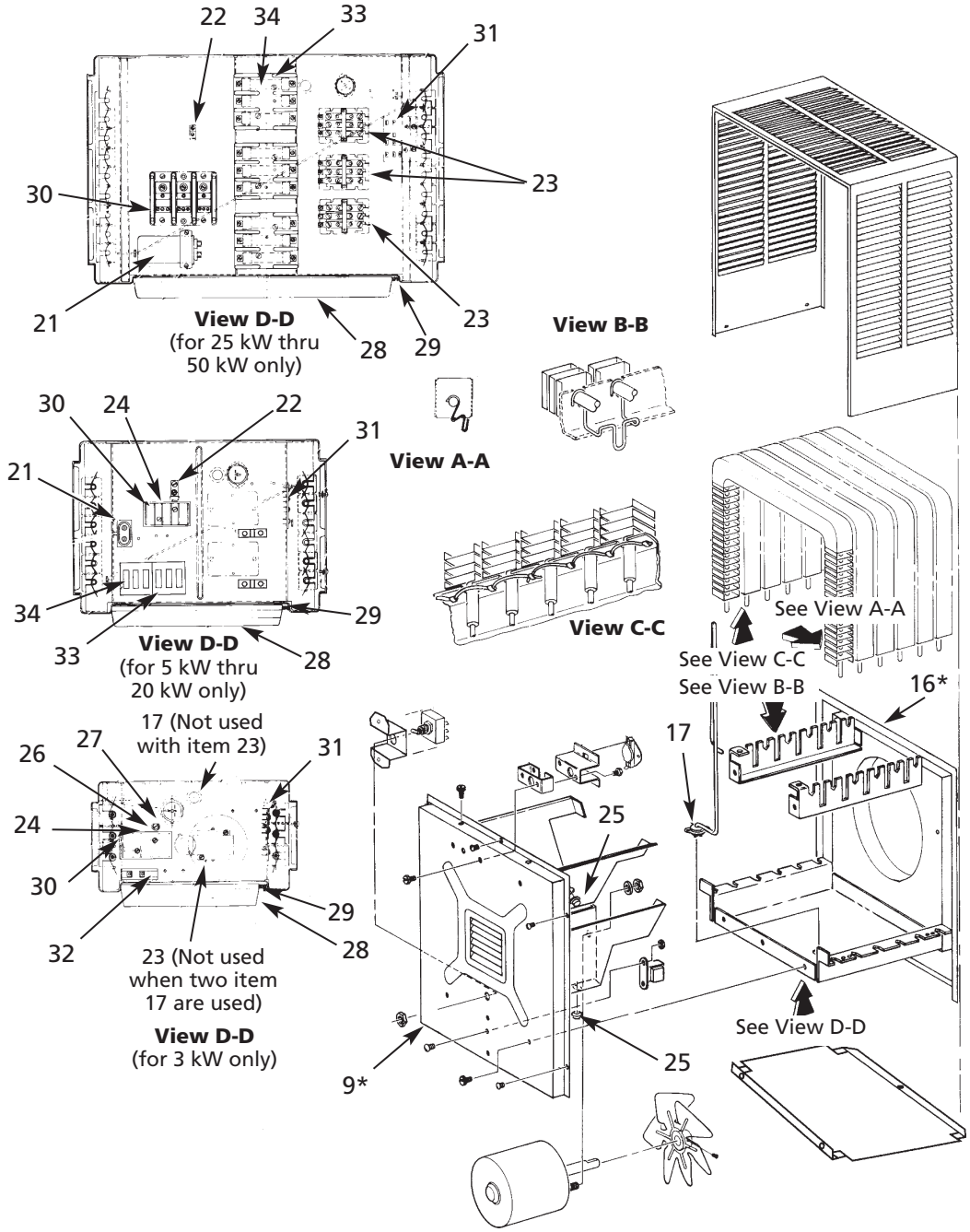
Please provide following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list



(*) Reference only. Not available as a repair part.

Figure 7 – Repair Parts Illustration for Heavy-Duty Electric Unit Heaters (Continued)

Models 2YU58 thru 2YU81, 3END3 and 3END4

Repair Parts List for Heavy-Duty Electric Unit Heaters (Continued)

Model	Ref. 21 Capacitor	Ref. 22 Ground Lug	Ref. 23 Relay-Contactor	Ref. 24 Insulator	Ref. 25 Bushing	Ref. 26 Ground Washer	Ref. 27 Ground Screw
2YU58	—	—	—	—	—	6401 0084 000	5202 0290 002
2YU59	—	—	5018 0004 100	2900 0030 000	—	6401 0084 000	5202 0290 002
2YU60	—	—	—	2900 0030 000	—	6401 0084 000	5202 0290 002
2YU61	—	—	—	—	—	6401 0084 000	5202 0290 002
2YU62	—	—	5018 0003 002	—	—	6401 0084 000	5202 0290 002
2YU63	—	—	5018 0004 100	2900 0030 000	—	6401 0084 000	5202 0290 002
2YU64	—	—	—	2900 0030 000	—	6401 0084 000	5202 0290 002
2YU65	—	—	5018 0003 002	—	—	6401 0084 000	5202 0290 002
2YU66	—	3504 7002 001	5018 0003 000	—	—	—	—
2YU67	—	3504 7002 001	5018 0004 100	2900 0030 000	—	—	—
2YU68	—	3504 7002 001	5018 0003 000	—	—	—	—
2YU69	—	3504 7002 001	5018 0003 000	—	—	—	—
2YU70	—	3504 7002 001	5018 0004 100	2900 0030 000	—	—	—
2YU71	—	3504 7002 001	5018 0004 100	—	—	—	—
2YU72	—	3504 7002 001	5018 0005 004	—	—	—	—
2YU73	—	3504 7002 001	5018 0004 100	2900 0030 000	—	—	—
2YU74	—	3504 7002 001	5018 0005 004	—	—	—	—
2YU75	1432 0002 003	3504 7002 001	5018 0006 000	—	—	—	—
2YU76	1432 0002 003	3504 7002 001	5018 0004 100	2900 0030 000	—	—	—
2YU77	1432 0002 003	3504 7002 001	5018 0005 004	—	25221-60131	—	—
3END3	1432 0002 001	3504 7002 001	5018 0005 004	2900 0030 000	25221-60131	—	—
2YU78	1432 0002 001	3504 7002 001	5018 0005 004	2900 0030 000	25221-60131	—	—
2YU79	1432 0002 001	3504 7002 001	5018 0006 000	—	25221-60131	—	—
3END4	1432 0002 004	3504 7002 001	5018 0005 004	2900 0030 000	25221-60131	—	—
2YU80	1432 0002 004	3504 7002 001	5018 0005 004	—	25221-60131	—	—
2YU81	1432 0002 004	3504 7002 001	*	2900 0030 000	25221-60131	—	—

Model	Ref. 28 Louver	Ref. 29 Spring Louver	Ref. 30 Terminal Block, Power	Ref. 31 Terminal Block, Control	Ref. 32 Terminal Block 3 Phase	Ref. 33 Fuse Block	Ref. 34 Fuse
2YU58	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000	—	—	—
2YU59	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU60	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000	—	—	—
2YU61	3503 2004 003	5208 7005 001	5823 0004 000	5823 0001 000	—	—	—
2YU62	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU63	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU64	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU65	3503 2004 003	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU66	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU67	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU68	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU69	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU70	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU71	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	5823 0003 000	—	—
2YU72	3503 2004 004	5208 7005 001	5823 0004 001	5823 0002 000	—	—	—
2YU73	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU74	3503 2004 004	5208 7005 001	5823 0004 003	5823 0002 000	5823 0003 000	2025 0002 000	2019 0007 010
2YU75	3503 2004 004	5208 7005 001	5823 0004 002	5823 0002 000	—	—	—
2YU76	3503 2004 004	5208 7005 001	5823 0004 000	5823 0002 000	—	—	—
2YU77	3503 2004 005	5208 7005 001	5823 0004 003	5823 0002 000	—	2025 7002 000	2019 7008 079
3END3	3503 2004 005	5208 7005 001	5823 0004 001	5823 0002 000	—	—	—
2YU78	3503 2004 005	5208 7005 001	5823 0004 001	5823 0002 000	—	—	—
2YU79	3503 2004 005	5208 7005 001	5823 0005 000	5823 0002 000	—	2025 7002 000	2019 7008 080
3END4	3503 2004 005	5208 7005 001	5823 0004 002	5823 0002 000	—	—	—
2YU80	3503 2004 005	5208 7005 001	5823 0005 000	5823 0002 000	—	2025 7002 000	2019 7008 080
2YU81	3503 2004 005	5208 7005 001	5823 0004 002	5823 0002 000	—	—	—

(*) Two relays are used: 35A relay, P/N 5018 0004 100, and 50A relay, P/N 5018 0006 000.

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For Repair Parts, call 1-800-Grainger

24 hours a day – 365 days a year

Please provide following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

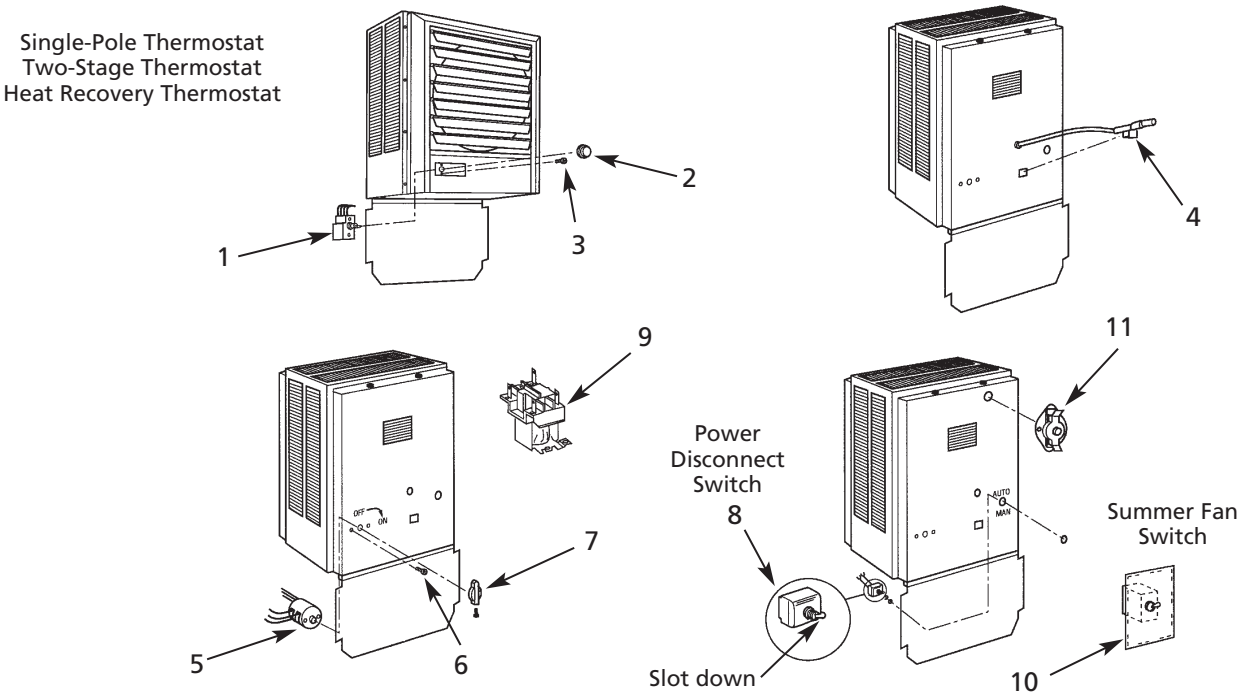

Figure 8 – Repair Parts Illustration for Heavy-Duty Electric Unit Heaters

Repair Parts List for Heavy-Duty Electric Unit Heaters

Reference Number	Description	Part Number	Quantity
1	One Pole Thermostat	5813 0036 000	1
1	Two Stage Thermostat	5813 0035 000	1
2	Thermostat Knob	3301 2020 0051	1
3	Screws	5202 7009 021	2
4	Thermostat Clip	1403 0041 000	1
5	25A, OEM Switch	5216 0132 000	1
5	25A, K & N Switch	5216 0204 000	1
5	63A, OEM Switch	5216 0131 000	1
5	63A, K & N Switch	5216 0200 000	1
6	Screw, M4 x 10, Rd. Hd. (25A)	*	1
6	Screw, 63A, M5 x 16, Rd. Hd.	*	1
7	Knob, 25A, OEM “T1”	OEM “T1”	1
7	Knob, 25A, K & N	K & N S1B 6001	1
7	Knob, 63A, OEM	OEM “S4”	1
7	Knob, 63A, K & N	K & N S2B G001	1
8	Switch, Toggle, 600V	5216 2011 000	1
9	Relay, Fan 24V Coil	5018 0008 000	1
10	Switch Assembly	5216 0199 000	1
11	Manual Reset Limit	4520 0012 000	1

(*) Included with item 7.

Models 2YU58 thru 2YU81, 3END3 and 3END4

Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Thermostat calls for heat, but heater does not function	1. Open (blown) fuse	1. Replace fuses, check for cause (See Repair Parts List for fuse size)
	2. Incorrect wiring	2. Check wiring connections
	3. Thermal cut-out open, de-energizing heater element and control circuit	3. Check for the following: Correct supply volts & phase. Correct control wiring (heater control must be thru thermostat control wiring section only). Power interruption to heater during heater operation Restriction of air around heater 1-5 minute fan purge after thermostat off
Fan motor runs "hot"	1. Dust accumulation or excessive dirt on fan motor	1. Clean fan motor and casing of grease and oil accumulation
	2. Dirt accumulation	2. Clean louvers and between heating elements
	3. Motor needs lubrication	3. See Maintenance
Fan motor runs, but no heat	1. Element contact not operating correctly	1. Check wiring for open circuit. Replace contactor if defective
	2. Element fuse blown	2. Replace fuses, check for cause

Notes

Notes

Dayton® Heavy-Duty Electric Unit Heaters

ENGLISH

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. *DAYTON® HEAVY-DUTY ELECTRIC UNIT HEATERS, MODELS COVERED IN THIS MANUAL, ARE WARRANTED BY DAYTON ELECTRIC MFG. CO. (DAYTON) TO THE ORIGINAL USER AGAINST DEFECTS IN WORKMANSHIP OR MATERIALS UNDER NORMAL USE FOR ONE YEAR AFTER DATE OF PURCHASE. ANY PART WHICH IS DETERMINED TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP AND RETURNED TO AN AUTHORIZED SERVICE LOCATION, AS DAYTON DESIGNATES, SHIPPING COSTS PREPAID, WILL BE, AS THE EXCLUSIVE REMEDY, REPAIRED OR REPLACED AT DAYTON'S OPTION. FOR LIMITED WARRANTY CLAIM PROCEDURES, SEE "PROMPT DISPOSITION" BELOW. THIS LIMITED WARRANTY GIVES PURCHASERS SPECIFIC LEGAL RIGHTS WHICH VARY FROM JURISDICTION TO JURISDICTION.*

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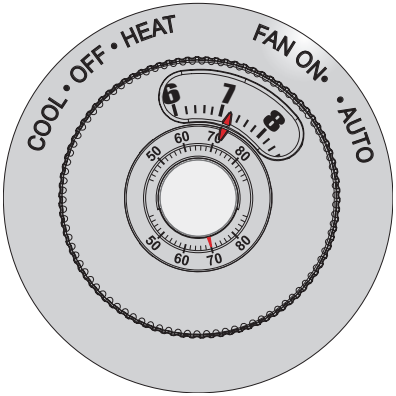
Manufactured for Dayton Electric Mfg. Co., 100 Grainger Parkway, Lake Forest, Illinois 60045-5201 U.S.A.

Manufactured for Dayton Electric Mfg. Co.
Lake Forest, Illinois 60045 U.S.A.

Dayton®

Honeywell Home



Owner's Manual

English: Page 1

Mode d'emploi

Français: Page 6

Manual de Uso

Español: Página 11

Read before installing
T87N, T87N1026

T87N Easy-To-See™

The Round®

Pre-installation checklist

Check package contents:

- Thermostat
- Wall anchors & screws (2 each)
- Owner's Manual
- Large Print Subbase Switch Labels
- Coverplate

Before you begin, make sure you have:

- No. 2 Phillips & small pocket screwdrivers
- Hammer
- Level (optional)
- Pencil
- Drill and bit (3/16" for drywall, 7/32" for plaster)

Must be installed by a trained, experienced technician

Read these instructions carefully. Failure to follow these instructions can damage the product or cause a hazardous condition.

CAUTION: ELECTRICAL HAZARD
Can cause electrical shock or equipment damage. Disconnect power before beginning installation.

MERCURY NOTICE
If this product is replacing a control that contains mercury in a sealed tube, do not place the old control in the trash. Contact your local waste management authority for instructions regarding recycling and proper disposal.

This thermostat contains a Lithium battery which may contain Perchlorate material.
Perchlorate Material—special handling may apply,
See www.dtsc.ca.gov/hazardouswaste/perchlorate

Product application

This thermostat provides electronic control of 24 VAC single-stage heating and cooling systems.

System Types

- Gas, oil, or electric heat with air conditioning
- Warm air, hot water, high-efficiency furnaces, heat pumps, steam, gravity
- Heat only
- Heat only with fan
- Cool only

System Settings

- Heat, Off, Cool

Fan Settings

- Auto, On

Specifications

Temperature Range

- 40° to 90°F (4.5° to 32°C)

Shipping Temperature

- -20° to 120°F (-28.9° to 48.9°C)

Operating Relative Humidity

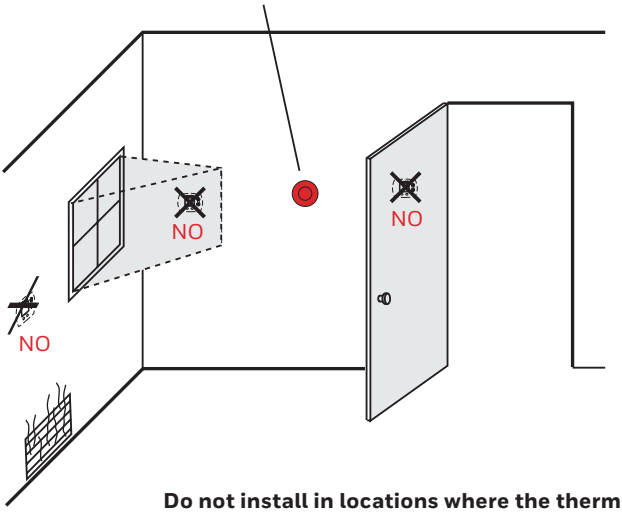
- 5% to 90% (non-condensing)

Electrical Ratings

- Voltage: 20–30 VAC
- Running current: 0.02–1.0 A, 50/60 Hz

Installation tips

Install the thermostat about 5 feet (1.5 m) above the floor in an area with good air circulation at average temperature.

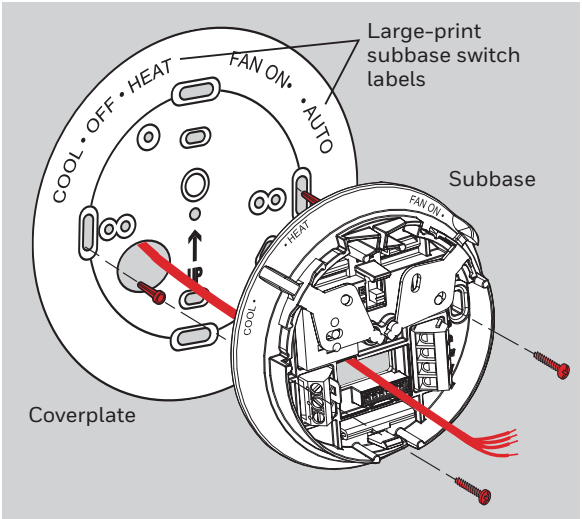


Do not install in locations where the thermostat can be affected by:

- Drafts or dead spots behind doors and in corners
- Hot or cold air from ducts
- Sunlight or radiant heat from appliances
- Concealed pipes or chimneys
- Unheated/uncooled areas such as an outside wall behind the thermostat

Subbase and base installation

1. Pull wires through wire hole. Position coverplate on wall, level and mark hole positions.
2. Drill holes (3/16” for drywall, 7/32” for plaster) and tap in supplied wall anchors.
3. Pull wire through coverplate and subbase, position over anchors, then insert and tighten mounting screws. Check level if desired.
4. Apply the large-print labels to the coverplate, matching the labels on the subbase.



Wiring

1. Loosen screw terminals, insert wires into terminal block, then re-tighten screws.
2. Push excess wire back into the wall opening.
3. Plug the wall opening with nonflammable insulation to prevent drafts from affecting thermostat operation.

Terminal Designations

W Heat relay.

Y Compressor contactor.

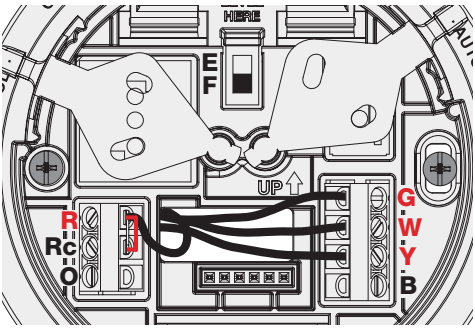
G Fan relay.

O Heat pump changeover valve energized in cooling.

Rc Cooling power. Connect to secondary side of cooling system transformer.

R Heating power. Connect to secondary side of heating system transformer.

B Heat pump changeover valve energized in heating.



NOTES

R & Rc terminals

In single-transformer system, leave metal jumper in place between **R** & **Rc**. Remove metal jumper if two-transformer system.

Heat pump systems

If wiring to a heat pump, use a small piece of wire (not supplied) to connect terminals **W** and **Y**.

Wire specifications

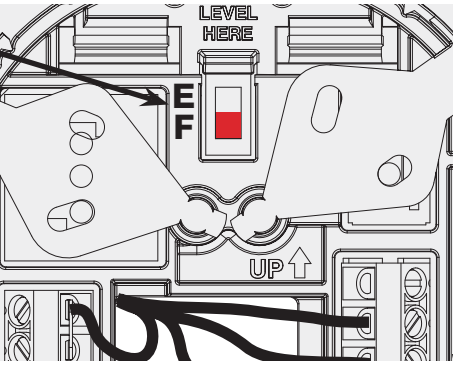
Use 18- to 22-gauge thermostat wire. Shielded cable is not required.

Fan operation settings

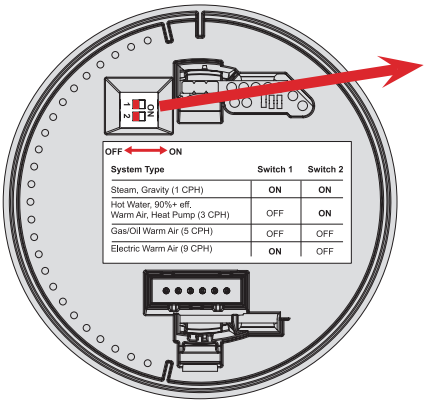
Fan operation settings:

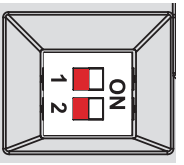
F: For gas or oil heating systems, leave the fan operation switch in this factory-set position (for systems that control the fan in a call for heat).

E: Change the switch to this setting for heat pump or electric heat systems. (This setting is for systems that allow the thermostat to control the fan in a call for heat, if a fan wire is connected to the G terminal.)



Cycle rate settings

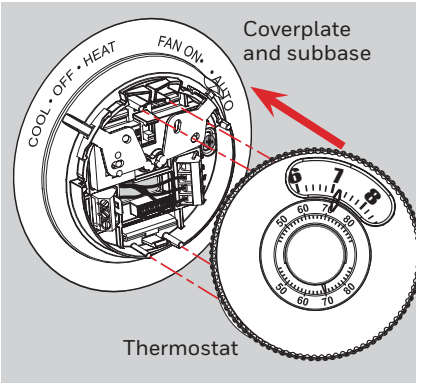




Move the cycle rate switches to the proper setting for your system (see table below).

Heating System	Switch 1	Switch 2
Steam or gravity (1 CPH)	On	On
High efficiency warm air (90%+), hot water, or heat pump (3 CPH)	Off	On
Gas or oil warm air (factory setting) (5 CPH)	Off	Off
Electric warm air (9 CPH)	On	Off

Thermostat mounting



Align the slots on the base with tabs on the thermostat, then push gently until the thermostat snaps into place.

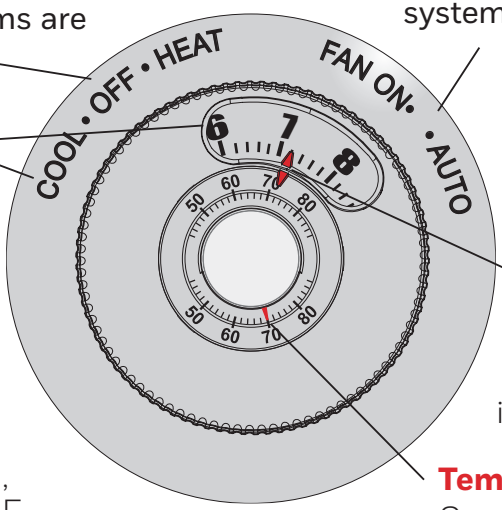
Operation

System switch

- **Cool:** Controls the cooling system.
- **Heat:** Controls the heating system.
- **Off:** All systems are off.

Fan switch

- **On:** Fan runs continuously.
- **Auto:** Fan runs only when heating or cooling system is on.



Markings

Enlarged, raised numbers indicate temperature range by touch or sight. The large 5, 6, 7 and 8 mean 50, 60, 70 and 80°F, respectively.

Temperature setting

Rotate to set, a click is heard every two degrees as the temperature is adjusted.

Temperature

Current indoor temperature.

CAUTION: EQUIPMENT DAMAGE HAZARD
Do not operate cooling system when outdoor temperature is below 50°F (10°C).

Limited 5-year warranty

Resideo warrants this product, excluding battery, to be free from defects in workmanship or materials, under normal use and service, for a period of five (5) years from the date of first purchase by the original purchaser. If at any time during the warranty period the product is determined to be defective due to workmanship or materials, Resideo shall repair or replace it (at Resideo's option).

If the product is defective,

(i) return it, with a bill of sale or other dated proof of purchase, to the place from which you purchased it; or

(ii) call Resideo Customer Care at 1-800-468-1502. Customer Care will make the determination whether the product should be returned to the following address: Resideo Return Goods, 1985 Douglas Dr. N., Golden Valley, MN 55422, or whether a replacement product can be sent to you.

This warranty does not cover removal or reinstallation costs. This warranty shall not apply if it is shown by Resideo that the defect was caused by damage which occurred while the product was in the possession of a consumer.

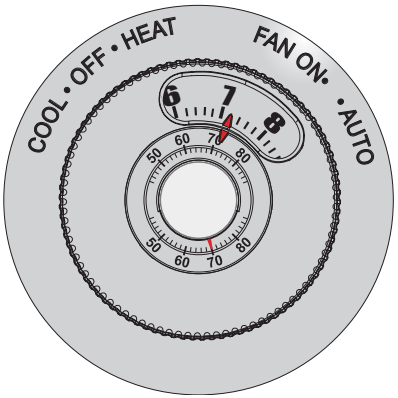
Resideo's sole responsibility shall be to repair or replace the product within the terms stated above. RESIDEO SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE OF ANY KIND, INCLUDING ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING, DIRECTLY OR INDIRECTLY, FROM ANY BREACH OF ANY WARRANTY, EXPRESS OR IMPLIED, OR ANY OTHER FAILURE OF THIS PRODUCT.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so this limitation may not apply to you.

THIS WARRANTY IS THE ONLY EXPRESS WARRANTY RESIDEO MAKES ON THIS PRODUCT. THE DURATION OF ANY IMPLIED WARRANTIES, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, IS HEREBY LIMITED TO THE FIVE YEAR DURATION OF THIS WARRANTY. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

This warranty gives you specific legal rights, and you may have other rights which vary from state to state. If you have any questions concerning this warranty, please write Resideo Customer Care, 1985 Douglas Dr, Golden Valley, MN 55422 or call 1-800-468-1502.

Honeywell Home



Owner's Manual

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Lire avant l'installation
T87N, T87N1026

T87N Easy-To-See™

The Round®

Liste de contrôle avant l'installation

Vérifier le contenu de l'emballage :

- Thermostat
- Chevilles et vis (2 chacun)
- Mode d'emploi
- Étiquettes à grands caractères pour plaque murale
- Plaque murale

Avant de commencer, s'assurer d'avoir à portée de la main :

- Petit tournevis de poche à pointe cruciforme n° 2
- Marteau
- Niveau (facultatif)
- Crayon
- Perceuse et mèche (3/16 po si le mur est en placoplâtre, et 7/32 po si le mur est en plâtre)

Doit être installé par un technicien d'expérience ayant reçu la formation pertinente.

Lire attentivement les instructions. Le fait de ne pas les suivre risque d'endommager le produit ou de constituer un danger.

MISE EN GARDE : RISQUE DE CHOC ÉLECTRIQUE
Peut provoquer des chocs électriques ou endommager le matériel. Couper l'alimentation électrique avant d'effectuer le raccordement.

AVIS SUR LE MERCURE
Si le nouveau thermostat remplace un ancien régulateur contenant un contact à mercure, ne pas mettre l'ancien régulateur aux poubelles. Communiquer avec le service local de cueillette des déchets pour obtenir de l'information sur le recyclage ou sur la bonne façon de disposer d'un ancien régulateur contenant un contact à mercure.

Ce thermostat contient une pile au lithium qui pourrait contenir du perchlorate.
Matériau contenant du perchlorate — des consignes de manipulation spéciales pourraient s'appliquer, prière de consulter www.dtsc.ca.gov/hazardouswaste/perchlorate

69-1840EFS-07

Utilisation du produit

Ce thermostat assure la régulation électronique de systèmes de chauffage et de refroidissement à un étage et à 24 V c.a.

Types de système

- Gaz, mazout ou chauffage électrique avec climatisation
- Air chaud, eau chaude, appareils de chauffage à haut rendement, thermopompes, vapeur et gravité
- Chauffage seulement
- Chauffage seulement (avec ventilateur)
- Refroidissement seulement

Réglages du système

- Heat-Off-Cool

Réglages du ventilateur

- Auto-On

Caractéristiques techniques

Gamme de température

- 4,5 à 32 °C (40 à 90 °F)

Température à l'expédition

- -28,9 à 48,9 °C (-20 à 120 °F)

Humidité relative de service

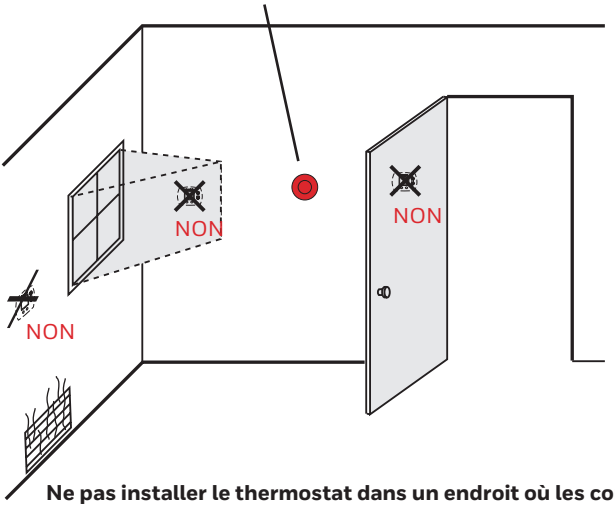
- 5 % à 90 % (sans condensation)

Caractéristiques électriques nominales

- Tension : 20–30 V c.a.
- Intensité de fonctionnement : 0,02–1,0 A, 50/60 Hz

Conseils d'installation

Installer le thermostat à environ 1,5 mètre (5 pieds) du sol dans un endroit où l'air circule bien et où la température est moyenne.

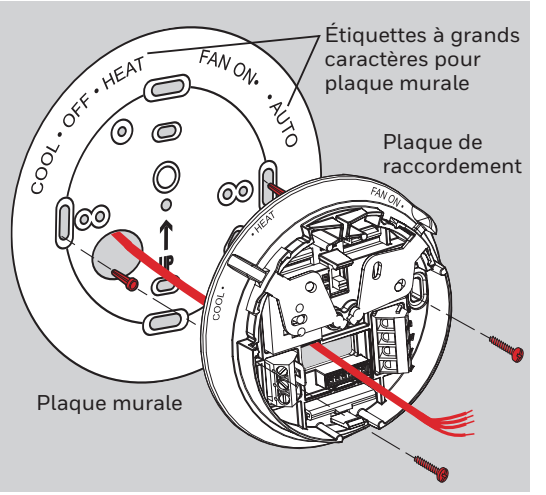


Ne pas installer le thermostat dans un endroit où les conditions suivantes peuvent nuire à son bon fonctionnement :

- Courants d'air ou zones sans circulation d'air derrière les portes et dans les coins
- Air chaud ou froid provenant des gaines
- Convection ou rayonnement du soleil ou d'un appareil électrique
- Tuyaux et cheminées dissimulés
- Endroits non chauffés (ou non refroidis), p. ex. mur extérieur à l'arrière du thermostat

Installation de la plaque murale et de la plaque de raccordement

1. Faire passer les fils par l'ouverture réservée aux fils. Placer la plaque murale sur le mur, la mettre au niveau et marquer au crayon l'emplacement des trous de vis.
2. Percer des ouvertures de 3/16 po s'il le mur est en placoplâtre, et des ouvertures de 7/32 po si le mur est en plâtre, puis insérer les chevilles d'ancrage fournies.
3. Faire passer les fils à travers la plaque murale et la plaque de raccordement, placer les deux plaques sur les chevilles, insérer puis resserrer les vis de fixation. Vérifier si l'installation est au niveau, au besoin.
4. Apposer les étiquettes à grands caractères sur la plaque murale en la faisant correspondre aux inscriptions de la plaque de raccordement.



Raccordement

1. Dévisser les bornes à vis, insérer les fils dans le bornier, puis resserrer les vis.
2. Repousser le fil en excès dans l'ouverture dans le mur.
3. Obstruer l'ouverture dans mur à l'aide d'isolant pour éviter qu'un courant d'air chaud ou froid ne nuise au fonctionnement du thermostat.

Désignations des bornes

W Relais de chauffage.

Y Contacteur du compresseur.

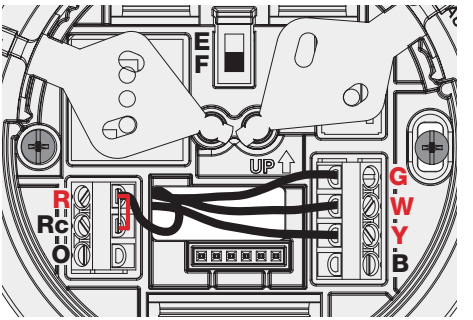
G Relais du ventilateur.

O Vanne d'inversion de la thermopompe déclenchée en mode de refroidissement.

Rc Alimentation électrique pour le refroidissement. Raccorder au côté secondaire du transformateur du système de refroidissement.

R Alimentation électrique pour le chauffage. Raccorder au côté secondaire du transformateur du système de chauffage.

B Vanne d'inversion de la thermopompe déclenchée en mode de chauffage.



REMARQUES

Bornes R et Rc

Dans un système à un seul transformateur, laisser le cavalier de métal en place entre les bornes **R** et **Rc**. Dans un système à deux transformateurs, retirer le cavalier de métal.

Thermopompes

Si le thermostat est raccordé à une thermopompe, utiliser un petit bout de fil (non fourni) pour raccorder les bornes **W** et **Y**.

Caractéristiques techniques des fils

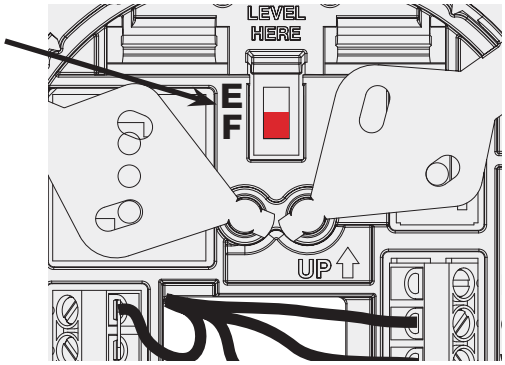
Utiliser du fil pour thermostat de calibre 18 à 22. Il n'est pas nécessaire d'utiliser du fil blindé.

Réglages du ventilateur

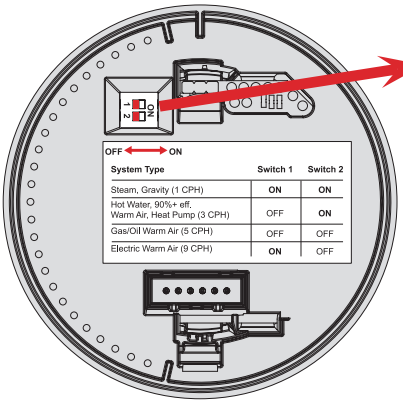
Réglages du ventilateur

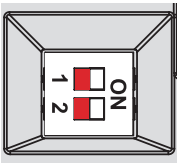
F : S'il s'agit d'un système de chauffage au gaz ou au mazout, laisser le commutateur à la position réglée en usine (pour les systèmes qui commandent la mise en marche du ventilateur lors d'une demande de chaleur).

E : Déplacer le commutateur à cette position si votre système est une thermopompe ou un appareil de chauffage électrique. (À cette position, le thermostat commande la mise en marche du ventilateur lors d'une demande de chaleur si un fil du ventilateur est raccordé à la borne G.)



Réglages du nombre de cycles

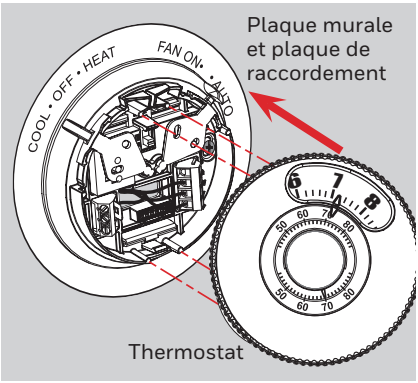




Déplacer les interrupteurs de réglage du nombre de cycles en fonction de votre système (consulter le tableau ci-dessous).

Système de chauffage	Interrupteur 1	Interrupteur 2
Vapeur ou gravité (1 CPH)	On	On
Système à air chaud à haut rendement (90 % d'efficacité et plus), eau chaude ou thermopompe (3 CPH)	Off	On
Air chaud au gaz ou au mazout (réglages de l'usine) (5 CPH)	Off	Off
Air chaud à l'électricité (9 CPH)	On	Off

Montage du thermostat



Placer les fentes du couvercle vis-à-vis les languettes du thermostat, puis pousser doucement jusqu'à ce que le thermostat s'emboîte sur la base.

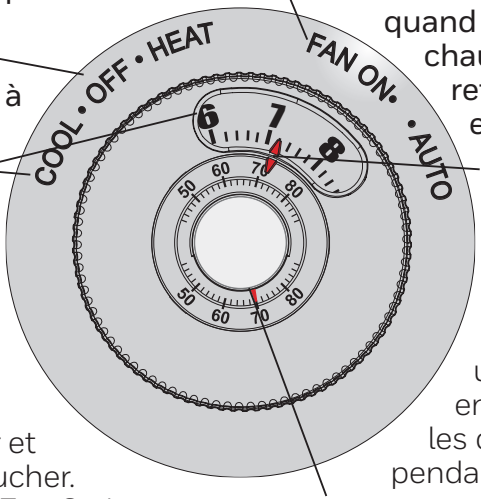
Fonctionnement

Sélecteur du système

- **Cool :** Commande le fonctionnement du système de refroidissement.
- **Heat :** Régule que le chauffage.
- **Off :** Tous les systèmes sont à l'arrêt.

Sélecteur du ventilateur

- **On :** Le ventilateur fonctionne sans interruption.
- **Auto :** Le ventilateur fonctionne seulement quand le système de chauffage ou de refroidissement est en marche.



Inscriptions

Des gros chiffres en surimpression indiquent la gamme de température à la vue et au toucher. Ils sont faciles à voir et on les sent au toucher. Les chiffres 5, 6, 7 et 8 plus gros signifient 50, 60, 70 et 80 °F, respectivement.

Réglage du point de consigne de température

Faites tourner le cadran; un clic se fait entendre à tous les deux degrés pendant le réglage.

La température

Température ambiante actuelle.

MISE EN GARDE : RISQUE DE DOMMAGE MATÉRIEL
Ne faites pas fonctionner le système de refroidissement lorsque la température extérieure est inférieure à 10 °C (50 °F).

Garantie limitée de 5 ans

Resideo garantit ce produit, à l'exception des piles, contre tout défaut de pièce ou de main-d'oeuvre, durant une période pour cinq (5) ans à partir de la date d'achat par le consommateur d'origine si le produit est utilisé et entretenu convenablement. En cas de défaillance ou de mauvais fonctionnement pendant la période de garantie, Resideo remplacera ou réparera le produit, à sa discrétion.

Si le produit est défectueux

(i) renvoyez-le avec la facture ou une autre preuve d'achat date au lieu d'achat; ou

(ii) appelez le service à la clientèle de Resideo en composant le 1-800-468-1502. Le service à la clientèle déterminera si le produit doit être retourné à l'adresse suivante : Resideo Return Goods, 1985 Douglas Dr. N., Golden Valley, MN 55422, ou si un produit de remplacement peut vous être expédié.

La présente garantie ne couvre pas les frais de retrait ou de réinstallation. La présente garantie ne s'applique pas s'il est démontré par Resideo que la défaillance ou le mauvais fonctionnement sont dus à un endommagement du produit alors que le consommateur l'avait en sa possession.

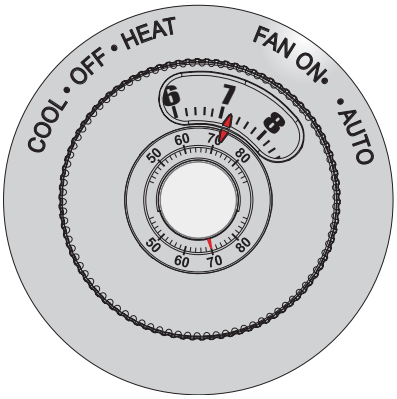
La responsabilité exclusive de Resideo se limite à réparer ou à remplacer le produit conformément aux modalités susmentionnées. RESIDEO N'EST EN AUCUN CAS RESPONSABLE DES PERTES OU DOMMAGES, Y COMPRIS LES DOMMAGES INDIRECTS OU ACCESSOIRES DÉCOULANT DIRECTEMENT OU INDIRECTEMENT D'UNE VIOLATION QUELCONQUE D'UNE GARANTIE, EXPRESSE OU TACITE, APPLICABLE AU PRÉSENT PRODUIT, OU TOUTE AUTRE DÉFAILLANCE DU PRÉSENT PRODUIT. Certaines provinces ne permettent pas l'exclusion ou la restriction des dommages indirects ou accessoires et, par conséquent, la présente restriction peut ne pas s'appliquer.

CETTE GARANTIE EST LA SEULE GARANTIE EXPRESSE FAITE PAR RESIDEO POUR CE PRODUIT. LA DURÉE DE TOUTE GARANTIE IMPLICITE, INCLUANT LES GARANTIES DE QUALITÉ MARCHANDE OU D'ADAPTATION À UNE UTILISATION PARTICULIÈRE, EST LIMITÉE PAR LES PRÉSENTES À LA PÉRIODE À CINQ ANNÉES DE LA PRÉSENTE GARANTIE. Certaines provinces ne permettent pas de limiter la durée des garanties tacites et, par conséquent, la présente limitation peut ne pas s'appliquer.

La présente garantie donne au consommateur des droits spécifiques et certains autres droits qui peuvent varier d'une province à l'autre.

Pour toute question concernant la présente garantie, prière d'écrire aux Services à la clientèle de Resideo à l'adresse suivante : Resideo Customer Relations, 1985 Douglas Dr, Golden Valley, MN 55422 ou composer le 1-800-468-1502.

Honeywell Home



T87N Easy-To-See™

The Round®

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Leer antes de instalar
T87N, T87N1026

Lista de comprobación previa a la instalación

Compruebe el contenido del paquete:

- Termostato
- Soportes de pared y tornillos de montaje (2 cada uno)
- Manual del operador
- Etiquetas con letras grandes para los indicadores de la parte interior del termostato
- Placa de cubierta

Herramientas y materiales necesarios:

- Destornillador Phillips N.º 2 y destornilladores de bolsillo
- Martillo
- Nivel (optativo)
- Lápiz
- Mecha de taladro (3/16" para mampostería en seco, 7/32" para yeso)

Debe instalarlo un técnico capacitado y con experiencia

Lea atentamente estas instrucciones. Si las ignora, podría dañarse el producto o generarse condiciones de peligro.

PRECAUCIÓN: PELIGRO ELÉCTRICO
Puede causar descarga eléctrica o daño del equipo. Desconecte la alimentación antes de iniciar la instalación.

AVISO DE MERCURIO
Si este producto reemplaza a un control que contiene mercurio en un tubo sellado, no arroje el control viejo a la basura. Comuníquese con la autoridad local de disposición de desechos para recibir instrucciones sobre reciclado y eliminación correcta.

Este termostato tiene una batería de litio que puede contener perclorato.
Perclorato: puede ser necesario manipularlo con métodos especiales.
Visite www.dtsc.ca.gov/hazardouswaste/perchlorate

69-1840EFS-07

Aplicación del producto

Este termostato brinda control electrónico de los sistemas de calefacción y refrigeración de una sola etapa de 24 VCA.

Tipos de sistemas

- Calefacción a gas, petróleo o eléctrica con aire acondicionado
- Aire caliente, agua caliente, estufas de alta eficiencia, bombas de calefacción, vapor, gravedad
- Sólo calefacción
- Sólo calefacción con ventilador
- Sólo refrigeración

Ajustes del sistema

- Heat, Off, Cool

Ajustes del Ventilador

- Auto, On

Especificaciones

Rangos de temperatura

- 40° a 90°F (4,5° a 32°C)

Temperatura de envío

- -20° a 120°F (-28,9° a 48,9°C)

Humedad relativa de funcionamiento

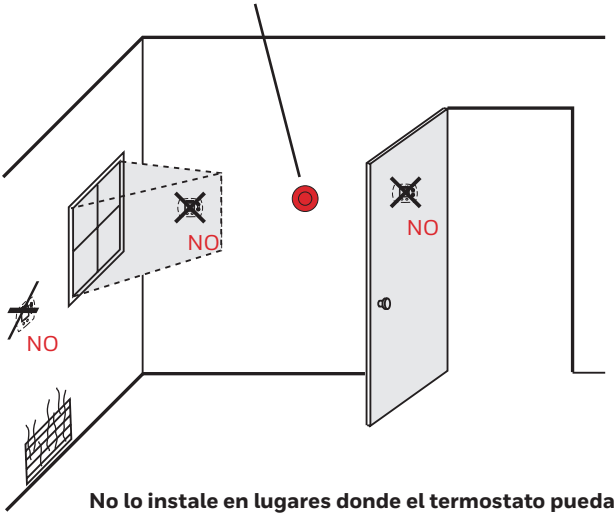
- 5% a 90% (sin condensación)

Regímenes eléctricos

- Tensión: 20–30 VAC
- Corriente: 0.02–1.0A, 50/60 Hz

Consejos de instalación

Instale el termostato a unos 5 pies (1,5 m) del nivel del suelo en un área con buena circulación de aire a temperatura promedio.

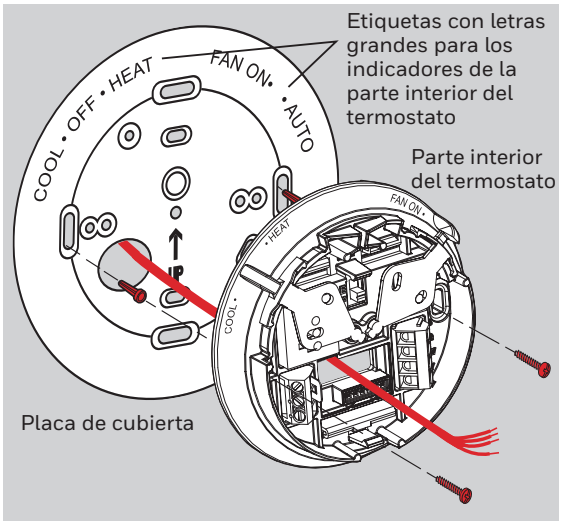


No lo instale en lugares donde el termostato pueda verse afectado por:

- Corrientes de aire, puntos muertos detrás de puertas y en rincones
- Aire caliente o frío proveniente de conductos
- Luz solar o calor radiante de artefactos
- Tuberías o chimeneas escondidas
- Áreas no calentadas/no refrigeradas como una pared exterior detrás del termostato

Instalación de placa de montaje

1. Hale los cables a través del agujero para los cables. Coloque la placa de cubierta en la pared, nivele y marque las posiciones de los agujeros.
2. Realice los agujeros (de 3/16 de pulgada para tablarroca o de 7/32 de pulgada para yeso) e introduzca las anclas de expansión con golpes leves.
3. Hale el cable a través de la placa de cubierta y de la parte interior del termostato; colóquelas sobre las anclas de expansión y ajuste los tornillos de montaje. Controle el nivel si lo desea.
4. Aplique las etiquetas en la placa de cubierta haciéndolas coincidir con las de la parte interior del termostato.



Cableado

1. Afloje los terminales atornillados, inserte los cables en el bloque de terminales y vuelva a ajustar los tornillos.
2. Empuje el exceso de cable de vuelta en la abertura de la pared.
3. Tapone la abertura de la pared con aislamiento no inflamable para evitar que las corrientes de aire afecten el funcionamiento del termostato.

Designaciones de terminales

W Relé de calefacción.

Y Contactor del compresor.

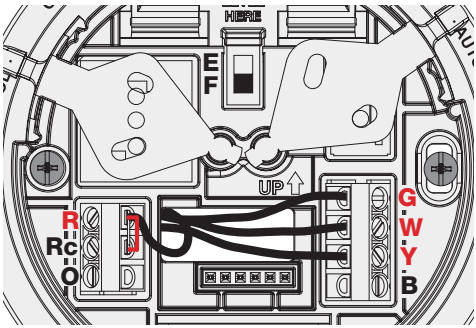
G Relé del ventilador.

O Válvula de cambio del bombeo de calor activada durante la refrigeración.

Rc Alimentación de refrigeración. Conecte al lado secundario del transformador del sistema de refrigeración.

R Alimentación de calefacción. Conecte al lado secundario del transformador del sistema de calefacción.

B Válvula de cambio del bombeo de calor activada durante la calefacción.



NOTAS

Terminales R y Rc

En el sistema de transformador único, deje en su lugar el empalme de metal entre **R** y **Rc**. Retire el empalme de metal si el sistema es de dos transformadores.

Sistemas de bombeo de calor

Si se lo conecta a un sistema de bombeo de calor, utilice un trozo de cable (no incluido) para conectar los terminales **W** e **Y**.

Especificaciones de cable

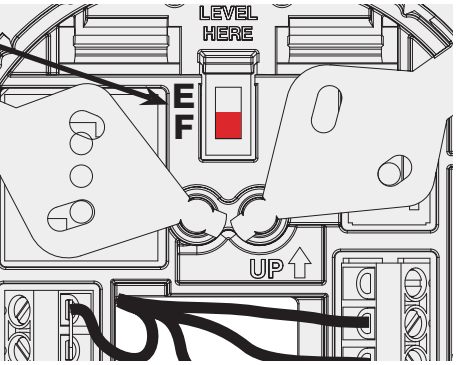
Use cable de termostato calibre 18 a 22. No se requiere cable blindado.

Ajuste de funcionamiento del ventilador

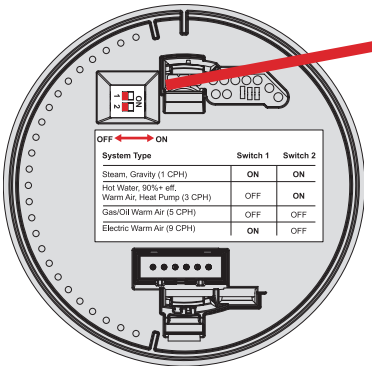
Fije el interruptor para su sistema:

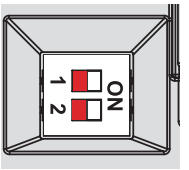
F: Para los sistemas de calefacción a gas o petróleo, deje el interruptor de funcionamiento del ventilador en la posición original de fábrica (esta posición es para los sistemas que controlan el ventilador cuando hay demanda de calefacción).

E: Cambie el interruptor a esta posición para los sistemas de calefacción eléctricos o de bombeo de calor. (Esta posición es para los sistemas que permiten que el termostato controle el ventilador cuando hay demanda de calefacción, si hay conectado un cable del ventilador al terminal G.)



Fije los interruptores de la tarifa del ciclo

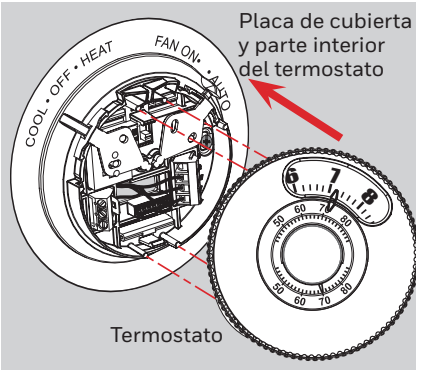




Fije los interruptores de la tarifa del ciclo para su sistema (véase la tabla abajo).

Sistema de calefacción	Interruptores 1	2
Sistema de vapor/gravedad	On	On
Aire caliente de alta eficiencia (90%+), agua caliente o pompa de calor	Apagado	On
Aire caliente (gas/petróleo) (ajuste de la fábrica)	Apagado	Apagado
Aire caliente eléctrico	On	Apagado

Montaje del termostato



Alinee las ranuras de la cubierta con las lengüetas del termostato, luego empuje con suavidad hasta que la cubierta calce en su lugar.

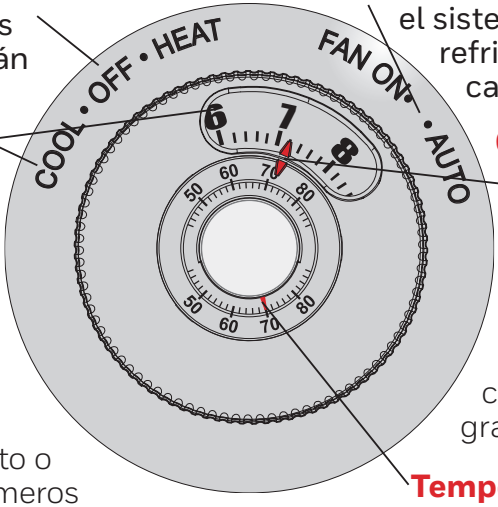
Instrucciones de manejo

Interruptor del sistema

- **Cool:** Controla el sistema de refrigeración.
- **Heat:** Controla el sistema de calefacción.
- **Off:** Todos los sistemas están apa gados.

Interruptor del ventilador

- **On:** El ventilador funciona continuamente.
- **Auto:** Funciona sólo cuando está encendido el sistema de refrigeración o calefacción.



Indicadores

Los números de la parte superior, aumentados y en relieve, indican el rango de temperatura mediante el tacto o la vista. Los números grandes 5, 6, 7 y 8 indican 50, 60, 70 y 80 °F respectivamente.

Configuración de temperatura

Gire la perilla para regular la temperatura. Escuchará un clic cada dos grados.

Temperatura

Temperatura de interior actual.

PRECAUCIÓN: PELIGRO DE DAÑO AL EQUIPO
No haga funcionar el sistema de refrigeración cuando la temperatura exterior sea inferior a 50°F (10°C).

Poliza de Garantia

IMPORTADO EN MEXICO POR:
Instromet Mexicana S. de R.L. de C.V.
Avenida Santa Fe 94, Torre A Piso 1,
Zedec ED Plaza Santa Fe, Alvaro Obregon,
Ciudad de Mexico, CP 01210
Telefono: 01 (55) 5081 0200

Instromet Mexicana S. de R.L. de C.V. garantiza que éste producto está libre de defectos en su mano de obra y materiales contra cualquier defecto de fabricación y funcionamiento, bajo uso normal, por el término de 1 año a partir de la fecha de la compra por el consumidor. Si se determina que el producto esta defectuoso o presenta algún funcionamiento erróneo, Instromet Mexicana S. de R.L. de C.V. deberá reparar o reemplazar (a opción de Instromet) el producto bajo las siguientes condiciones:

1. Regresar el producto y la póliza de garantía, acompañado de la factura de venta o algún otro comprobante de compra fechado al establecimiento donde se realizó la compra, o a la siguiente dirección. En la cual también tendrá la información para obtener las partes, componentes, consumibles y accesorios del producto: Av. Salvador Nava Martinez 3125, Col. Colinas del Parque. San Luis Potosi, SLP Mexico 78294.
2. O puedes llamar al centro de atención al cliente al 01-800-083-5925 para México (ver teléfonos para otros países) donde se determinará si el producto debe regresarse o si se enviará un reemplazo del producto al consumidor sin costo alguno cubriendo los gastos que se deriven del cumplimiento de la presente garantía incluyendo los gastos de transporte. No es necesario pedir piezas ni accesorios. El producto será reemplazado bajo esta garantía.

Nota: Esta garantía no cubre gastos de mano de obra por re-instalación. No ampara el reemplazo de la pieza si el defecto ocurre por daño causado por el consumidor o desgaste normal

La única responsabilidad de Instromet será reparar o reemplazar el producto dentro de los términos establecidos más arriba. Instromet Mexicana S. de R.L. de C.V. no será responsable de ninguna pérdida o daño de ningún tipo, incluidos los daños incidentales o derivados, que resulten, de manera directa o indirecta, del incumplimiento de la garantía, expresa o implícita, o de cualquier otra falla de este producto.

Esta garantía es la única garantía expresa que Instromet Mexicana S. de R.L. de C.V. ofrece respecto de este producto. La duración de cualquier garantía implícita, incluidas las garantías de comerciabilidad e idoneidad para un fin específico, se limita por el presente a la duración de un año de esta garantía.

Esta garantía no es válida en los siguientes casos:

1. Cuando el producto haya sido utilizado en condiciones distintas a las normales (aquellas para las que está destinado)
2. Cuando el producto no ha sido operado de acuerdo con el instructivo de uso e instalación proporcionado.
3. Cuando el producto ha sido alterado o reparado por personas no autorizadas por Instromet Mexicana S. de R.L. de C.V.

Datos del producto:

Marca: _____

Modelo: _____

Número de serie: _____

Nombre del consumidor: _____

Dirección (calle y número): _____

Delegación o municipio: _____

Ciudad, estado y código postal: _____

Vendor stamp and date of purchase

Accessories • Accessoires • Accesorios

Please contact your distributor to order replacement parts.
Temperature range stop.....Part Number 50010944-001
Cover plate.....Part Number 50000066-001
(Use to cover marks left by old thermostats.)

Veuillez contacter votre distributeur pour commander des pièces de rechange.
Butée d'arrêt de la température.....Numéro de la pièce 50010944-001
Cache-trou.....Numéro de la pièce 50000066-001
(Sert à dissimuler les marques laissées par d'anciens thermostats.)

Comuníquese con su distribuidor para encargar piezas de repuesto.
Limitador de rango de temperatura .....Número de pieza 50010944-001
Cubierta.....Número de pieza 50000066-001
(Para cubrir marcas dejadas por otros termostatos.)

Need Help?

For assistance with this product please visit
http://honeywellhome.com
or call Customer Care toll-free at 1-800-468-1502

Besoin d'aide?

Pour obtenir de l'aide et apprendre à faire fonctionner votre produit, veuillez consulter le site Web http://honeywellhome.com ou vous adresser aux Services à la clientèle en composant le 1-800-468-1502

¿Necesita ayuda?

Consulte sobre este producto en http://honeywellhome.com
o llamando sin cargo a atención al cliente 1-800-468-1502

resideo

Resideo Inc., 1985 Douglas Drive North
Golden Valley, MN 55422

www.resideo.com

69-1840EFS—07 M.S. 06-19 | Printed in United States

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5. CONTROLS

GS23X-4010 Cut Sheet

AUTOMATIONDIRECT.com
www.automationdirect.com

DURApulse GS20X series AC general purpose drive, NEMA 4X, 460 VAC, 10hp with 3-phase input, SVC, V/Hz, FOC or torque mode, C frame, RS-485, Modbus, 100kA SCCR. Optional EtherNet/IP and Modbus TCP card available.

For complete product information, please see this item on our store at the following link:

https://www.automationdirect.com/pn/GS23X-4010

Technical Specifications

Brand	DURApulse
Item	Drive
Controller Type	General purpose
Series	GS20X
Voltage Type	AC
Nominal Drive Input Voltage	460 VAC
Nominal Drive Output Voltage	460 VAC
Number of Input Phases	3
Number of Output Phases	3
Horsepower By Input Phase	10hp with 3-phase input
Amperage Rating	17A
Variable Torque Amperage Rating	20.5A
Control Mode	SVC, V/Hz, FOC or torque
Safe Torque Off (STO)	Yes
Temperature Rating	-20 to 40 deg C
Enclosure Type	NEMA 4X
IP Rating	IP66
Mounting	Panel or wall
Frame Size	C
Dynamic Braking	Integrated dynamic braking unit
Communication Port and Connection Type(s)	• (1) RS-485 (RJ45) • (1) USB B
Port Protocol(s)	• Modbus RTU Slave • Modbus ASCII Slave
Port Speed(s)	• up to 115.2k baud
Input Signal	4-20 mA, voltage, potentiometer or pulse train input
Output Type	PWM output
Reverse Capability	Built-in
Internally Bypassed	No
Carrier Frequency Range	2-15 kHz
Output Frequency Range	0.1-599 Hz
Number of Analog Input Channels	2

Number Of Input Channels	2
Analog Input Signal Type	Current/voltage
Number of Non-Isolated Analog Input Commons	1
Number of Points per Analog Input Common	2
Input Resolution	10-bit and 12-bit
Input Current Signal Range	0-20 mA, 4-20 mA
Input Voltage Signal Range	+/- 10 VDC
Number of Analog Output Channels	1
Number Of Output Channels	1
Analog Output Signal Type	Current/voltage
Number of Non-Isolated Analog Output Commons	1
Number of Points per Analog Output Common	1
Output Resolution	10-bit
Output Current Signal Range	0-20 mA and 4-20 mA
Output Voltage Signal Range	0-10 VDC
Number of Discrete Input Points	7
Nominal Discrete Input Voltage	24 VDC
Discrete Input Type	Sinking/sourcing
Number of Non-Isolated Discrete Input Commons	2
Number of Points per Discrete Input Common	4
Number of Discrete Output Points	3
Nominal Discrete Output Voltage	240 VAC and 48 VDC
Discrete Output Type	Relay/sinking/sourcing
Relay Configuration	(1) Form C (SPDT) relay

Number of Non-Isolated Discrete Output Commons	1
Number of Isolated Discrete Output Commons	1
Number of Points per Discrete Output Common	2
Load Current	3A/point relay, 50 mA/point discrete

Fuse Type	User-supplied external fuse
Programming Language	Ladder
SCCR Rating	100kA SCCR
Connector Type	Spring clamp terminals
For Use With	3-phase induction and permanent magnet AC motors
Additional Information	Optional EtherNet/IP and Modbus TCP card available

Agency Approvals

UL Listed File #	E198015
UL Recognized File #	None
UL Hazardous File #	None
CE	View CE declarations
CSA File #	none
RoHS Status	Yes (See CE Doc)
EU REACH	Vew EU REACH document
Other	None

GS23X-45P0 Cut Sheet

AUTOMATIONDIRECT.com
www.automationdirect.com

DURApulse GS20X series AC general purpose drive, NEMA 4X, 460 VAC, 5hp with 3-phase input, SVC, V/Hz, FOC or torque mode, B frame, RS-485, Modbus, 100kA SCCR. Optional EtherNet/IP and Modbus TCP card available.

For complete product information, please see this item on our store at the following link:

https://www.automationdirect.com/pn/GS23X-45P0

Technical Specifications

Brand	DURApulse
Item	Drive
Controller Type	General purpose
Series	GS20X
Voltage Type	AC
Nominal Drive Input Voltage	460 VAC
Nominal Drive Output Voltage	460 VAC
Number of Input Phases	3
Number of Output Phases	3
Horsepower By Input Phase	5hp with 3-phase input
Amperage Rating	9A
Variable Torque Amperage Rating	10.5A
Control Mode	SVC, V/Hz, FOC or torque
Safe Torque Off (STO)	Yes
Temperature Rating	-20 to 40 deg C
Enclosure Type	NEMA 4X
IP Rating	IP66
Mounting	Panel or wall
Frame Size	B
Dynamic Braking	Integrated dynamic braking unit
Communication Port and Connection Type(s)	• (1) RS-485 (RJ45) • (1) USB B
Port Protocol(s)	• Modbus RTU Slave • Modbus ASCII Slave
Port Speed(s)	• up to 115.2k baud
Input Signal	4-20 mA, voltage, potentiometer or pulse train input
Output Type	PWM output
Reverse Capability	Built-in
Internally Bypassed	No
Carrier Frequency Range	2-15 kHz
Output Frequency Range	0.1-599 Hz
Number of Analog Input Channels	2

Number Of Input Channels	2
Analog Input Signal Type	Current/voltage
Number of Non-Isolated Analog Input Commons	1
Number of Points per Analog Input Common	2
Input Resolution	10-bit and 12-bit
Input Current Signal Range	0-20 mA, 4-20 mA
Input Voltage Signal Range	+/- 10 VDC
Number of Analog Output Channels	1
Number Of Output Channels	1
Analog Output Signal Type	Current/voltage
Number of Non-Isolated Analog Output Commons	1
Number of Points per Analog Output Common	1
Output Resolution	10-bit
Output Current Signal Range	0-20 mA and 4-20 mA
Output Voltage Signal Range	0-10 VDC
Number of Discrete Input Points	7
Nominal Discrete Input Voltage	24 VDC
Discrete Input Type	Sinking/sourcing
Number of Non-Isolated Discrete Input Commons	2
Number of Points per Discrete Input Common	4
Number of Discrete Output Points	3
Nominal Discrete Output Voltage	240 VAC and 48 VDC
Discrete Output Type	Relay/sinking/sourcing
Relay Configuration	(1) Form C (SPDT) relay

Number of Non-Isolated Discrete Output Commons	1
Number of Isolated Discrete Output Commons	1
Number of Points per Discrete Output Common	2
Load Current	3A/point relay, 50 mA/point discrete

Fuse Type	User-supplied external fuse
Programming Language	Ladder
SCCR Rating	100kA SCCR
Connector Type	Spring clamp terminals
For Use With	3-phase induction and permanent magnet AC motors
Additional Information	Optional EtherNet/IP and Modbus TCP card available

Agency Approvals

UL Listed File #	E198015
UL Recognized File #	None
UL Hazardous File #	None
CE	View CE declarations
CSA File #	none
RoHS Status	Yes (See CE Doc)
EU REACH	Vew EU REACH document
Other	None

AUTOMATIONDIRECT.com

DURAPULSE GS20 & GS20X DRIVE USER MANUAL

GS20_UMW

ORIGINAL INSTRUCTIONS

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Warnings and Trademarks

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To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and usually change with time. It is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation is in compliance with the latest revision of these codes.

At a minimum, you should follow all applicable sections of the National Fire Code, National Electrical Code, and the codes of the National Electrical Manufacturer's Association (NEMA). There may be local regulatory or government offices that can also help determine which codes and standards are necessary for safe installation and operation.

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Afin de réduire au minimum le risque d'éventuels problèmes de sécurité, vous devez respecter tous les codes locaux et nationaux applicables régissant l'installation et le fonctionnement de votre équipement. Ces codes diffèrent d'une région à l'autre et, habituellement, évoluent au fil du temps. Il vous incombe de déterminer les codes à respecter et de vous assurer que l'équipement, l'installation et le fonctionnement sont conformes aux exigences de la version la plus récente de ces codes.

Vous devez, à tout le moins, respecter toutes les sections applicables du Code national de prévention des incendies, du Code national de l'électricité et des codes de la National Electrical Manufacturer's Association (NEMA). Des organismes de réglementation ou des services gouvernementaux locaux peuvent également vous aider à déterminer les codes ainsi que les normes à respecter pour assurer une installation et un fonctionnement sûrs.

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Warnings

Warning: Read this manual thoroughly before using DURApulse Series AC Motor Drives.

Warning: AC input power must be disconnected before performing any maintenance. Do not connect or disconnect wires or connectors while power is applied to the circuit. Maintenance must be performed only by a qualified technician.

Warning: There are highly sensitive MOS components on the printed circuit boards, and these components are especially sensitive to static electricity. To avoid damage to these components, do not touch these components or the circuit boards with metal objects or your bare hands.

Warning: A charge may still remain in the DC-link capacitor with hazardous voltages, even if the power has been turned off. To avoid personal injury, do not remove the cover of the AC drive until all "DISPLAY LED" lights on the digital keypad are off. Please note that there are live components exposed within the AC drive. Do not touch these live parts.

Warning: Ground the DURApulse AC Drive using the ground terminal. The grounding method must comply with the laws of the country where the AC drive is to be installed. Refer to "Basic Wiring Diagram" in Chapter 2.

Warning: The mounting enclosure of the AC drive must comply with EN50178. Live parts shall be arranged in enclosures or located behind barriers that meet at least the requirements of the Protective Type IP20. The top surface of the enclosures or barrier that is easily accessible shall meet at least the requirements of the Protective Type IP40. Users must provide this environment for DURApulse Series AC Drive.

Warning: The AC drive may be destroyed beyond repair if incorrect cables are connected to the input/output terminals. Never connect the AC drive output terminals T1, T2, and T3 directly to the AC main circuit power supply.

Three-phase DURApulse drives require a symmetrical 3-phase power source.
Do not connect them to grounded, center-tapped delta transformers of the type typically used for lighting circuits.

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DURAPULSE GS20 & GS20X DRIVE USER MANUAL REVISION HISTORY

PLEASE INCLUDE THE MANUAL NUMBER AND THE MANUAL ISSUE, BOTH SHOWN BELOW, WHEN COMMUNICATING WITH TECHNICAL SUPPORT REGARDING THIS PUBLICATION.

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1st Edition, Rev C	10/26/2021	Updates to chapters 1, 4, 6, and appendices A, B, and D to reflect changes due to firmware update and addition of new parameters.
1st Edition, Rev D	03/03/2022	Numerous updates throughout manual to correct errors, improve clarity, and provide additional information as needed.

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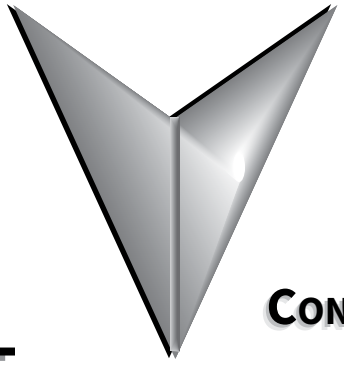

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Getting Started

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User Manual Overview

Overview of this Publication

The *DURAPULSE* GS20 & GS20X Drive User Manual describes the installation, configuration, and methods of operation of the *DURAPULSE* GS20(X) Series AC Drive. Throughout this manual, please note:

- *GS20 refers to GS21 and GS23 models only*
- *GS20X refers to GS21X and GS23X models only*
- *GS20(X) refers to all drive models*

Who Should Read This Manual

This manual contains important information for those who will install, maintain, and/or operate any of the GS20(X) Series AC Drives.

Supplemental Publications

The National Electrical Manufacturers Association (NEMA) publishes many different documents that discuss standards for industrial control equipment. Global Engineering Documents handles the sale of NEMA documents. For more information, you can contact Global Engineering Documents at:

15 Inverness Way East
Englewood, CO 80112-5776
1-800-854-7179 (within the U.S.)
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We also encourage you to visit our web site where you can find technical and non-technical information about our products and our company. Visit us at www.automationdirect.com.

Produced By

GS20(X) series drives are a product of:
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3505 Hutchinson Road
Cumming, GA 30040-5860

Special Symbols

NOTE: When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note.

WARNING: When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death (in extreme cases).

Purpose of AC Drives

AC drives are generally known by many different names: Adjustable Frequency Drives (AFD), Variable Frequency Drives (VFD), and Inverters. Drives are used primarily to vary the speed of three phase AC induction motors, and they also provide non-emergency start and stop control, acceleration and deceleration, and overload protection. By gradually accelerating the motor, drives can reduce the amount of motor startup inrush current.

AC drives function by converting incoming AC power to DC, which is then synthesized back into three phase output power. The voltage and frequency of this synthesized output power is directly varied by the drive, where the frequency determines the speed of the three phase AC induction motor.

Selecting the Proper Drive Rating

Determine Motor Full-Load Amperage (FLA)

Motor FLA is located on the nameplate of the motor.
NOTE: FLA of motors that have been rewound may be higher than stated.

Determine Motor Overload Requirements

Many applications experience temporary overload conditions due to starting requirements or impact loading. Most AC drives are designed to operate at 150% overload for 60 seconds. If the application requires an overload greater than 150% or longer than 60 seconds, the AC drive must be oversized.

NOTE: Applications that require replacement of existing motor starters with AC drives may require up to 600% overload.

Determine Application Type; Constant Torque or Variable Torque

This torque requirement has a direct effect on which drive to select. Variable Torque (VT) applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Constant Torque (CT) category (machine control, conveyors, etc.). If you are unsure of the application, assume Constant Torque. The specification, derating, and selection tables are generally segregated by Constant Torque and Variable Torque.

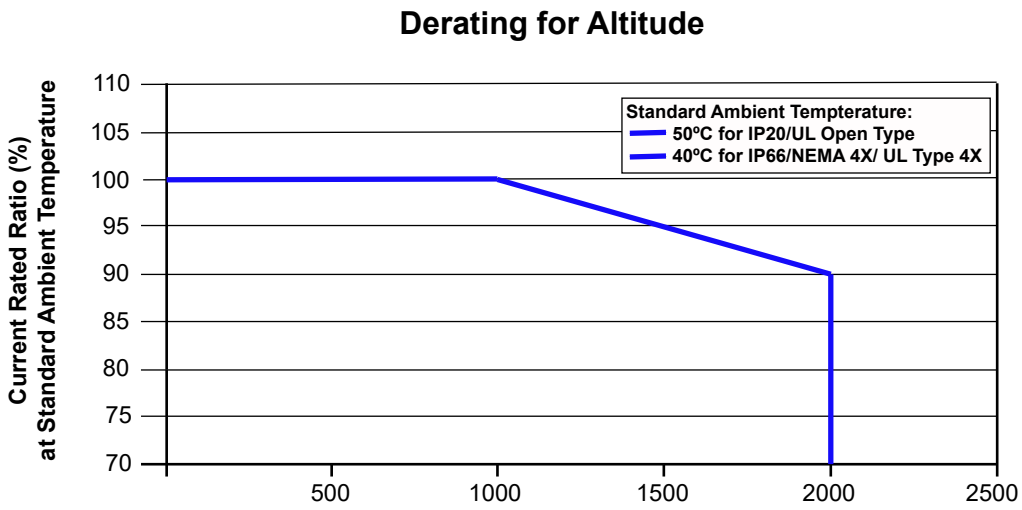
Installation Altitude

AC drives rely on air flow for cooling. As the altitude increases, the air becomes less dense, and this drop in air density decreases the cooling properties of the air. Therefore, the AC drive must be oversized to compensate for the decrease in cooling. Most AC drives are designed to operate at 100% capacity at altitudes up to 1000 meters.

NOTE: For use above 1000m, the AC drive must be derated as described below.

Derate Output Current Based on Altitude Above 1000 Meters

- *If the AC drive is installed at an altitude of 0~1000m, follow normal operation restrictions.*
- *If installed at an altitude of 1000~2000m, decrease 1% of the rated current or lower 0.5°C of temperature for every 100m increase in altitude.*
- *Maximum altitude for Corner Grounded is 2000m. If installation at an altitude higher than 2000m is required, please contact AutomationDirect.*



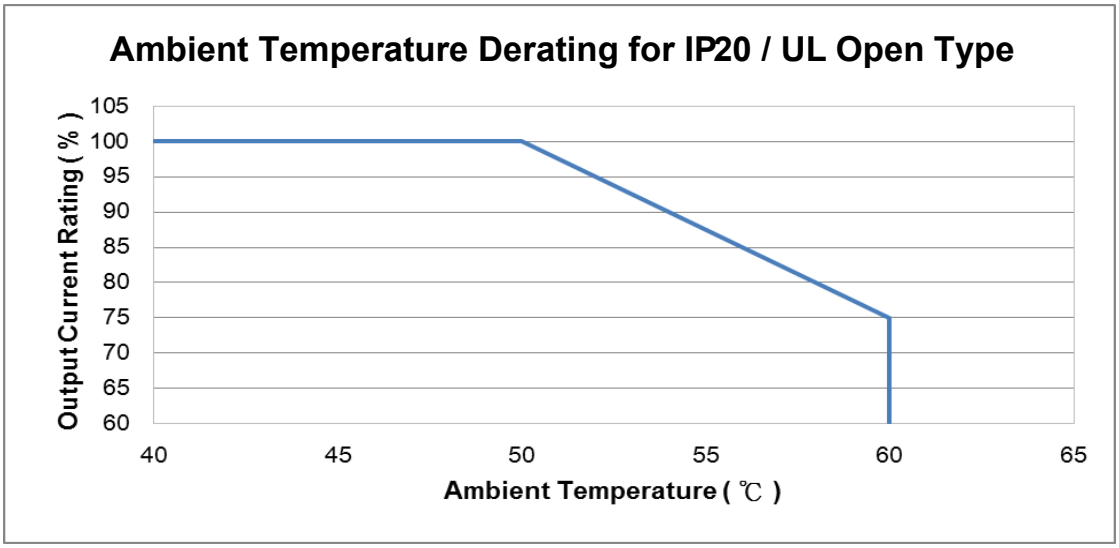
Determine Maximum Enclosure Internal Temperature

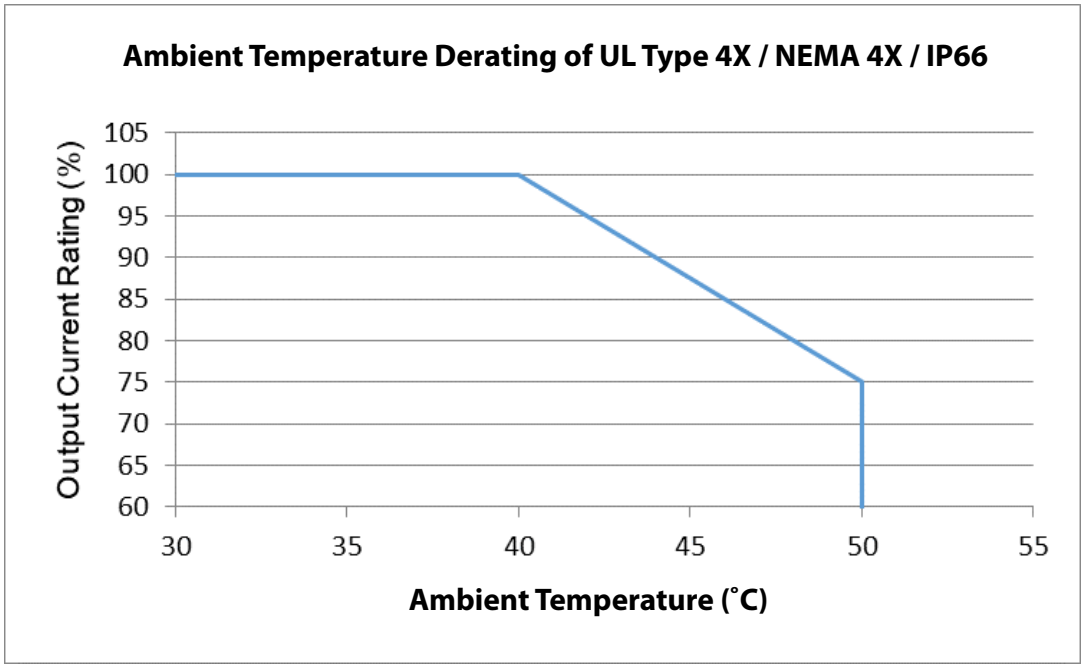
AC drives generate a significant amount of heat and will cause the internal temperature of an enclosure to exceed the rating of the AC drive, even when the ambient temperature is less than 104°F (40°C). Enclosure ventilation and/or cooling may be required to maintain a maximum internal temperature of 104°F (40°C) or less. Ambient temperature measurements/calculations should be made for the maximum expected temperature. When permissible, flange mounting the AC drive (mounting with the drive heatsink in open ambient air) can greatly reduce heating in the enclosure.

For use above 104˚F (40˚C), the AC drive must be derated as described below.

Derate Output Current Based on Temperature Above 104°F (40°C)

Drive Derating by Temperature and Protection Level	
Protection Level	***Derating***
UL Open Type / IP20 *	If the AC motor drive operates at the rated current, the ambient temperature needs to be between -20–50°C. If the temperature is above 50°C, decrease 2.5% of the rated current for every 1°C increase in temperature. The maximum allowable temperature is 60°C.
UL Type 4X / NEMA 4X / IP66 *	When the AC motor drive is operating at the rated current, the ambient temperature must be between -20–40°C. When the temperature is over 40 °C, for every increase by 1°C, decrease the rated current 2.5%. The maximum allowable temperature is 50°C.
** For more information about environmental ratings, refer to the "DURApulse GS20 & GS20X AC Drive Environmental Information" on page 1–17 of this chapter.*	




Ambient Temperature Derating of UL Type 4X / NEMA 4X / IP66
Output Current Rating (%)
105
100
95
90
85
80
75
70
65
60
30
35
40
45
50
55
Ambient Temperature (˚C)

Derate Output Current Based on Carrier Frequency (if necessary)

Carrier Frequency Effects

AC Drives rectify the incoming 50 or 60Hz line power resulting in DC power at 0Hz. The resulting DC power is then pulse-width modulated and supplied to the motor by the drive's power electronics. IGBTs invert the DC power, simulating a sine wave at the desired frequency (that's what allows variable speed in AC induction motors). The speed at which the IGBTs are turned ON and OFF is called Carrier Frequency. In AC drives, the Carrier Frequency can range from 2kHz to 15kHz. The Carrier Frequency can be adjusted in most AC Drives.

There are trade-offs between choosing High Carrier Frequencies and Low Carrier Frequencies.

Benefits of Higher Carrier Frequencies:

- *Better efficiency (lower harmonic losses) in the motor*
- *Lower audible noise*

Benefits of Lower Carrier Frequencies:

- *Better efficiency in the drive*
- *Lower EMI (electrical noise)*
- *Reduced reflective wave peak voltage*

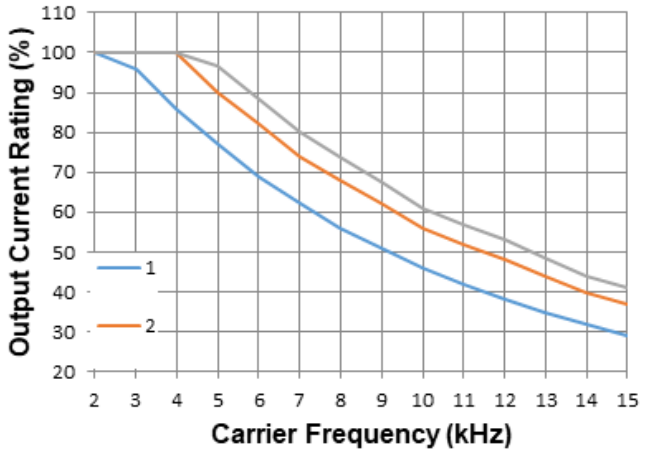
As a general rule, the Carrier Frequency should be set as low as possible without creating unacceptable audible noise in the motor. Smaller systems can have higher Carrier Frequencies, but larger drives (>20 or 30hp) should not have Carrier Frequencies set higher than 6kHz. Constant torque applications typically run around 2~4kHz.

GS20(X) Variable Torque Carrier Frequency Derating

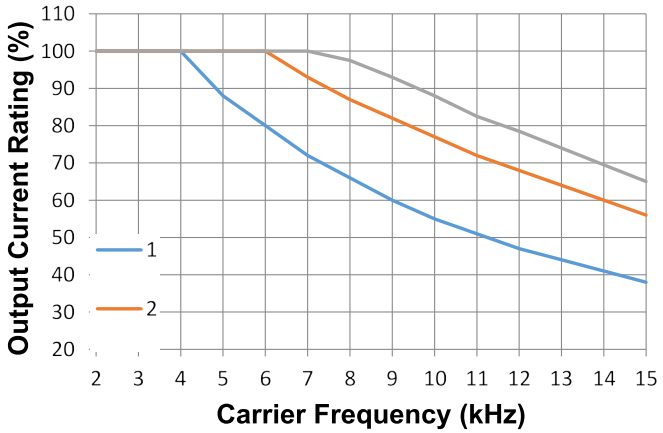
- *Line 1: Ta = 50°C / Load = 100%*
- *Line 2: Ta = 50°C / Load = 75% or Ta = 40°C / Load = 100%*
- *Line 3: Ta = 50°C / Load = 50% or Ta = 35°C / Load = 100%*

Note: Space Vector Pulse Width Modulation (SVPWM) and Two-Phase Pulse Width Modulation (DPWM) are determined by parameter P11.41. See Chapter 4 for details.

SVPWM Mode

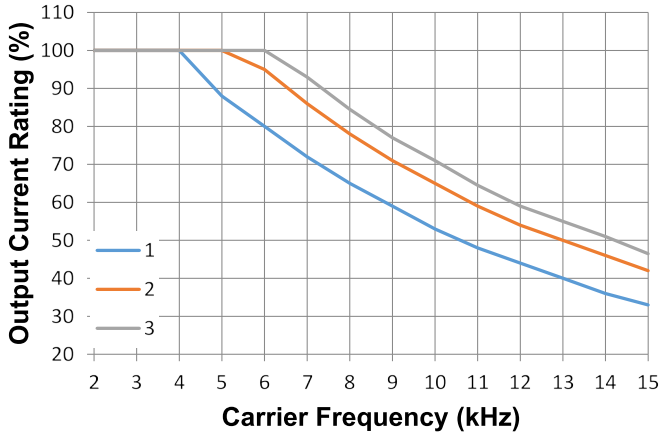


DPWM Mode

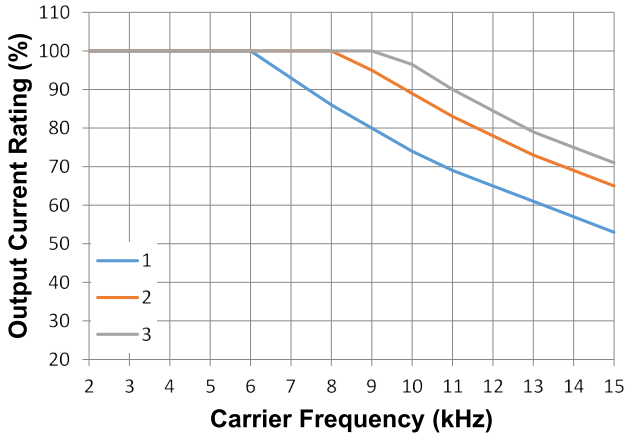


GS20(X) Constant Torque Carrier Frequency Derating

SVPWM Mode



DPWM Mode



DURAPULSE GS20 & GS20X AC DRIVE ENVIRONMENTAL INFORMATION

STORAGE AND TRANSPORTATION

AC drives should be kept in the shipping cartons or crates until they are installed. In order to retain the warranty coverage, they should be stored as described below if not to be installed and used within three months.

- *Store in a clean and dry location free from direct sunlight and corrosive fumes.*
- *Store within environmental conditions shown below in the "Environmental Conditions" table.*
- *DO NOT store in an area with rapid changes in temperature , to avoid condensation and frost.*
- *DO NOT place directly on the ground.*

If the drive is stored or is otherwise unused for more than a year, the drive's internal DC link capacitors should be recharged before use. Otherwise, the capacitors may be damaged when the drive starts to operate. We recommend recharging the capacitors of any unused drive at least once per year. (Refer to Chapter 6, "Maintenance and Troubleshooting" for information about recharging DC link capacitors.)

GS20 ENVIRONMENTAL CONDITIONS

Environmental Conditions for GS20 AC Drives			
Condition	Operation	Storage	Transportation
Installation Location	IEC 60364-1/ IEC 60664-1 Pollution degree 2, Indoor use only.	n/a	n/a
Ambient Temperature	IP20/UL Open Type: -20–50°C (-20–60°C w/derating)	-40–85°C	-20–70°C
	Non-condensing, non-freezing		
Relative Humidity	90%, no water condensation	95%, no water condensation	
Air Pressure	86–106 kPa	70–106 kPA	
Pollution Level	IEC 60721-3, concentrate prohibited		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Altitude	<1000 m (For altitudes > 1000 m, derate to use it.)		
Package Drop	n/a	ISTA procedure 1A (according to weight) IEC 60068-2-31	
Vibration	1.0 mm, peak to peak value range from 2–13.2 Hz; 0.7–2.0 G range from 13.2–55 Hz; 2.0 G range from 55–512 Hz. Compliance with IEC 60068-2-6	2.5 G peak, 5 Hz–2 kHz 0.015" maximum displacement	
Impact	15 G, 11 ms, compliance with IEC/EN60068-2-27	30G	
DO NOT expose the GS20 AC Drive to harsh environments such as dust, direct sunlight, corrosive/flammable gases, humidity, liquid, or vibrations. The salts in the air must be less than 0.01 mg/cm^2 every year.			

GS20X ENVIRONMENTAL CONDITIONS

Environmental Conditions for GS20X AC Drives			
Condition	Operation	Storage	Transportation
Installation Location	PCB design is compliant with IEC 60364-1 / IEC 60664-1 Pollution Degree 2. The outer case meets IP66 standard for indoor use. If the drive is for outdoor application, avoid direct sunlight.	n/a	n/a
Ambient Temperature	IP66 / NEMA 4X / UL Type 4X: -20–40°C (-20–50°C w/derating)	-40–85°C	-20–70°C
	Non-condensing, non-freezing		
Relative Humidity	0-100%, no water condensation	95%, no water condensation	
Air Pressure	86–106 kPa	70–106 kPA	
Pollution Level	IEC 60721-3, concentrate prohibited		
	Class 3C2; Class 3S2	Class 2C2; Class 2S2	Class 1C2; Class 1S2
Altitude	<1000 m (For altitudes > 1000 m, derate to use it.)		
Package Drop	n/a	ISTA procedure 1A (according to weight) IEC 60068-2-31	
Vibration	1.0 mm, peak to peak value range from 2–13.2 Hz; 0.7–2.0 G range from 13.2–55 Hz; 2.0 G range from 55–512 Hz; complies with IEC 60068-2-6.	2.5 G peak, 5 Hz–2 kHz 0.015" maximum displacement	
Impact	15 G, 11 ms, compliance with IEC/EN60068-2-27	30G	
DO NOT expose the GS20X AC Drive to harsh environments such as direct contact with chemical substance and solvent, and exposure to direct sunlight.			

GS20 & GS20X General Specifications

General Specifications for GS20(X) AC Drives				
Control Characteristics	Control Method		V/F, Sensorless Vector (SVC), Field Oriented Control (FOC) Sensorless, Volt/ Frequency with Pulse Generator intput (VFPG), Torque (TQC Sensorless)	
	Applicable Motor		IM (Induction Motor), Simple PM motor control (IPM and SPM)	
	Starting Torque[1]		150% / 3 Hz 100% / (motor rated frequency/20) 200% / 0.5 Hz	(V/F, SVC control for IM, CT, rated) (SVC control for PM, CT, rated) (FOC control for IM, CT, rated)
	Torque Accuracy		± 15% TQC Sensorless	
	Torque Limits	120/230/460V	VT: 160% of output current, max CT: 180% of output current, max	
		575V	200% of output current, max	
	Speed Control Range[1]		1: 50 (V/F, SVC control for IM, CT, rated) 1: 20 (SVC control for PM, CT, rated) 1: 100 (FOC control for IM, CT, rated)	
	Max. Output Frequency		0.00–599.00 Hz	
	Overload Capacity		VT: rated output current of 120% 60 sec., 150% 3 sec. CT: rated output current of 150% 60 sec., 200% 3 sec.	
	Frequency Setting Signal		0–10 V / -10–10 V 4–20 mA / 0–10 V 1 channel pulse input (33 kHz), 1 channel pulse output (33 kHz)	
	Digital Inputs		Seven (7) - 24VDC NPN or PNP, includes 1 frequency input 33kHz	
	Digital Outputs		Three (3) - (2)-48VDC, (1) Relay-250VAC/30VDC	
	Analog Inputs		Two (2) - (1) voltage, (1) selectable Voltage or Current	
	Analog Outputs		One (1) - selectable voltage or current	
	Frequency Output		One (1) - 30VDC, 33kHz	
	Safe Torque Off		STO1 and STO2 inputs- 24VDC	
	Main Functions		Multiple motor switching (a maximum of four independent motor parameter settings), Fast start-up, Deceleration Energy Back (DEB) function, Wobble frequency function, Fast deceleration function, Master and Auxiliary frequency source selectable, Restart after momentary power loss, Speed tracking, Over-torque detection, 16-step speed (including the master speed), Accel./decel. time switch, S-curve accel./decel., three-wire operation control, JOG frequency, Frequency upper/lower limit settings, DC brake at start-up and stop, PID control, Built-in PLC (2000 steps), and Simple positioning function.	
	Application Macro		Built-in application parameter groups (selected by industry) and user-defined application parameter groups.	
Protection Characteristics	Motor Protection		Over-current, Over-voltage, Over-heating, Phase loss.	
	Stall Prevention		Stall prevention during acceleration, deceleration and running (independent settings).	
Accessory	Communication Card		EtherNet/IP and Modbus TCP (GS20A-CM-ENETIP, single card)	
	External DC Power Supply		GS20A-BPS (24V power backup supply card)	
Agency Approvals[2]	UL, CE, TÜV (SIL 2), RoHS, REACH			

1: Control accuracy may vary depending on the environment, application conditions or different motors. For more information contact AutomationDirect.

2: See CE declaration here: https://support.automationdirect.com/docs/GS20A-GS20AX-CE.pdf

Efficiency Class

The EU Ecodesign regulation directive establishes a framework to set mandatory ecological requirements for energy-using and energy-related products. The IEC 61800-9-2 standard defines the efficiency classes for AC drives. The efficiency classes range (low to high) from IE0 to IE2. These classes apply to AC drives rated 100 to 1000 V and 0.12 to 1000 kW (1/6 to 1,340 HP).

Drive manufacturers must declare power losses in terms of percentage of rated apparent output power at eight different operating points, as well as standby losses. The International Efficiency (IE) level is given at the nominal point.

The power losses of GS20(X) drives shall not exceed the maximum power losses corresponding to the IE2 efficiency level. For specific power losses of each drive model, see the drive specification tables.

DURAPULSE GS20 AC DRIVE SPECIFICATIONS

120V CLASS – 1-PHASE MODEL-SPECIFIC SPECIFICATIONS

GS20 120V Class Specifications; Frame Size A, C[1,3]						
Model Name: GS21-1xxx				**GS21-10P2**	**GS21-10P5**	**GS21-11P0**
Frame Size				**A**	**A**	**C**
Output Rating	**Max Motor Output**		**hp**	1/4	1/2	1
			kW	0.2	0.4	0.75
	CT	**Rated Output Capacity**	**kVA**	0.6	1	1.8
		Rated Output Current	**A**	1.6	2.5	4.8
		Carrier Frequency[2]	**kHz**	2–15 (default 4)		
	VT	**Rated Output Capacity**	**kVA**	0.7	1	2.1
		Rated Output Current	**A**	1.8	2.7	5.5
		Carrier Frequency[2]	**kHz**	2–15 (default 4)		
Input Rating	**CT**	**Rated Input Current**	**A**	6	9.4	18
	VT	**Rated Input Current**	**A**	6.8	10.1	20.6
	Rated Voltage/Frequency			One-phase: 100–120 VAC (-15% to +10%), 50/60 Hz		
	Operating Voltage Range (VAC)			85–132		
	Frequency Tolerance (Hz)			47–63		
IE2 Efficiency – Relative Power Loss				4.9%	3.5%	3.0%
Weight (kg)				0.65	0.74	1.24
Cooling Method				Convective		Fan
IP Rating				IP20		

1 - For use with three-phase motors only.

2 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

3 - DC Common bus and DC reactor terminals are not available on 120V models. See "Main terminals" section for more details.

230V Class – 1-Phase Model-Specific Specifications

GS20 230V Class Specifications; Frame Size A, B, C[1]								
Model Name: GS21-2xxx				**GS21-20P2**	**GS21-20P5**	**GS21-21P0**	**GS21-22P0**	**GS21-23P0**
Frame Size				**A**	**A**	**B**	**C**	**C**
Output Rating	**Max Motor Output**		**hp**	1/4	1/2	1	2	3
			kW	0.2	0.4	0.75	1.5	2.2
	CT	**Rated Output Capacity**	**kVA**	0.6	1.1	1.8	2.9	4.2
		Rated Output Current	**A**	1.6	2.8	4.8	7.5	11
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
	VT	**Rated Output Capacity**	**kVA**	0.7	1.2	1.9	3.2	4.8
		Rated Output Current	**A**	1.8	3.2	5	8.5	12.5
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
Input Rating[2]	**CT**	**Rated Input Current**	**A**	5.1	7.3	10.8	16.5	24.2
	VT	**Rated Input Current**	**A**	5.8	8.3	11.3	18.5	27.5
	Rated Voltage/Frequency			One-phase 200-240 VAC (-15% to +10%), 50/60 Hz				
	Operating Voltage Range (VAC)			170–265				
	Frequency Tolerance (Hz)			47–63				
IE2 Efficiency – Relative Power Loss				5.2%	3.4%	2.9%	2.6%	2.4%
Weight (kg)				0.65	0.76	0.95	1.24	1.24
Cooling Method				Convective			Fan	
IP Rating				IP20				

1 - For use with three-phase motors only.

2 - Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

230V Class – 3-Phase Model-Specific Specifications

GS20 230V Class Specifications; Frame Size A, B, C[1]								
Model Name: GS23-2xxx				**GS23-20P2**	**GS23-20P5**	**GS23-21P0**	**GS23-22P0**	**GS23-23P0**
Frame Size				**A**	**A**	**A**	**B**	**C**
Output Rating	**Max Motor Output (3-phase [1-phase])[4]**		**hp**	0.25 [0.1]	0.5 [0.25]	1 [0.5]	2 [1]	3 [1.5]
			kW	0.2 [0.1]	0.4 [0.2]	0.75 [0.375]	1.5 [0.75]	2.2 [1.1]
	CT	**Rated Output Capacity (3-phase [1-phase])**	**kVA**	0.6 [0.3]	1.1 [0.55]	1.8 [0.9]	2.9 [1.5]	4.2 [2.1]
		Rated Output Current (3-phase [1-phase])	**A**	1.6 [0.8]	2.8 [1.4]	4.8 [2.4]	7.5 [3.75]	11 [5.5]
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
	VT	**Rated Output Capacity**	**kVA**	0.7	1.2	1.9	3	4.8
		Rated Output Current	**A**	1.8	3.2	5	8	12.5
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
Input Rating[2]	**CT**	**Rated Input Current**	**A**	1.9	3.4	5.8	9	13.2
	VT	**Rated Input Current**	**A**	2.2	3.8	6	9.6	15
	Rated Voltage/Frequency			3-phase or 1-phase 200-240 VAC (-15% to +10%), 50/60 Hz				
	Operating Voltage Range (VAC)			170–265				
	Frequency Tolerance (Hz)			47–63				
IE2 Efficiency – Relative Power Loss				5.2%	3.4%	2.9%	2.5%	2.5%
Weight (kg)				0.65	0.65	0.81	1.05	1.24
Cooling Method				Convective			Fan	
IP Rating				IP20				

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

4 - Three phase models can be powered with 1-phase or 3-phase input power. If using 1-phase input power, GS21 models up to 3HP provide higher output power than equivalent GS23 model with 1-phase.

230V Class – 3-Phase Model-Specific Specifications

GS20 230V Class Specifications; Frame Size C, D, E, F[1]								
Model Name: GS23-2xxx				**GS23-25P0**	**GS23-27P5**	**GS23-2010**	**GS23-2015**	**GS23-2020**
Frame Size				**C**	**D**	**E**	**E**	**F**
Output Rating	**Max Motor Output (3-phase [1-phase])[4]**		**hp**	5 [2.5]	7.5 [3.5]	10 [5]	15 [7.5]	20 [10]
			kW	3.7 [1.85]	5.5 [2.75]	7.5 [3.75]	11 [5.5]	15 [7.5]
	CT	**Rated Output Capacity (3-phase [1-phase])**	**kVA**	6.5 [3.25]	9.5 [4.75]	12.6 [6.3]	18.7 [9.35]	24.8 [12.4]
		Rated Output Current (3-phase [1-phase])	**A**	17 [8.5]	25 [12.5]	33 [16.5]	49 [24.5]	65 [32.5]
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
	VT	**Rated Output Capacity**	**kVA**	7.4	10.3	13.7	19.4	26.3
		Rated Output Current	**A**	19.5	27	36	51	69
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
Input Rating[2]	**CT**	**Rated Input Current**	**A**	20.4	30	39.6	58.8	78
	VT	**Rated Input Current**	**A**	23.4	32.4	43.2	61.2	82.8
	Rated Voltage/Frequency			3-phase or 1-phase 200-240 VAC (-15% to +10%), 50/60 Hz				
	Operating Voltage Range (VAC)			170–265				
	Frequency Tolerance (Hz)			47–63				
IE2 Efficiency – Relative Power Loss				2.2%	2.3%	2.5%	2.2%	2.1%
Weight (kg)				1.24	2.07	3.97	3.97	6.25
Cooling Method				Fan				
IP Rating				IP20				

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

4 - Three phase models can be powered with 1-phase or 3-phase input power. If using 1-phase input power, GS21 models up to 3HP provide higher output power than equivalent GS23 model with 1-phase.

460V Class – 3-Phase Model-Specific Specifications

GS20 460V Class Specifications; Frame Size A, B, C[1]								
Model Name: GS23-4xxx				**GS23-40P5**	**GS23-41P0**	**GS23-42P0**	**GS23-43P0**	**GS23-45P0**
Frame Size				**A**	**A**	**B**	**C**	**C**
Output Rating	**Max Motor Output**		**hp**	1/2	1	2	3	5
			kW	0.4	0.75	1.5	2.2	3.7
	CT	**Rated Output Capacity**	**kVA**	1.1	2.1	3.2	4.2	6.9
		Rated Output Current	**A**	1.5	2.7	4.2	5.5	9
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
	VT	**Rated Output Capacity**	**kVA**	1,4	2.3	3.5	5	8
		Rated Output Current	**A**	1.8	3	4.6	6.5	10.5
		Carrier Frequency[3]	**kHz**	2–15 (default 4)				
Input Rating[2]	**CT**	**Rated Input Current**	**A**	1.7	3	5.8	6.1	9.9
	VT	**Rated Input Current**	**A**	2	3.3	6.4	7.2	11.6
	Rated Voltage/Frequency			Three-phase 380-480 VAC (-15% to +10%), 50/60 Hz				
	Operating Voltage Range (VAC)			323-528				
	Frequency Tolerance (Hz)			47–63				
IE2 Efficiency – Relative Power Loss				4.0%	2.6%	2.3%	2.3%	2.0%
Weight (kg)				0.76	0.81	1	1.24	1.24
Cooling Method				Convective		Fan		
IP Rating				IP20				

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

460V Class – 3-Phase Model-Specific Specifications

GS20 460V Class Specifications; Frame Size D, E, F[1]									
Model Name: GS23-4xxx				**GS23-47P5**	**GS23-4010**	**GS23-4015**	**GS23-4020**	**GS23-4025**	**GS23-4030**
Frame Size				**D**	**D**	**E**	**E**	**F**	**F**
Output Rating	**Max Motor Output**		**hp**	7 1/2	10	15	20	25	30
			kW	5.5	7.5	11	15	18.5	22
	CT	**Rated Output Capacity**	**kVA**	9.9	13	19.1	24.4	29	34.3
		Rated Output Current	**A**	12	17	25	32	38	45
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
	VT	**Rated Output Capacity**	**kVA**	12	15.6	21.3	27.4	31.6	37.3
		Rated Output Current	**A**	15.7	20.5	28	36	41.5	49
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
Input Rating[2]	**CT**	**Rated Input Current**	**A**	14.3	18.7	27.5	35.2	41.8	49.5
	VT	**Rated Input Current**	**A**	17.3	22.6	30.8	39.6	45.7	53.9
	Rated Voltage/Frequency			Three-phase 380-480 VAC (-15% to +10%), 50/60 Hz					
	Operating Voltage Range (VAC)			323-528					
	Frequency Tolerance (Hz)			47–63					
IE2 Efficiency – Relative Power Loss				2.0%	1.9%	1.8%	1.7%	1.5%	1.5%
Weight (kg)				2.07	2.07	3.97	3.97	6.25	6.25
Cooling Method				Fan					
IP Rating				IP20					

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

575V Class – 3-Phase Model-Specific Specifications

GS20 575V Class Specifications; Frame Size A, B, C, D[1]									
Model Name: GS23-5xxx				**GS23-51P0**	**GS23-52P0**	**GS23-53P0**	**GS23-55P0**	**GS23-57P5**	**GS23-5010**
Frame Size				**A**	**B**	**C**	**C**	**D**	**D**
Output Rating	**Max Motor Output**		**hp**	1	2	3	5	7 1/2	10
			kW	0.75	1.5	2.2	3.7	5.5	7.5
	CT	**Rated Output Capacity**	**kVA**	1.7	3	4.2	6.6	9.9	12.2
		Rated Output Current	**A**	1.7	3	4.2	6.6	9.9	12.2
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
	VT	**Rated Output Capacity**	**kVA**	2.1	3.6	5	8	11.5	15
		Rated Output Current	**A**	2.1	3.6	5	8	11.5	15
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
Input Rating[2]	**CT**	**Rated Input Current**	**A**	2	3.5	4.9	7.7	11.5	14.2
	VT	**Rated Input Current**	**A**	2.4	4.2	5.8	9.3	13.4	17.5
	Rated Voltage/Frequency			Three-phase 500-600 VAC (-15% to +10%), 50/60 Hz					
	Operating Voltage Range (VAC)			425–660					
	Frequency Tolerance (Hz)			47–63					
IE2 Efficiency – Relative Power Loss				3.9%	2.7%	2.3%	1.9%	2.0%	1.9%
Weight (kg)				0.85	0.87	1.18	1.29	2.04	2.04
Cooling Method				Convective	Fan				
IP Rating				IP20					

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

DURAPULSE GS20X AC DRIVE SPECIFICATIONS

230V CLASS – 1-PHASE MODEL-SPECIFIC SPECIFICATIONS

GS20X 230V Class Specifications; Frame Size A, B[1]							
Model Name: GS21X-2xxx				**GS21X-20P5**	**GS21X-21P0**	**GS21X-22P0**	**GS21X-23P0**
Frame Size				**A**	**A**	**A**	**B**
Output Rating	**Max Motor Output**		**hp**	1/2	1	2	3
			kW	0.4	0.75	1.5	2.2
	CT	**Rated Output Capacity**	**kVA**	1.1	1.7	2.9	4.2
		Rated Output Current	**A**	2.8	4.8	7.5	11
		Carrier Frequency[3]	**kHz**	2–15 (default 4)			
	VT	**Rated Output Capacity**	**kVA**	1.2	1.9	3.2	4.8
		Rated Output Current	**A**	3.2	5	8.5	12.5
		Carrier Frequency[3]	**kHz**	2–15 (default 4)			
Input Rating[2]	**CT**	**Rated Input Current**	**A**	7.3	10.8	16.5	24.2
	VT	**Rated Input Current**	**A**	8.3	11.3	18.5	27.5
	Rated Voltage/Frequency			One-phase 200-240 VAC (-15% to +10%), 50/60 Hz			
	Operating Voltage Range (VAC)			170–264			
	Frequency Tolerance (Hz)			47–63			
IE2 Efficiency – Relative Power Loss				3.4%	2.9%	2.5%	2.5%
Weight (kg)				2.25	2.6	3.1	3.5
Cooling Method				Convective			Fan
IP Rating				IP66 / NEMA 4X			

1 - For use with three-phase motors only.
2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.
3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

230V Class – 3-Phase Model-Specific Specifications

GS20X 230V Class Specifications; Frame Size A, B, C[1]									
Model Name: GS23X-2xxx				**GS23X-20P5**	**GS23X-21P0**	**GS23X-22P0**	**GS23X-23P0**	**GS23X-25P0**	**GS23X-27P5**
Frame Size				**A**	**A**	**A**	**B**	**B**	**C**
Output Rating	**Max Motor Output (3-phase [1-phase])[4]**		**hp**	0.5 [0.25]	1 [0.5]	2 [1]	3 [1.5]	5 [2.5]	7.5 [3.5]
			kW	0.4 [0.2]	0.75 [0.375]	1.5 [0.75]	2.2 [1.1]	3.7 [1.85]	5.5 [2.75]
	CT	**Rated Output Capacity (3-phase [1-phase])**	**kVA**	1.1 [0.55]	1.8 [0.9]	2.9 [1.5]	4.2 [2.1]	6.5 [3.25]	9.5 [4.75]
		Rated Output Current (3-phase [1-phase])	**A**	2.8 [1.4]	4.8 [2.4]	7.5 [3.75]	11 [5.5]	17 [8.5]	25 [12.5]
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
	VT	**Rated Output Capacity**	**kVA**	1.2	1.9	3	4.8	7.4	10.3
		Rated Output Current	**A**	3.2	5	8	12.5	19.5	27
		Carrier Frequency[3]	**kHz**	2–15 (default 4)					
Input Rating[2]	**CT**	**Rated Input Current**	**A**	3.4	5.8	9	13.2	20.4	30
	VT	**Rated Input Current**	**A**	3.8	6	9.6	15	23.4	32.4
	Rated Voltage/Frequency			3-phase or 1-phase 200-240 VAC (-15% to +10%), 50/60 Hz					
	Operating Voltage Range (VAC)			170–264					
	Frequency Tolerance (Hz)			47–63					
IE2 Efficiency – Relative Power Loss				3.4%	2.9%	2.5%	2.5%	2.2%	2.3%
Weight (kg)				2.3	2.45	2.75	3.4	3.5	4.25
Cooling Method				Convective			Fan		
IP Rating				IP66 / NEMA 4X					

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to "Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

4 - Three phase models can be powered with 1-phase or 3-phase input power. If using 1-phase input power, GS21 models up to 3HP provide higher output power than equivalent GS23 model with 1-phase.

460V Class – 3-Phase Model-Specific Specifications

GS20X 460V Class Specifications; Frame Size A, B, C[1]									
Model Name: GS23X-4xxx				GS23X-40P5	GS23X-41P0	GS23X-42P0	GS23X-43P0	GS23X-45P0	GS23X-47P5	GS23X-4010
Frame Size				A	A	A	A	B	C	C
Output Rating	Max Motor Output		hp	1/2	1	2	3	5	7 1/2	10
			kW	0.4	0.75	1.5	2.2	3.7	5.5	7.5
	CT	Rated Output Capacity	kVA	1.1	2.1	3.2	4,2	6.9	9.9	13
		Rated Output Current	A	1.5	2.7	4.2	5.5	9	13	17
		Carrier Frequency[3]	kHz	2–15 (default 4)						
	VT	Rated Output Capacity	kVA	1,4	2.3	3.5	5	8	12	15.6
		Rated Output Current	A	1.8	3	5.6	6.5	10.5	15.7	20.5
		Carrier Frequency[3]	kHz	2–15 (default 4)						
Input Rating[2]	CT	Rated Input Current	A	2.1	3.7	5.8	6.2	9.9	14.3	18.7
	VT	Rated Input Current	A	2.5	4.2	6.4	7.2	11.6	17.3	22.6
	Rated Voltage/Frequency			Three-phase 380-480 VAC (-15% to +10%), 50/60 Hz						
	Operating Voltage Range (VAC)			323–528						
	Frequency Tolerance (Hz)			47–63						
IE2 Efficiency – Relative Power Loss				4.0%	2.6%	2.3%	2.3%	2.0%	2.0%	1.9%
Weight (kg)				2.35	2.6	2.8	3.6	3.45	4.25	4.25
Cooling Method				Convective				Fan		
IP Rating				IP66 / NEMA 4X						

1 - For use with three-phase motors only.

2 - If three-phase power source is non-symmerical, refer to ""Circuit Connections – RFI Jumper" on page 2–16. Please refer to "Appendix A - Accessories" for input fusing information.

3 - The value of the carrier frequency is a factory default. Decrease the current value if you need to increase the carrier frequency. Refer to "Derate Output Current Based on Carrier Frequency (if necessary)" on page 1–15

Receiving and Inspection

Drive Package Contents

After receiving the GS20(X) AC drive, please check the following:

1) Make sure that the package includes the DURApulse GS20 or GS20X AC drive and the Quick-Start Guide that matches your product.
2) Please inspect the unit after unpacking to assure it was not damaged during shipment. Make sure that the part number printed on the package corresponds with the part number indicated on the nameplate.
3) Make sure that the part number indicated on the nameplate corresponds with the part number of your order.
4) Make sure that the voltage for the wiring lies within the range as indicated on the nameplate. Please install the GS20(X) AC drive according to this manual.
5) Before applying the power, please make sure that all the devices, including power, motor, control board, and digital keypad are connected correctly.
6) When wiring the GS20(X) AC drive, please make sure that the wiring of input terminals "R/L1, S/L2, T/L3" and output terminals "U/T1, V/T2, W/T3" are correct to prevent drive damage.
7) When power is applied, select the language and set parameter groups via the digital keypad. When executing a trial run, please begin with a low speed, and then gradually increase the speed until the desired speed is reached.

The GS20(X) AC drive should be kept in the shipping carton before installation. In order to retain the warranty coverage, the GS20(X) AC drive should be stored properly when it is not to be used for an extended period of time. Refer to the preceding "Environmental Information" section for proper storage conditions.

Model Number Explanation

GS21(x)- 4 7P5

Applicable Motor Capacity*

0P2: 0.25hp	0P5: 0.5hp	1P0: 1.0hp	2P0: 2.0hp
3P0: 3.0hp	5P0: 5.0hp	7P5: 7.5hp	010: 10hp
015: 15hp	020: 20hp	025: 25hp	030: 30hp

*Not all capacities are available in each voltage.

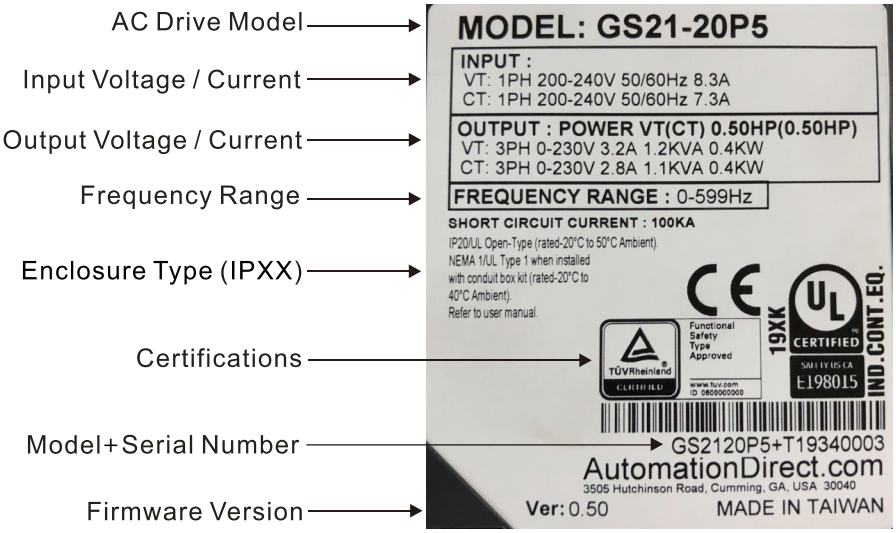
Input Voltage
1: 120VAC
2: 230VAC
4: 460VAC
5: 575VAC

Model Line
<blank>: Standard GS20
X: NEMA 4X
A: Accessories

Phase
1: One-phase
3: Three-phase

Series Name

Nameplate Information



Installation and Wiring

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Drive Models by Frame Size

GS20 *DURA*PULSE Drive Models by Frame Size	
Frame	***Drive***
A	GS21-10P2, GS21-20P2, GS23-20P2, GS23-20P5, GS21-10P5, GS21-20P5, GS23-40P5, GS23-21P0, GS23-41P0, GS23-51P0
B	GS23-22P0, GS23-42P0, GS23-52P0, GS21-21P0
C	GS21-11P0, GS21-22P0, GS21-23P0, GS23-23P0, GS23-25P0, GS23-43P0, GS23-45P0, GS23-53P0, GS23-55P0
D	GS23-27P5, GS23-47P5, GS23-4010, GS23-57P5, GS23-5010
E	GS23-2010, GS23-2015, GS23-4015, GS23-4020
F	GS23-2020, GS23-4025, GS23-4030

GS20X *DURA*PULSE Drive Models by Frame Size	
Frame	***Drive***
A	GS21X-20P5, GS21X-21P0, GS21X-22P0, GS23X-20P5, GS23X-40P5, GS23X-41P0, GS21X-22P0, GS23X-22P0, GS23X-42P0, GS23X-43P0
B	GS21X-23P0, GS23X-23P0, GS23X-25P0, GS23X-45P0
C	GS23X-27P5, GS23X-47P5, GS23X-4010

Installation

Install the AC drive in an enclosure that is specifically designed to house electrical and electronic control equipment. Provide proper spacing within the enclosure to allow the dissipation of heat produced by the drive and any other included electrical and electronic equipment. Ventilation or air conditioning may also be required, depending upon the application.

Failure to observe these precautions may damage the drive and void the warranty!

Improper installation of the AC drive will greatly reduce its life. Observe the following precautions when installing the drive:

GS20:

- *Do not mount the AC drive near heat-radiating elements or in direct sunlight.*
- *Do not install the AC drive in a place subjected to high temperature, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles.*
- *Install the AC drive in Pollution Degree 2 environments only.*
  Pollution Degree 2: Normally only non-conductive pollution occurs. Temporary conductivity caused by condensation is to be expected.
- *Install the AC drive in a cabinet. When installing one drive below another, use a metal separator between the drives to prevent mutual heating and to prevent the risk of fire.*
- *Mount the AC drive securely on a flat, rigid, non-flammable surface.*
- *Mount the AC drive vertically and do not restrict the air flow to the heat sink fins.*
- *Prevent fiber particles, scraps of paper, shredded wood saw dust, metal particles, etc. from adhering to the heat sink.*

GS20X:

- *Prevent fiber particles, scraps of paper, shredded wood, saw dust, metal particles, etc., from adhering to the heat sink.*
- *Install the AC motor drive in an incombustible (non-flammable) indoor environment to prevent the risk of accidental fire.*
- *Install the AC motor drive in Pollution Degree 2 environments only: normally only nonconductive pollution occurs and temporary conductivity caused by condensation is expected.*

AC drives generate a large amount of heat which may damage them. Auxiliary cooling methods are typically required in order not to exceed maximum ambient temperatures.

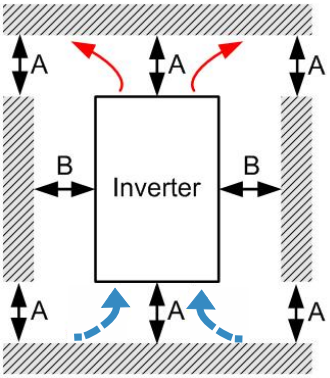
Minimum Clearances and Air Flow

Diagram Directional Arrows

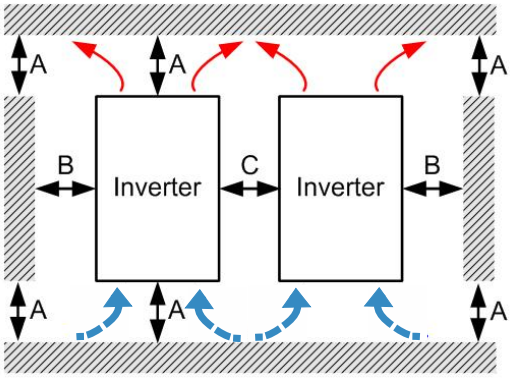
- *Air Inflow: Blue Arrow* → →
- *Air Outflow: Red Arrow* → →
- *Distance: Black Arrows* ↔ ↔

GS20 Series Minimum Clearance Distances

1) Single Drive Installation (Frames A–F)



2) Multiple Drives Side-By-Side



GS20 Minimum Mounting Clearances*					
Installation Method	**A (mm)**	**B (mm)**	**C (mm)**	**Operation Temperature (°C)**	
				Max (w/out derating)	**Max (Derating)**
Single drive installation	50	30	–	50	60
Side-by-side horizontal installation	50	30	30	50	60
Zero stack installation	50	30	0	40	50
** The minimum mounting clearances stated in this table apply to GS20 drives frames A to F. Failure to follow the minimum mounting clearances may cause the fan to malfunction and cause a heat dissipation problem.*					

GS20 Airflow and Power Dissipation

GS20 Airflow and Power Dissipation						
Model Number	Frame Size	Airflow Rate for Cooling		Power Dissipation (Watts)		
		Flow Rate (cfm)	Flow Rate (m^3/hr)	Loss External (Heat sink)	Internal	Total
GS21-10P2	A	0.0	0.0	8.0	10.0	18.0
GS21-10P5				14.2	13.1	27.3
GS21-11P0	C	16.0	27.2	29.1	23.9	53.0
GS21-20P2	A	0.0	0.0	8.0	10.3	18.3
GS21-20P5				16.3	14.5	30.8
GS21-21P0	B			29.1	20.1	49.2
GS21-22P0	C	16.0	27.2	29.1	23.9	53.0
GS21-23P0				70.0	35	105
GS23-2010	E	53.7	91.2	244.5	79.6	324.1
GS23-2015				374.2	86.2	460.4
GS23-2020	F	67.9	115.2	492.0	198.2	690.2
GS23-20P2	A	0.0	0.0	8.6	10.0	18.6
GS23-20P5				16.5	12.6	29.1
GS23-21P0				31.0	13.2	44.2
GS23-22P0	B	10.0	16.99	50.1	24.2	74.3
GS23-23P0	C	16.0	27.2	76.0	30.7	106.7
GS23-25P0				108.2	40.1	148.3
GS23-27P5	D	23.4	39.7	192.8	53.3	246.1
GS23-4010				164.7	55.8	220.5
GS23-4015	E	53.7	91.2	234.5	69.8	304.3
GS23-4020				319.8	74.3	394.1
GS23-4025	F	67.9	115.2	423.5	181.6	605.1
GS23-4030				501.1	200.3	701.4
GS23-40P5	A	10.0	16.99	17.6	11.1	28.7
GS23-41P0				30.5	17.8	48.3
GS23-42P0	B			45.9	21.7	67.6
GS23-43P0	C	16.0	27.2	60.6	22.8	83.4
GS23-45P0				93.1	42	135.1
GS23-47P5	D	23.4	39.7	132.8	39.5	172.3
GS23-5010				108.4	51	159.4
GS23-51P0	A	0.0	0.0	23.5	12.5	36
GS23-52P0	B	10.0	16.99	38.1	19	57.1
GS23-53P0	C	16.0	27.2	56.6	22.2	68.8
GS23-55P0				76.1	30	106.1
GS23-57P5	D	23.4	39.7	93.9	37	130.9

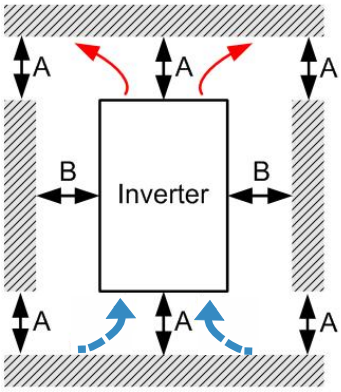
- Published flow rates are the result of active cooling using fans, factory installed in the drive.
- Unpublished flow rates (0.0) are the result of passive cooling in drives without factory installed fans.
- The required airflow shown in the chart is for installing a single GS20 drive in a confined space.
- When installing multiple GS20 drives, the required air volume would be the required air volume for a single GS20 drive multiplied by the number of GS20 drives.
- When calculating power dissipation (Watt Loss), use the Total value. Heat dissipation shown in the chart is for installing a single GS20 drive in a confined space.
- When installing multiple drives, the volume of heat/power dissipation should be the heat/power dissipated by a single GS20 drive multiplied by the number of GS20 drives.
- Heat dissipation for each model is calculated by rated voltage, current and default carrier frequency.

GS20X Series Minimum Clearance Distances

Diagram Directional Arrows

- *Air Inflow: Blue Arrow* → →
- *Air Outflow: Red Arrow* → →
- *Distance: Black Arrows* ↔ ↔

1) Single Drive Installation (Frames A–C)



GS20X Minimum Mounting Clearances*				
Installation Method	**A (mm)**	**B (mm)**	**Operation Temperature (°C)**	
			Max (w/out derating)	**Max (Derating)**
Single drive installation	50	30	40	50
** The minimum mounting clearances stated in this table apply to GS20X drives frames A to C. Failure to follow the minimum mounting clearances may cause a heat dissipation problem.*				

GS20X Airflow and Power Dissipation

GS20X Airflow and Power Dissipation						
Model Number	**Frame Size**	**Airflow Rate for Cooling**		**Power Dissipation (Watts)**		
		Flow Rate (cfm)	**Flow Rate (m^3/hr)**	**Loss External (Heat sink)**	**Internal**	**Total**
GS21X-20P5	A	0.0	0.0	16.3	14.5	30.8
GS21X-21P0				29.1	20.1	49.2
GS23X-20P5				16.5	12.6	29.1
GS23X-21P0				29.1	20.1	49.2
GS23X-40P5				17.6	11.1	28.7
GS23X-41P0				30.5	17.8	48.3
GS21X-22P0				46.5	31	77.5
GS23X-22P0				50.1	24.2	74.3
GS23X-42P0				45.9	21.7	67.6
GS23X-43P0				60.6	22.8	83.4
GS21X-23P0	B	27.3	46.4	70.0	35.0	105.0
GS23X-23P0				76.0	30.7	106.7
GS23X-25P0				108.2	40.1	148.3
GS23X-45P0				93.1	42.0	135.1
GS23X-27P5	C	33.5	56.6	192.8	53.3	246.1
GS23X-47P5				132.8	39.5	172.3
GS23X-4010				164.7	53.3	246.1
• Published flow rates are the result of active cooling using fans, factory installed in the drive. • Unpublished flow rates (-) are the result of passive cooling in drives without factory installed fans. • The required airflow shown in the chart is for installing a single GS20X drive in a confined space.				• When calculating power dissipation (Watt Loss), use the Total value. Heat dissipation shown in the chart is for installing a single GS20X drive in a confined space. • Heat dissipation for each model is calculated by rated voltage, current and default carrier frequency.		

Dimensions

(Units = mm [in])

See our website: for complete engineering drawings and 3D models.

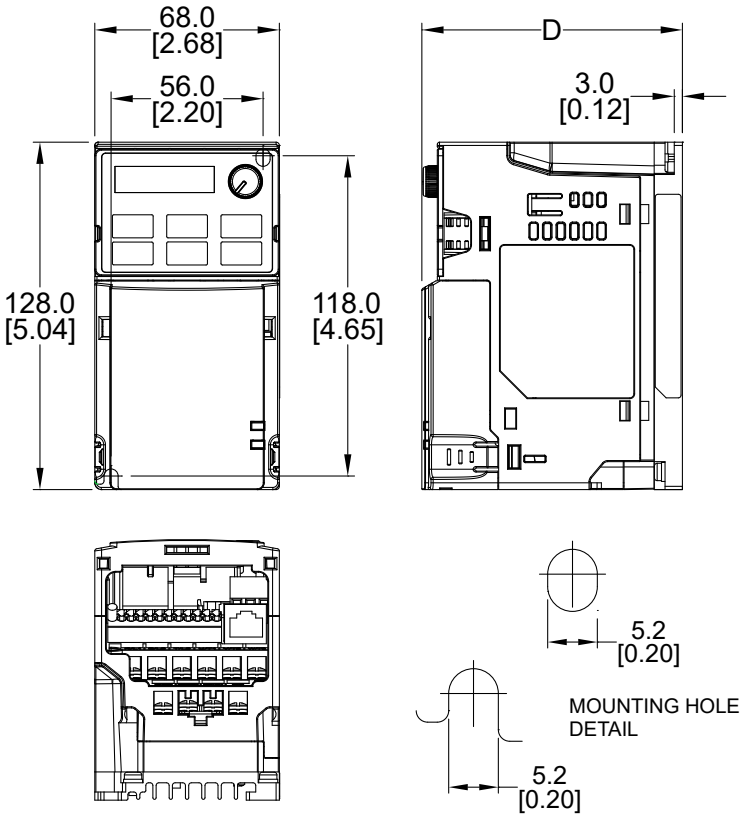
GS20 DURAPULSE Frame Sizes by Drive Model							
120V		230V		460V		575V	
Drive	Frame	Drive	Frame	Drive	Frame	Drive	Frame
GS21-10P2	A1	GS21-20P2	A1	GS23-40P5	A4	GS23-51P0	A5
GS21-10P5	A3	GS21-20P5	A3	GS23-41P0	A5	GS23-52P0	B1
GS21-11P0	C1	GS21-21P0	B2	GS23-42P0	B1	GS23-53P0	C1
		GS21-22P0	C1	GS23-43P0	C1	GS23-55P0	C1
		GS21-23P0	C1	GS23-45P0	C1	GS23-57P5	D1
		GS23-20P2	A1	GS23-47P5	D1	GS23-5010	D1
		GS23-20P5	A2	GS23-4010	D1		
		GS23-21P0	A5	GS23-4015	E1		
		GS23-22P0	B1	GS23-4020	E1		
		GS23-23P0	C1	GS23-4025	F1		
		GS23-25P0	C1	GS23-4030	F1		
		GS23-27P5	D1				
		GS23-2010	E1				
		GS23-2015	E1				
		GS23-2020	F1				

GS20X DURAPULSE Frame Sizes by Drive Model			
230V		460V	
Drive	Frame	Drive	Frame
GS21X-20P5	A1	GS23X-40P5	A1
GS21X-21P0	A1	GS23X-41P0	A1
GS21X-22P0	A2	GS23X-42P0	A2
GS21X-23P0	B	GS23X-43P0	A3
GS23X-20P5	A1	GS23X-45P0	B
GS23X-21P0	A1	GS23X-47P5	C
GS23X-22P0	A2	GS23X-4010	C
GS23X-23P0	B		
GS23X-25P0	B		
GS23X-27P5	C		

Dimensions (Units = mm [in])

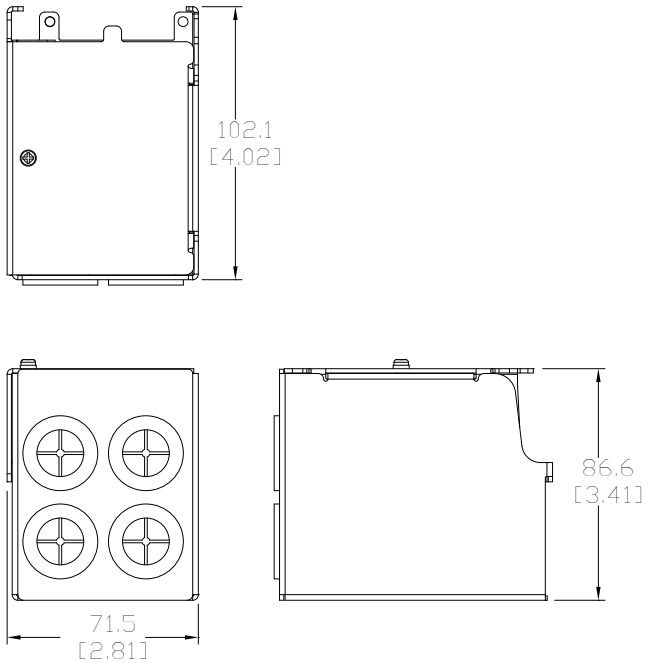
See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size A



A Frame "D" Dimension	
Frame	**D mm [in]**
A1	96.0 [3.78]
A2	110.0 [4.33]
A3	125.0 [4.92]
A4	129.0 [5.08]
A5	143.0 [5.63]

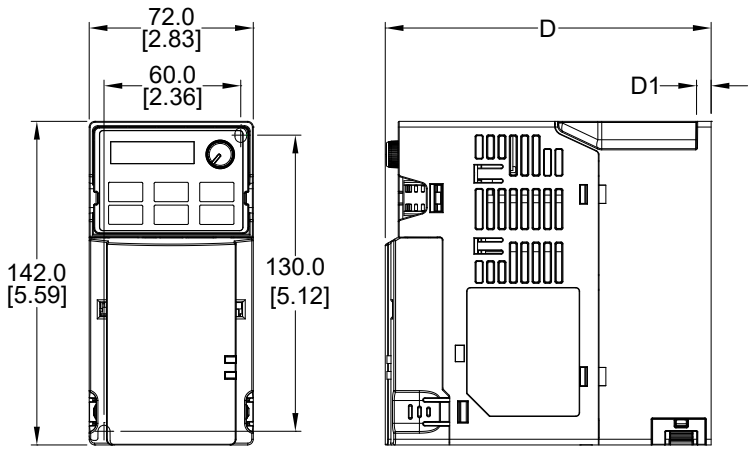
GS20 Frame Size A Conduit Box

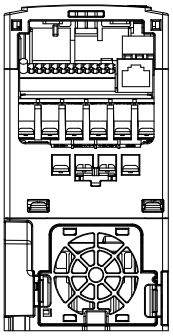


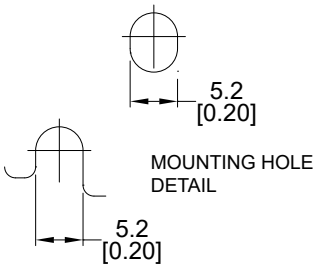
Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size B



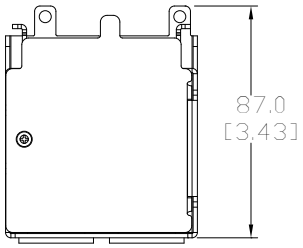


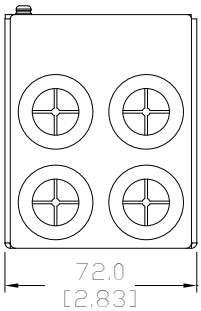


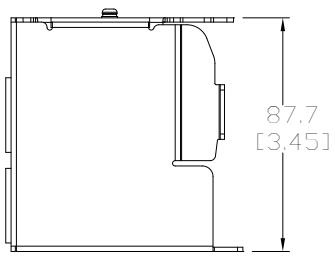
B Frame "D" & "D1"Dimensions		
Frame	D mm [in]	D1 mm [in]
B1	143.0 [5.63]	6.4 [0.25]
B2	143.0 [5.63]	3.0 [0.12]

NOTE: B2 frame does not have a cooling fan.

GS20 Frame Size B Conduit Box



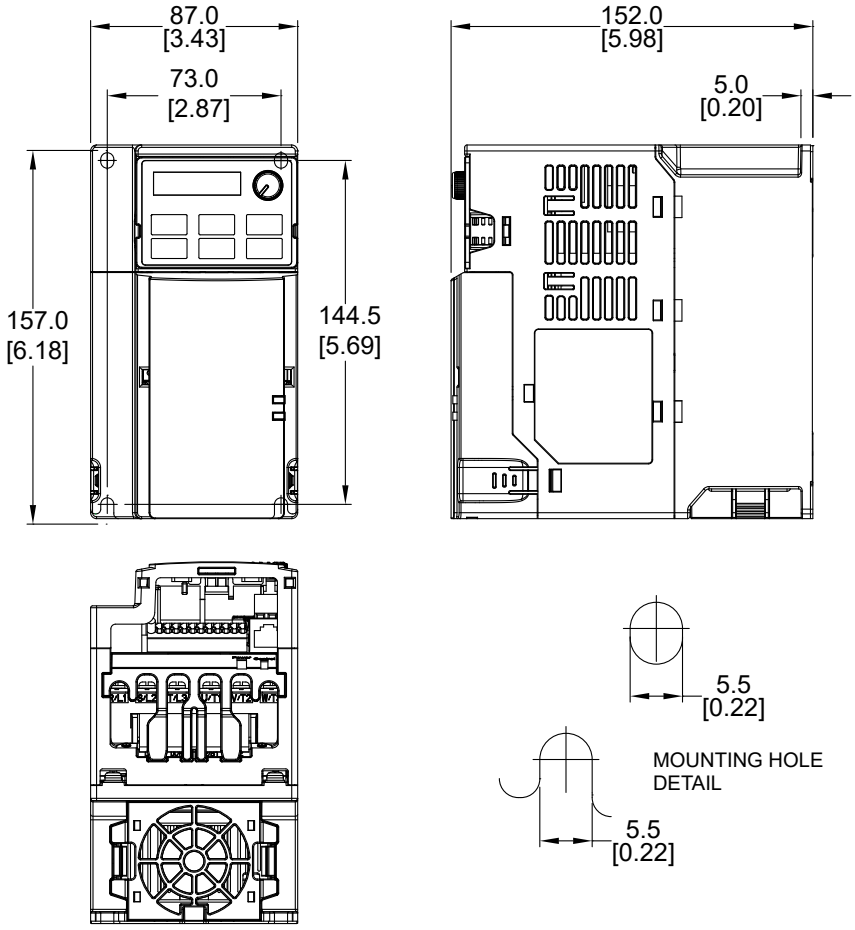




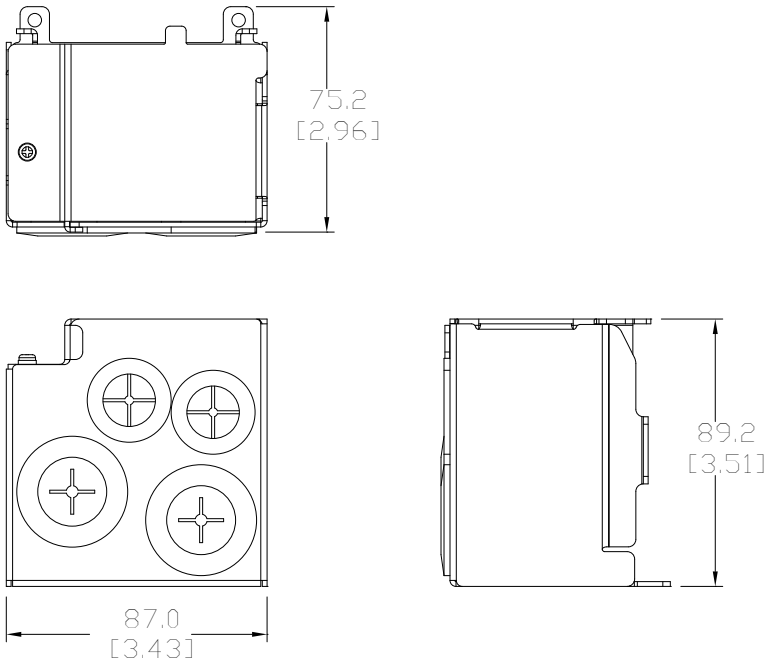
Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size C



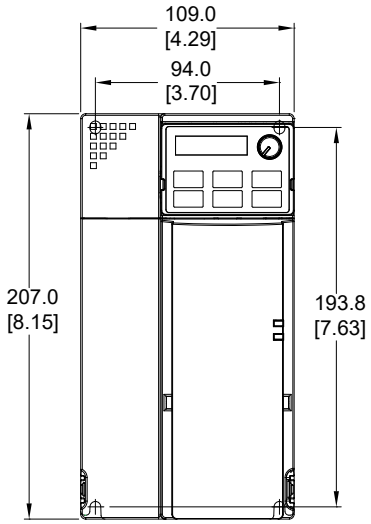
GS20 Frame Size C Conduit Box

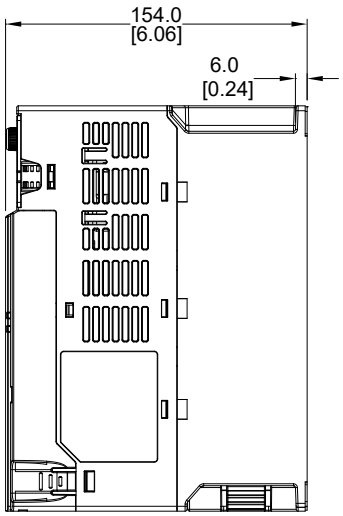


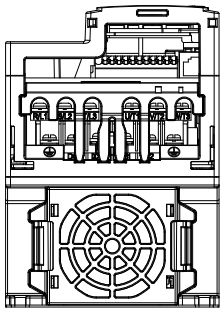
Dimensions (Units = mm [in])

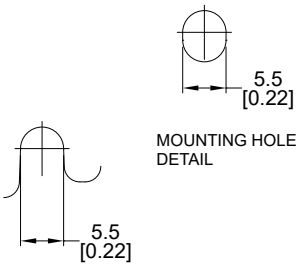
See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size D

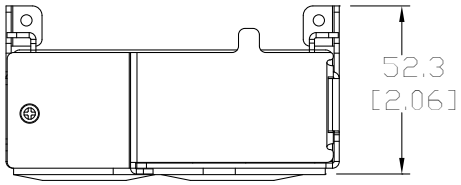


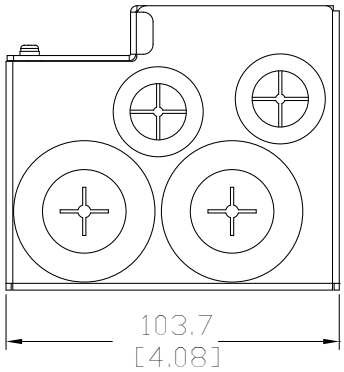


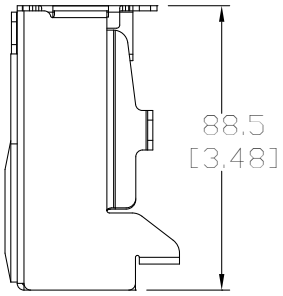




GS20 Frame Size D Conduit Box



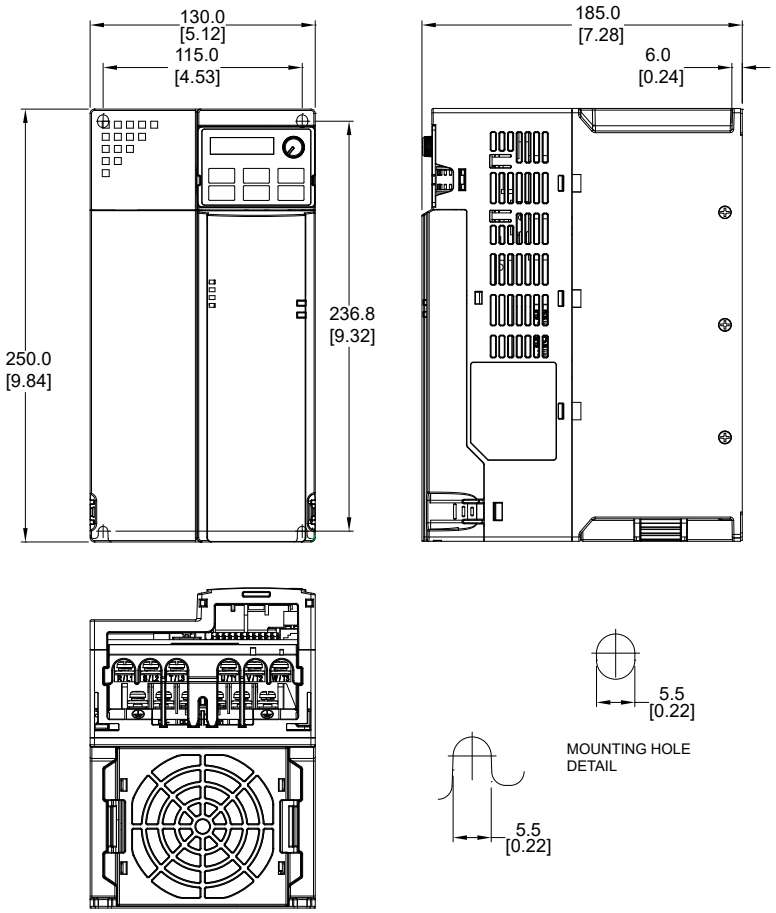




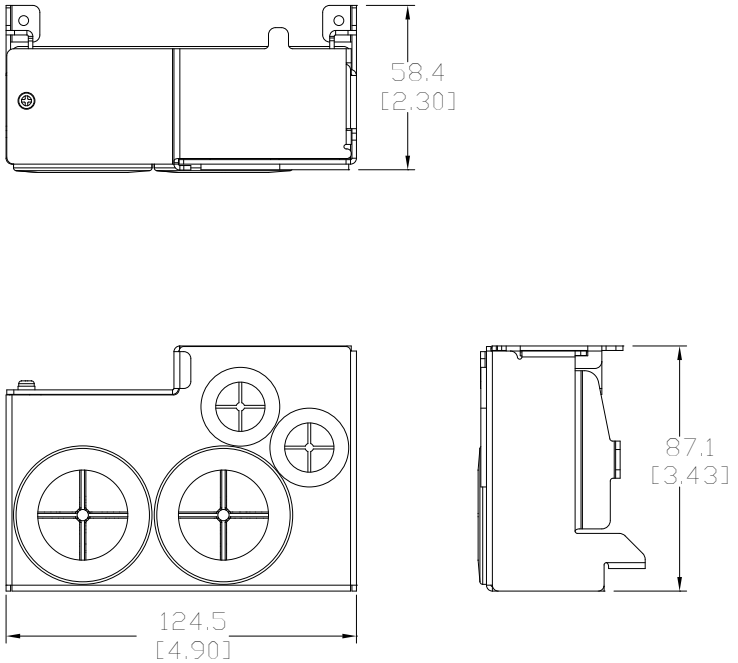
Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size E



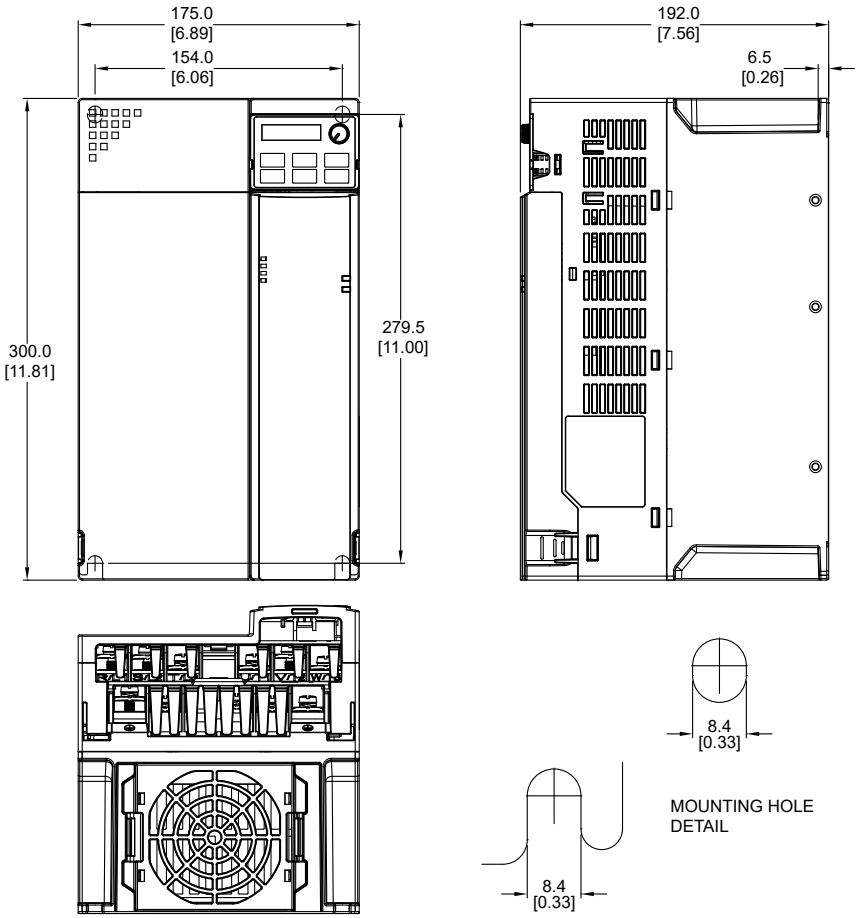
GS20 Frame Size E Conduit box



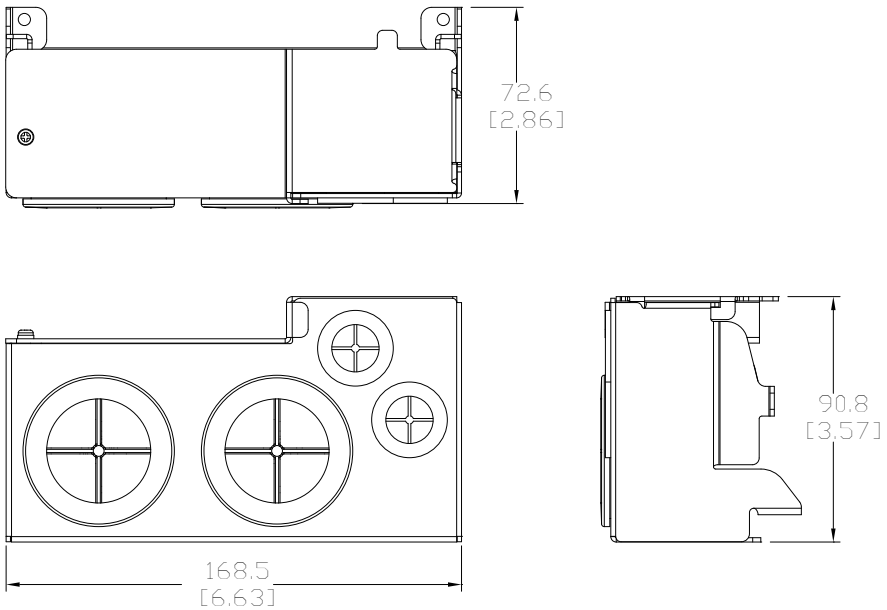
Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20 Frame Size F



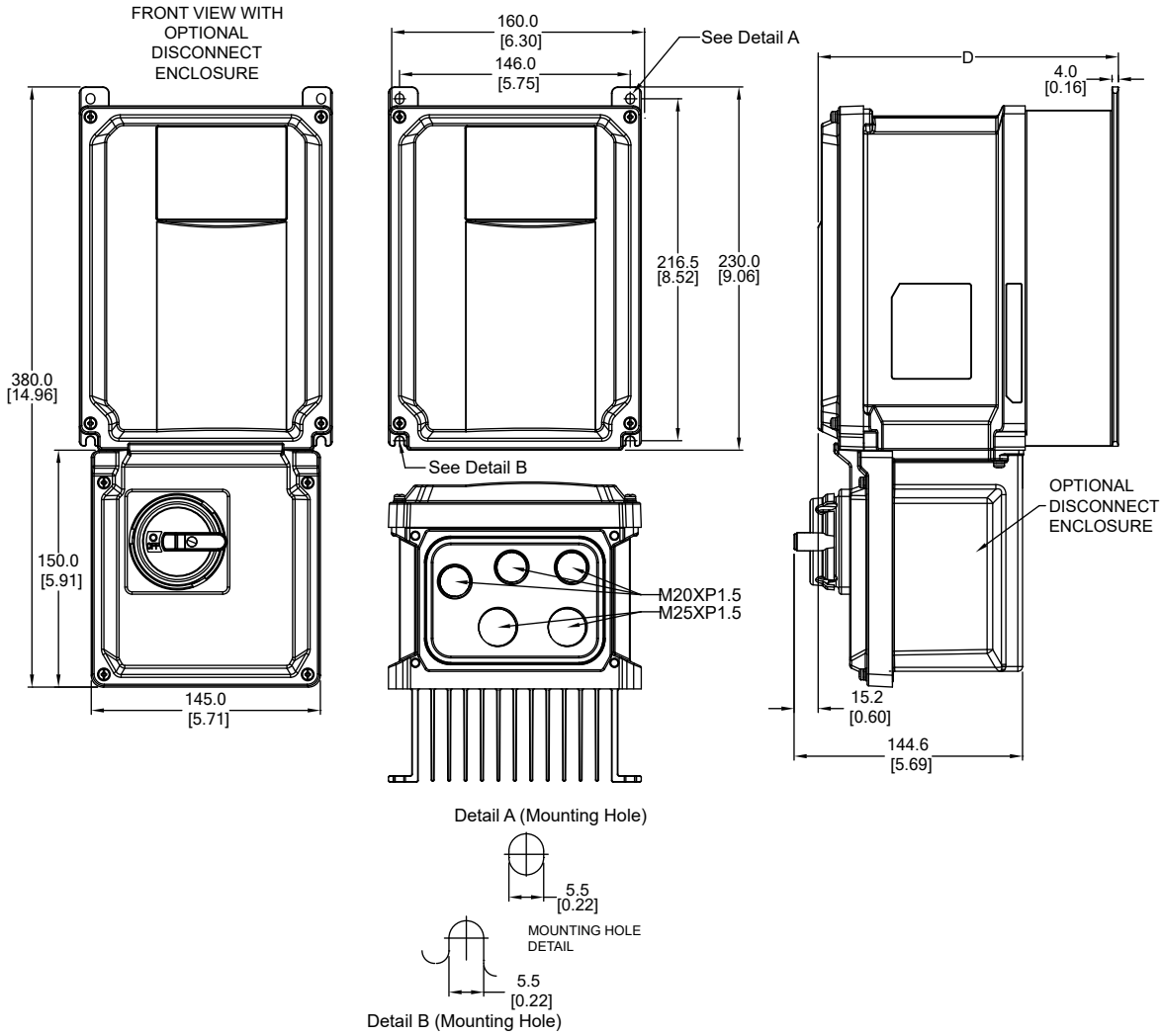
GS20 Frame Size F Conduit box



Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20X Frame Size A

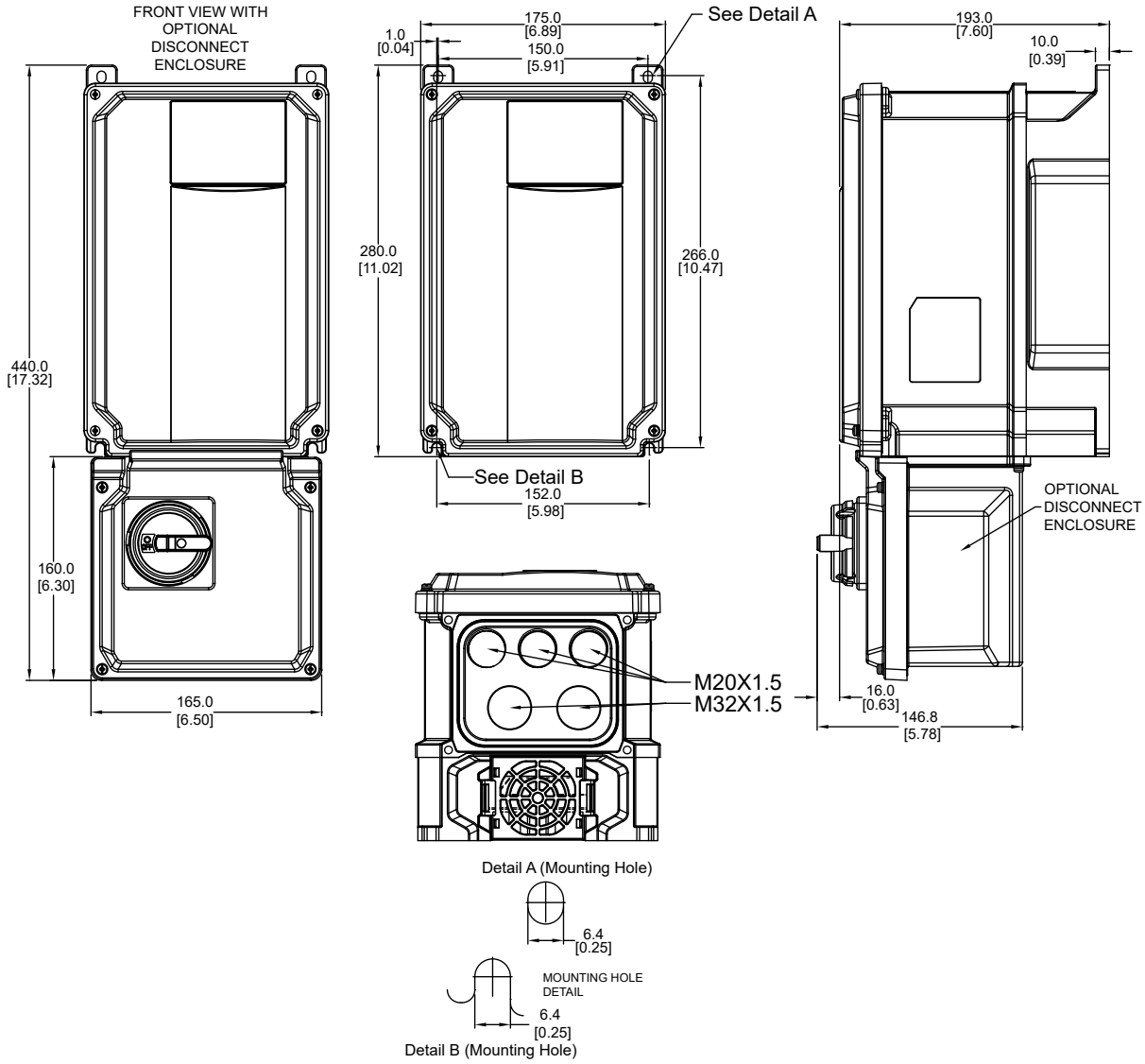


A Frame "D" Dimension	
Frame	**D mm [in]**
A1	151.0 [5.94]
A2	167.0 [6.57]
A3	190.0 [7.48]

Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

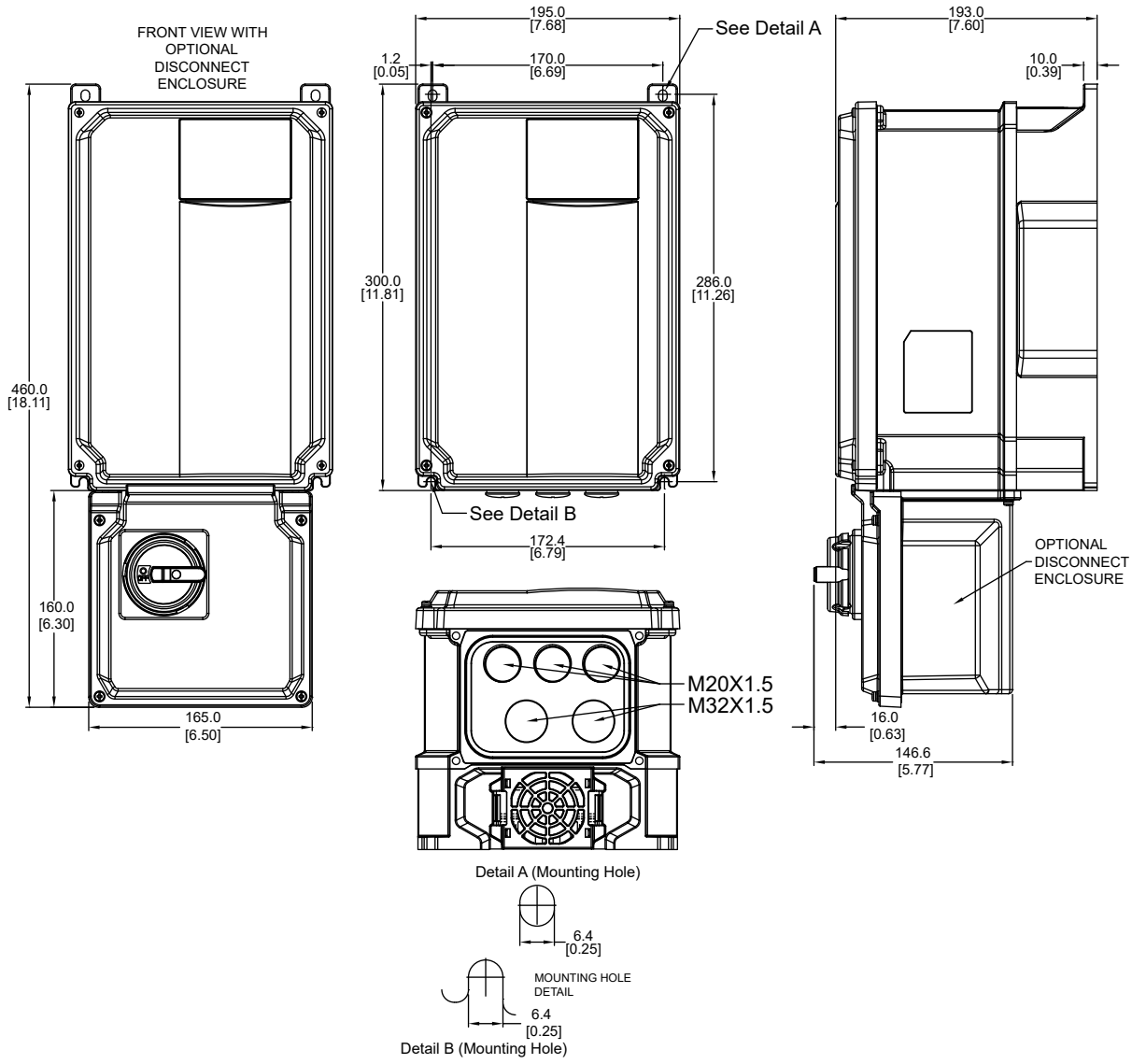
GS20X Frame Size B



Dimensions (Units = mm [in])

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.

GS20X Frame Size C



Circuit Connections – RFI Jumper

RFI Jumper: The GS20 & GS20X drives may emit electrical noise. The drive contains Varistors / MOVs that are connected from phase to phase and from phase to ground to prevent the drive from unexpected stop or damage caused by mains surges or voltage spikes. Because the Varistors / MOVs from phase to ground are connected to ground with the RFI jumper, removing the RFI jumper disables the protection.

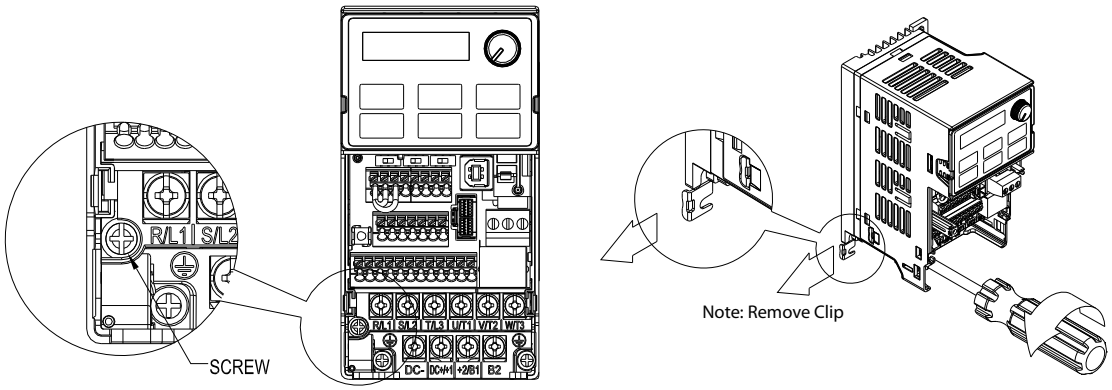
RFI Jumper Removal

The RFI jumper may need to be removed in some cases, such as situations in which the GS20(X) drive is powered from an Asymmetric Ground System (Corner Grounded TN System), as described on page 2–18.

GS20 Frames A~F

Screw Torque: 4~6 kg·cm [3.5~5.2 lb·in]

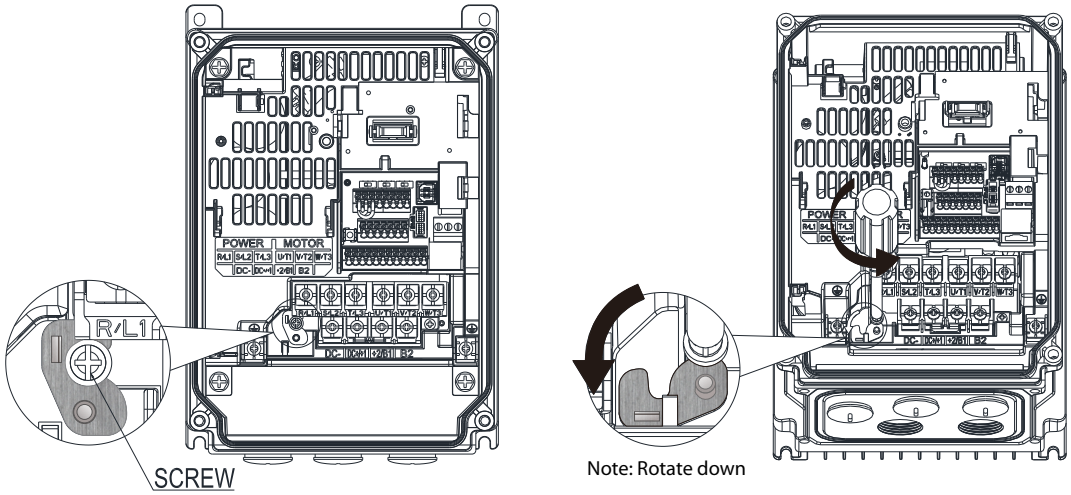
Loosen the screw indicated in the view below, and remove the RFI jumper. Tighten the screw to the specified torque after the RFI jumper is removed.



GS20X Frames A~C

Screw Torque: 4~6 kg·cm [3.5~5.2 lb·in]

Loosen the screw indicated in the view below, and remove the RFI jumper. Tighten the screw to the specified torque after the RFI jumper is removed.



Isolating Main Power from Ground

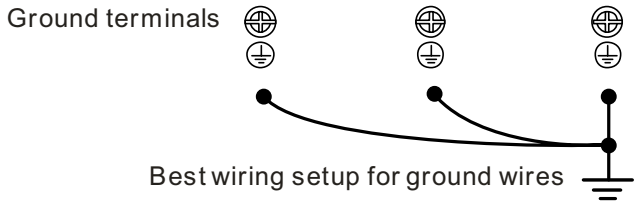
WARNING: If the power distribution system supplying the GS20 or GS20X drive is 120V, the RFI jumper must be removed.

WARNING: If the power distribution system supplying the GS20 or GS20X drive is a floating-ground system (IT) or an asymmetric-ground system (TN), the RFI jumper MUST BE REMOVED.

If the power distribution system supplying the GS20 or GS20X drive is a floating ground system (IT) or an asymmetric ground system (TN), the RFI jumper must be removed. Removing the RFI jumper disconnects the internal RFI filter capacitor between the drive's frame and circuits to avoid damaging those circuits and to reduce ground leakage current.

Important points regarding ground connection

- *To ensure the safety of personnel, proper operation, and to reduce electromagnetic radiation, the GS20 or GS20X drive must be properly grounded during installation.*
- *The diameter of the cables must meet the size specified by applicable codes and regulations.*
- *The shield of shielded cables must be connected to the ground of the GS20 or GS20X drive to meet safety regulations.*
- *The shield of shielded cables can be used as the ground for equipment only when the aforementioned points are met.*
- *When installing multiple GS20(X) drives, do not connect the grounds of the AC motor drive in series. Instead, utilize a single-point grounding scheme (as shown below), or provide individual grounding rods for each GS20(X) drive.*



Pay particular attention to the following WARNINGS:

WARNING: Do not remove the RFI jumper while power is applied to the GS20(X) drive.

WARNING: Cutting the RFI short-circuit cable will also cut off the conductivity of the capacitor. Gap discharge may occur once the transient voltage exceeds 1000V.

WARNING: The RFI jumper may not be removed if the main power is a symmetrically grounded power system.

WARNING: The RFI jumper may not be removed while conducting high voltage tests.

WARNING: When conducting a high voltage test to the entire facility, the main power and the motor must be disconnected if leakage current is too high.

Floating Ground System (IT Systems)

A floating ground system is also called an IT system, an ungrounded system, or a high impedance/ resistance grounding system (greater than 30Ω).

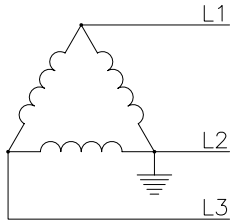
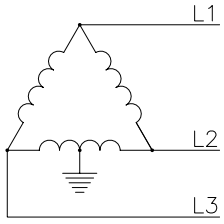
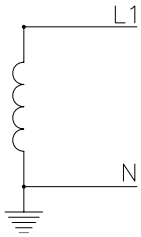
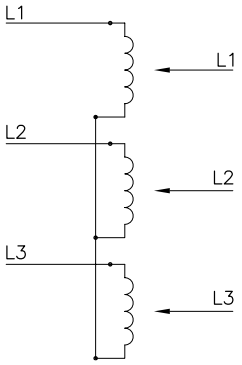
Disconnect the RFI Jumper

CAUTION: Do not install an external RFI/EMC filter! The EMC filter will pass through the RFI capacitor, thus connecting power input to ground. This is very dangerous and can easily damage the GS20 drive.

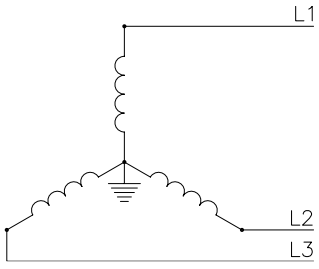
Asymmetric Ground System (Corner Grounded TN Systems)

CAUTION: Do not remove the RFI jumper while the input terminals of the GS20 drive carries power.

The RFI jumper must be removed in the following four situations. This is to prevent the system from grounding through the RFI capacitor, damaging the GS20 drive.

RFI Jumper Must Be Removed (Asymmetric Ground / Corner Grounded TN Systems)	
1) Grounding at a Corner of a Triangle Configuration 	**2) Grounding at a Midpoint in a Polygonal Configuration** 
3) Grounding at One End in a Single-Phase Configuration 	**4) No Stable Neutral Grounding in a Three-Phase Autotransformer Configuration** 

The RFI jumper should be left in place for a symmetrically grounded system.

RFI Jumper Left In Place (Symmetrical Ground System)	
Internal grounding through internal RFI filter, which reduces electromagnetic radiation. In a situation with higher requirements for electromagnetic compatibility, and using a symmetrical grounding power system, an EMC filter can be installed. As a reference, the diagram on the right is a symmetrical grounding power system.	

Circuit Connections – Warnings and Notes

Danger!

Hazardous Voltage! Before making any connection to the AC drive, disconnect all power to the AC drive, and wait five minutes for DC bus capacitors to discharge.

Warning: Any electrical or mechanical modification to this equipment will void all warranties, may result in a safety hazard, and may void the UL listing.

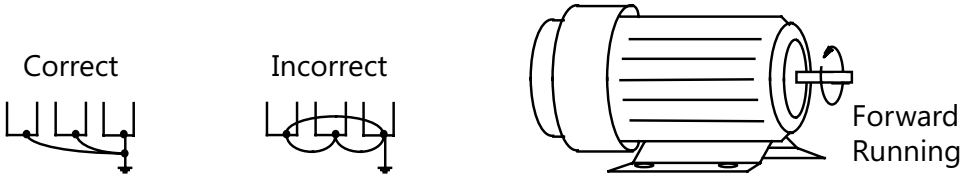
Warning: Do not connect the AC input power to the T1, T2, and T3 output terminals. Doing this will damage the AC drive.

Warning: Do not connect single-phase power to a three-phase drive model.

Warning: Tighten all screws to the proper torque rating. See "Main Circuit Wiring" later in this chapter.

Wiring Notes: PLEASE READ PRIOR TO INSTALLATION.

1) During installation, follow all local electrical, construction, and safety codes for the country in which the AC drive is to be installed.
2) Refer to the "DURApulse GS20 & GS20X Drive Specifications" in chapter 1 for voltage and current requirements.
3) Torque the screws of the main circuit terminals to prevent loosening due to vibration.
4) The addition of a magnetic contactor (MC) in the AC line power input wiring is recommended to turn off power quickly and reduce the possibility of malfunction if the protection function of the GS20(X) AC drive is activated. Both ends of the MC should have an R-C surge absorber.
5) Do not use a power circuit contactor or disconnect switch for normal run/stop control of the GS20(X) AC drive and motor. This will reduce the operating life cycle of the AC drive. Cycling a power circuit switching device while the AC drive is in run mode should be done only in emergency situations.
6) Make sure the appropriate protective devices (circuit breaker or fuses) are connected between the power supply and AC drive.
7) Make sure that the leads are connected correctly and that the GS20(X) AC drive is properly grounded. (Ground resistance should not exceed 0.1Ω.)
8) Use ground leads that comply with AWG/MCM standards and keep them as short as possible.
9) Multiple GS20(X) AC drives can be installed in one location. All of the units should be grounded directly to a common ground terminal. The GS20(X) AC drive ground terminals may also be connected in parallel, as shown in the figure below.
   Make sure there are no ground loops.



10) When the GS20(X) AC drive output terminals T1, T2, and T3 are connected to the motor terminals T1, T2, and T3, respectively, the motor will rotate counterclockwise (as viewed from the shaft end of the motor) when a forward operation command is received. To reverse the direction of motor rotation, switch the connections of any of the two motor leads.
11) Make sure that the power source is capable of supplying the correct voltage and required current to the GS20(X) AC drive.
12) Do not attach or remove wiring when power is applied to the GS20(X) AC drive.
13) Do not inspect components unless inside "POWER" lamp is turned off.
14) Do not monitor the signals on the circuit board while the GS20(X) AC drive is in operation.
15) Route the power and control wires separately, or at 90 degree angle to each other.

16) Ground both ends of the shield wire or conduit for the power wiring.
a) If using a "VFD cable," follow the manufacturer's recommendation for grounding the cable shield.
b) If using conduit, bond and ground conduit according to applicable electrical codes.
17) If a filter is required for reducing EMI (Electro Magnetic Interference), install it as close as possible to the GS20 AC drive input. EMI can also be reduced by lowering the Carrier Frequency. Please refer to the "Applied EMI/RFI Techniques" white paper at support.automationdirect.com.
18) If the GS20 AC drive is installed in a place where a load reactor is needed, install the reactor close to the T1, T2, and T3 side of GS20 AC drive. Do not use a Capacitor, L-C Filter (Inductance-Capacitance), or R-C Filter (Resistance-Capacitance).
19) When using a GFCI (Ground Fault Circuit Interrupt), select current sensor with sensitivity of 200mA or higher, and not less than 0.1-second operation time to avoid nuisance tripping.

Main Power Terminals

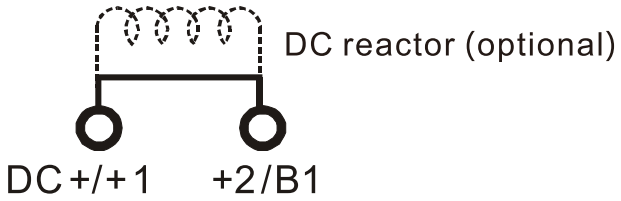
- *Do not supply GS20(X) 460 & 575 VAC models with single-phase power. R/L1, S/L2, and T/L3 have no phase-sequence requirement; they can be wired in any order.*
- *Do NOT start/stop the GS20(X) AC drive by turning input power ON/OFF. Start/stop the GS20(X) AC drive using RUN/STOP commands via control terminals or the keypad. If you must start/stop the GS20(X) AC drive by turning power ON/OFF, it is recommended to do so only ONCE per hour.*

Output Terminals for Main Circuit

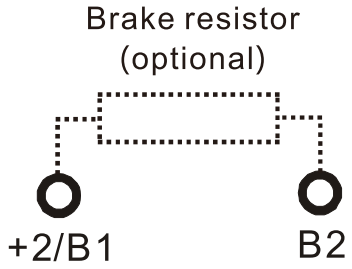
- *DO NOT connect phase-compensation capacitors or surge absorbers to the output terminals of the GS20(X) AC drive.*
- *Use a well-insulated motor suitable for inverter operation.*

Terminals for Connecting DC Reactor, External Brake Resistor, External Brake Resistor and DC Circuit

- *Terminals +1 and +2 are used to connect an optional DC reactor or choke to improve power factor. From the factory, these terminals are connected with a short-circuit jumper. Remove this jumper before connecting a DC reactor. Note that not all GS20 drives include terminal +1.*
- *Tighten the jumper if a DC reactor is not connected and DC+/+1 and +2/B1 terminals are used for common DC bus or brake resistors. This will prevent the AC motor drive from losing power and damage to the terminals. If the jumper is missing due to wiring, refer to the recommended main circuit terminal wire to short-circuit the DC+/+1 and +2/B1 terminals.*



- *When the GS20 AC Drive is connected directly to a large-capacity power transformer (600kVA or above) or when a phase lead capacitor is switched, peak currents may occur in the power input circuit due to the load change, resulting in damage to the converter section of the drive. To avoid this damage install a line reactor at the GS20 input terminals, R/L1, S/L2, and T/L3. The installation of a line reactor will reduce current and improve input power efficiency.*
- *Install an external brake resistor for applications in frequent deceleration to stop, short deceleration time (such as high frequency operation and heavy load operation), too low braking torque, or increased braking torque.*



- *For GS20(X) drives, the external brake resistor should be connected to the B1 and B2 terminals.*
- *If the terminals [+1], [+2], and [DC-] are not used, leave these three terminals open.*
- *To avoid personal injury and to prevent damage to the GS20 drive; DO NOT jumper DC- to DC+, DC- to +2/B1, DC- to B2. Connect braking resistors to B1 and B2 ONLY*
- *DC+ and DC- are connected for common DC bus, please refer to "Main Circuit Wiring Terminals" in this chapter for wiring terminal specification and wire gauge information.*
- *Please refer to the DURApulse Drives Dynamic Braking User Manual for more information on installing brake units.*
  (Available for free download at http://www.automationdirect.com/static/manuals/index.html.)

Motor Operation Precautions

1) When using the GS20(X) AC drive to operate a standard 3-phase induction motor, notice that the energy loss is greater than for an inverter duty motor.
2) Avoid running a standard induction motor at low speed, which may cause the motor temperature to exceed the motor rating due to limited airflow produced by the motor's fan.
3) When the standard motor operates at low speed, the output load must be decreased.
4) If **100% output torque** is desired at low speed, it may be necessary to use a special **"inverter-duty" rated motor**.

Short Circuit Withstand (SCCR)

All *DURApulse* GS20(X) series drives are suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes.

Applicable Codes

All *DURApulse GS20(X)* AC drives are Underwriters Laboratories, Inc. (UL) and Canadian Underwriters Laboratories (cUL) listed, and therefore comply with the requirements of the National Electrical Code (NEC) and the Canadian Electrical Code (CEC).

Installations intended to meet the UL and cUL requirements must follow the instructions provided in "Wiring Notes" as a minimum standard. Follow all local codes that exceed UL and cUL requirements. Refer to the technical data label affixed to the AC drive and the motor nameplate for electrical data.

The "Circuit Protection Devices" section in Appendix A lists the recommended fuse part number for each *DURApulse* part number. These fuses (or equivalent) must be used on all installations where compliance with U.L. standards is required.

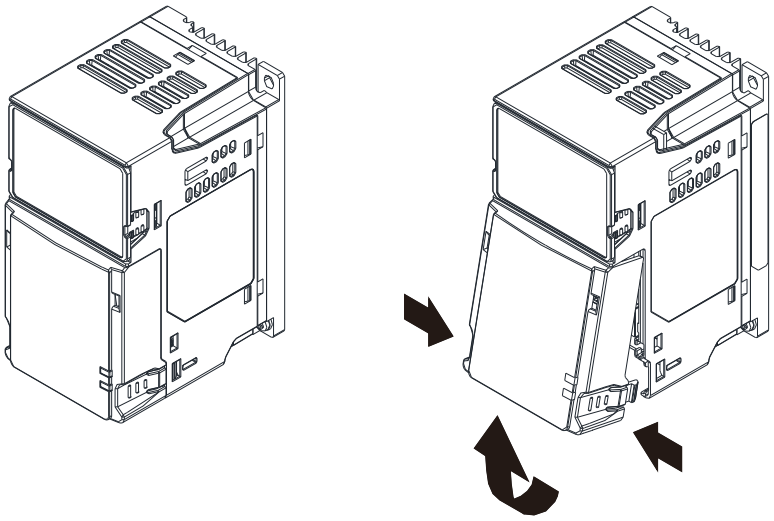
Wiring Terminal Access

Control Terminal Access

Remove the drive front cover to access and wire the multi-function input/output control terminals.

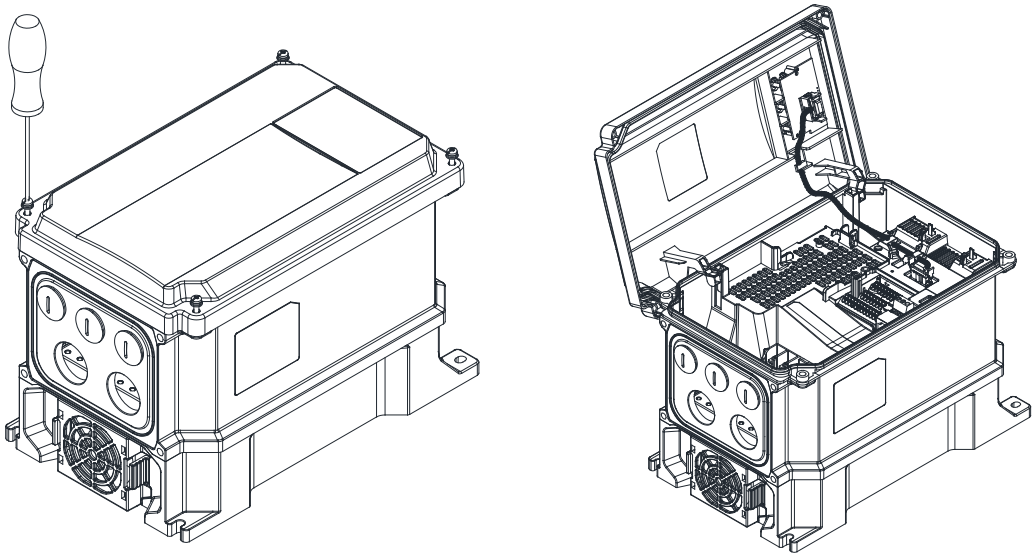
GS20 Drive Frames A ~ F

Press the tabs on both sides to remove the cover.



GS20X Drive Frames A ~ C

Loosen the four screws on the front cover and then open to the left.



Main Circuit Wiring Terminals

Main Terminal Specifications

Main Circuit Terminals	
Terminal	***Description***
R/L1, S/L2	Input Power – 1-phase
R/L1, S/L2, T/L3	Input Power – 3-phase
U/T1, V/T2, W/T3	AC Motor Drive Output
+1, +2[1]	Connection for DC reactor (remove jumper before installing a DC reactor)
B1, B2	Braking Resistor Connection (optional)
DC+, DC-[1]	Common DC Bus
⏚	Ground
1 - DC- and DC +/+1 terminals are not available on 120V series drives.	

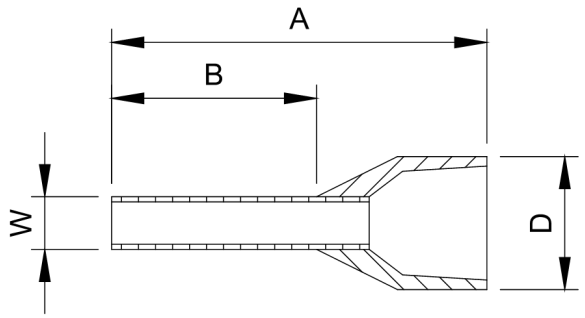
GS20 Main Circuit Wiring Specifications								
AC Drive Frame Size	***AC Drive Model***	***Main Circuit Terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, DC-, DC+/+1, +2/B1, B2***			***Ground Terminals*** ⏚		
		Max Wire Gauge	***Min Wire Gauge***	***Screw Size & Torque (±10%)***	***Max Wire Gauge***	***Min Wire Gauge***	***Screw Size & Torque (±10%)***
A	***GS21-10P2***	2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	M3.5 9 kg-cm [7.8 in-lb] [0.88 N·m]	2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	M3.5 9 kg-cm [7.8 in-lb] [0.88 N·m]
	GS21-10P5						
	GS21-20P5						
	GS23-21P0		1.5 mm² [16 AWG]				
	GS21-20P2						
	GS23-20P2		0.75 mm² [18 AWG]				
	GS23-20P5						
	GS23-40P5						
	GS23-41P0						
	GS23-51P0						
B	***GS21-21P0***	4 mm² [12 AWG]	4 mm² [12 AWG]	M4 15 kg-cm [13.0 in-lb] [1.47 N·m]	4 mm² [12 AWG]	4 mm² [12 AWG]	M4 15 kg-cm [13.0 in-lb] [1.47 N·m]
	GS23-22P0						
	GS23-42P0		2.5 mm² [14 AWG]		2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	
	GS23-52P0		0.75 mm² [18 AWG]				
C	***GS21-11P0***	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]
	GS21-22P0						
	GS21-23P0						
	GS23-25P0						
	GS23-23P0		6 mm² [10 AWG]		6 mm² [10 AWG]	6 mm² [10 AWG]	
	GS23-45P0		4 mm² [12 AWG]		4 mm² [12 AWG]	4 mm² [12 AWG]	
	GS23-55P0						
	GS23-43P0		2.5 mm² [14 AWG]		2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	
	GS23-53P0						
D	***GS23-27P5***	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]
	GS23-4010						
	GS23-47P5		6 mm² [10 AWG]		6 mm² [10 AWG]	6 mm² [10 AWG]	
	GS23-57P5						
	GS23-5010						
E	***GS23-2015***	25 mm² [4 AWG]	25 mm² [4 AWG]	M5 25 kg-cm [21.7 in-lb] [2.45 N·m]	25 mm² [4 AWG]	16 mm² [6 AWG]	M5 25 kg-cm [21.7 in-lb] [2.45 N·m]
	GS23-2010	16 mm² [6 AWG]	16 mm² [6 AWG]		16 mm² [6 AWG]		
	GS23-4015						
	GS23-4020						
F	***GS23-2020***	35 mm² [2 AWG]	35 mm² [2 AWG]	M6 40 kg-cm [34.7 in-lb] [3.92 N·m]	35 mm² [2 AWG]	16 mm² [6 AWG]	M6 40 kg-cm [34.7 in-lb] [3.92 N·m]
	GS23-4030						
	GS23-4025		25 mm² [4 AWG]		25 mm² [4 AWG]		

UL installations must use 600V, 75˚C or 90˚C wires. Use copper wire only.

GS20X Main Circuit Wiring Specifications							
AC Drive Frame Size	**AC Drive Model**	**Main Circuit Terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, DC-, DC+/+1, +2/B1, B2**			**Ground Terminals** ⏚		
		Max Wire Gauge	**Min Wire Gauge**	**Screw Size & Torque (±10%)**	**Max Wire Gauge**	**Min Wire Gauge**	**Screw Size & Torque (±10%)**
A	GS21X-20P5	2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	M3.5 9 kg-cm [7.8 in-lb] [0.88 N·m]	2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]
	GS23X-21P0		1.5 mm² [16 AWG]				
	GS23X-20P5		0.75 mm² [18 AWG]				
	GS23X-40P5						
	GS23X-41P0						
	GS21X-21P0	4 mm² [12 AWG]	4 mm² [12 AWG]	M4 15 kg-cm [13.0 in-lb] [1.47 N·m]	4 mm² [12 AWG]	4 mm² [12 AWG]	
	GS23X-22P0		2.5 mm² [14 AWG]		2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	
	GS23X-42P0		1.5 mm² [16 AWG]				
	GS21X-22P0	6 mm² [10 AWG]	6 mm² [10 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]	6 mm² [10 AWG]	6 mm² [10 AWG]	
	GS23X-43P0		2.5 mm² [14 AWG]		2.5 mm² [14 AWG]	2.5 mm² [14 AWG]	
B	GS21X-23P0	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]
	GS23X-25P0						
	GS23X-23P0		6 mm² [10 AWG]		6 mm² [10 AWG]	6 mm² [10 AWG]	
	GS23X-45P0		4 mm² [12 AWG]		4 mm² [12 AWG]	4 mm² [12 AWG]	
C	GS23X-27P5	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]	10 mm² [8 AWG]	10 mm² [8 AWG]	M4 20 kg-cm [17.4 in-lb] [1.96 N·m]
	GS23X-4010						
	GS23X-47P5		6 mm² [10 AWG]		6 mm² [10 AWG]	6 mm² [10 AWG]	

Recommended models or dimensions for ferrule terminals

Wire Gauge	Manufacturer	Model Name	A (MAX)	B (MAX)	D (MAX)	W (MAX)
0.25 mm2 [24 AWG]	PHOENIX CONTACT	AI 0,25- 8 YE	12.5	8	2.6	1.1
0.34 mm2 [22 AWG]	PHOENIX CONTACT	AI 0,34- 8 TQ	12.5	8	3.3	1.3
0.5 mm2 [20 AWG]	PHOENIX CONTACT	AI 0,5 - 8 WH	14	8	3.5	1.4
	Z+F	V30AE000006	14	8	2.6	1.15



Wiring Terminal Connector Dimensions – Main-Circuit Terminals

Dimensions = mm

GS20 Drives, Frame Size A ~ F

NOTE: *Heat shrink should comply with UL (600V, YDPU2).*

Power Terminal Wiring Connectors:

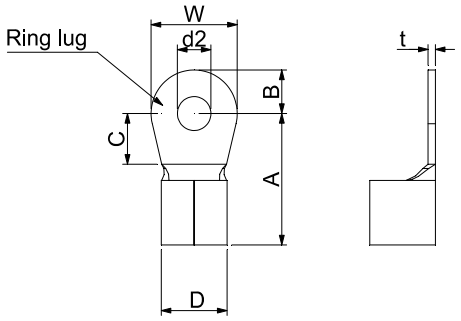


Figure 1.

Heat Shrink Tubing:

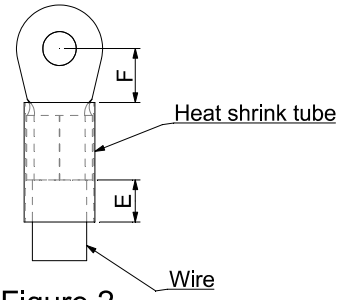


Figure 2.

GS20 Ring Lug Dimensions (mm)											
Frame	**AWG**	**Part Number (Manuf: K.S. Terminals)**	**A (Max)**	**B (Max)**	**C (Min)**	**D (Max)**	**d2 (Min)**	**E (Min)**	**F (Min)**	**W (Max)**	**t (Max)**
A	**18**	RNBS 1.3.7	9.8	3.2	4.8	4.1	3.7	13.0	4.2	6.6	0.8
	16	RNBS 2-3.7									
	14	RNBS 2-3.7									
B	**18**	RNBS1-4	12.1	3.6	6.1	5.6	4.3	13.0	4.5	7.2	1
	16	RNBS1-4									
	14	RNBS2-4									
	12	RNBS5-4									
C	**14**	RNBS2-4	17.8	5.0	6.1	7.2	4.3	13.0	5.5	10.5	1.2
	12	RNBS5-4									
	10	RNBS5-4									
	8	RNBS8-4									
D	**10**	RNBS5-4	17.8	5.0	6.1	7.2	4.3	13.0	5.5	10.5	1.2
	8	RNBS8-4									
E	**6**	RNBS8-4	27.1	6.1	10.5	11.5	5.3	13.0	6.5	12.6	1.7
	4	RNBS14-5									
F	**6**	RNBS14-6	35.0	9.0	13.3	14.0	6.2	13.0	10.0	19.5	1.8
	4	RNBS22-6									
	2	RNBS38-6									

GS20X Drives, Frame Size A ~ C

NOTE: Heat shrink should comply with UL (600V, YDPU2).

Power Terminal Wiring Connectors:

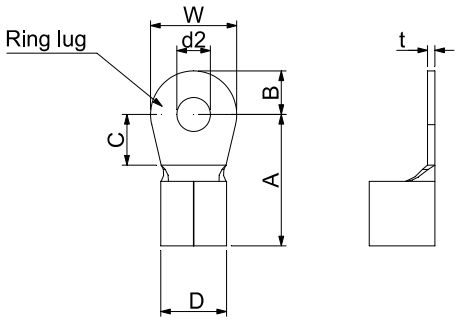


Figure 1.

Heat Shrink Tubing:

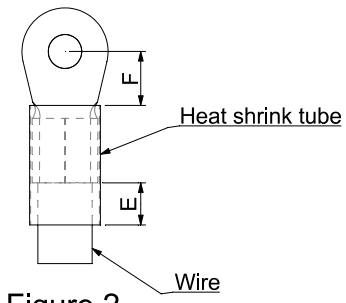


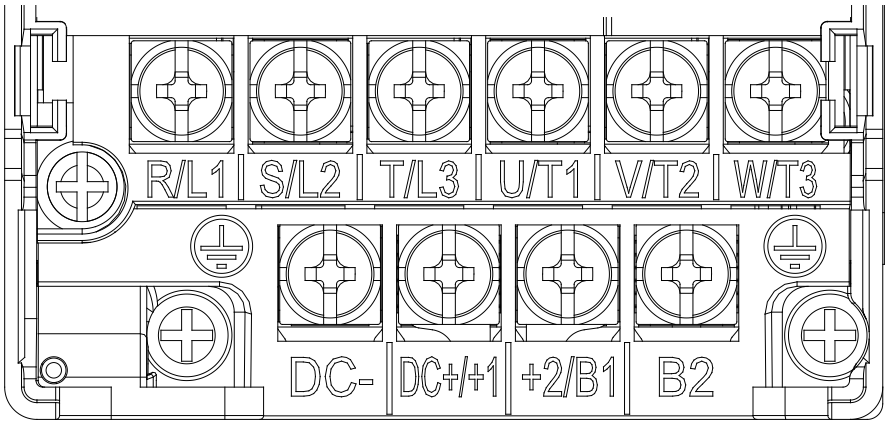
Figure 2.

GS20X Ring Lug Dimensions (mm)											
Frame	***AWG***	***Part Number (Manuf: K.S. Terminals)***	***A (Max)***	***B (Max)***	***C (Min)***	***D (Max)***	***d2 (Min)***	***E (Min)***	***F (Min)***	***W (Max)***	***t (Max)***
A	***18***	RNBS1-4	11.1	4.0	6.3	3.4	4.3	13.0	4.5	6.6	0.8
	16	RNBS1-4									
	14	RNBS2-4				4.1			5.5		
	12	RNBS5-4	12.1		6.1	5.6				7.2	1
	10	RNBS5-4									
B	***14***	RNBS2-4	17.8	5.0	6.1	7.2	4.3	13.0	5.5	8.0	1.2
	12	RNBS5-4									
	10	RNBS5-4									
	8	RNBS8-4									
C	***14***	RNBS2-4	17.8	5.0	6.1	7.2	4.3	13.0	5.5	8.0	1.2
	12	RNBS5-4									
	10	RNBS5-4									
	8	RNBS8-4									

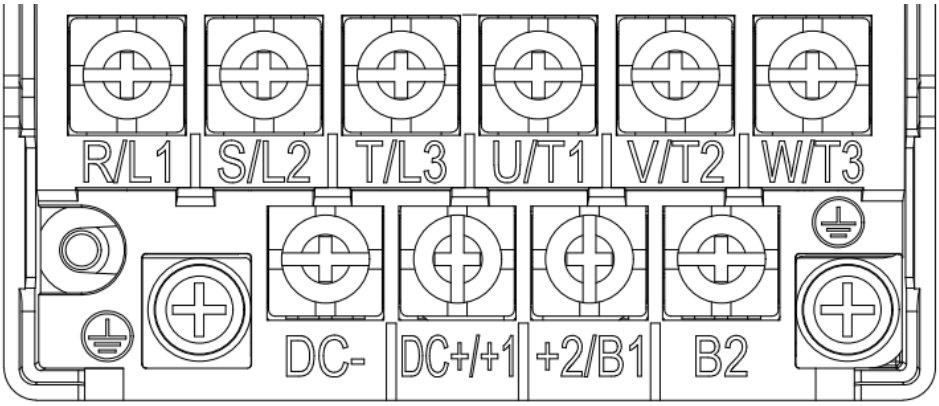
Main Terminal Diagrams

NOTE: DC- and DC+/+1 terminals are not available on 120V series drives (Frame A and C).

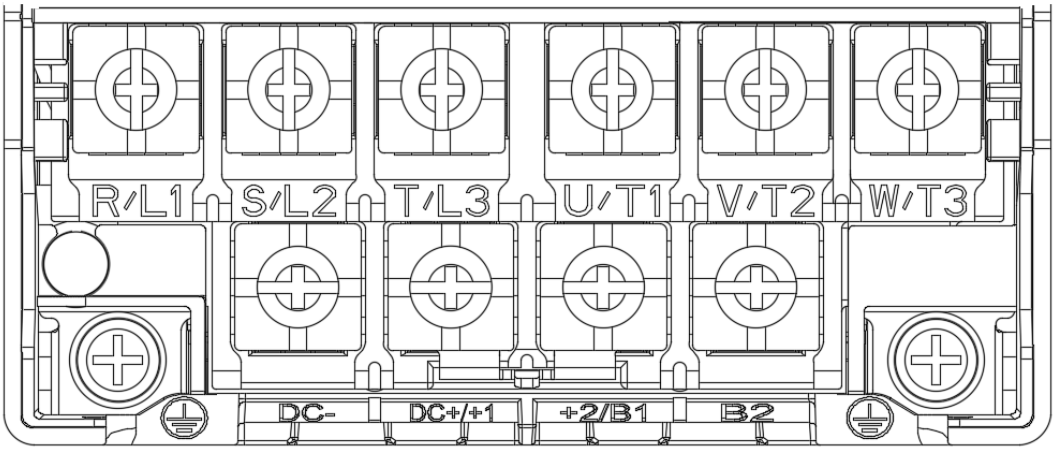
GS20 Frame Size A Main Terminals



GS20 Frame Size B Main Terminals

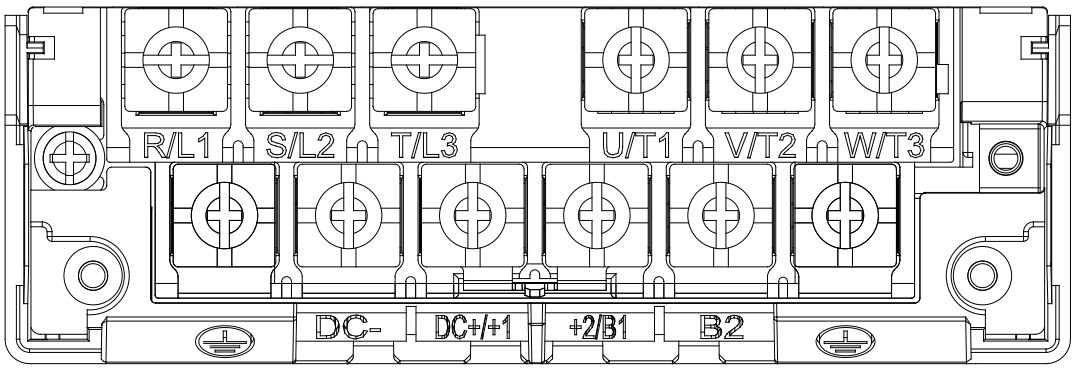


GS20 Frame Size C Main Terminals

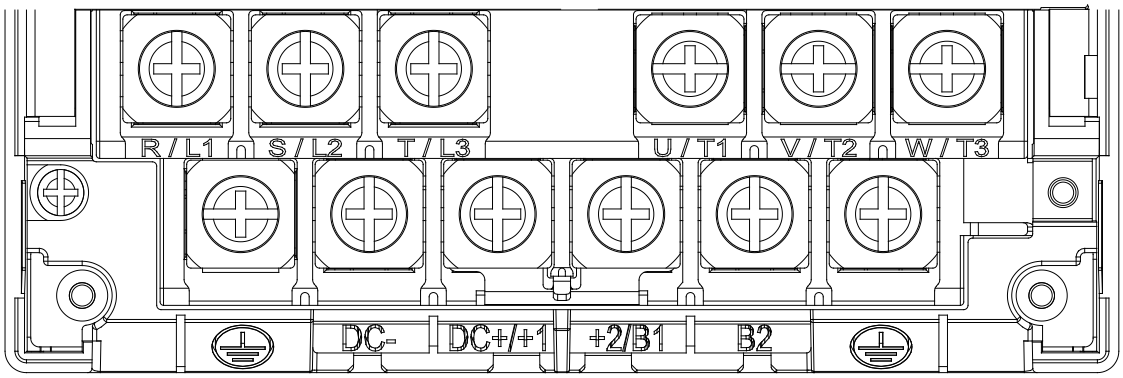


Main Terminal Diagrams (continued)

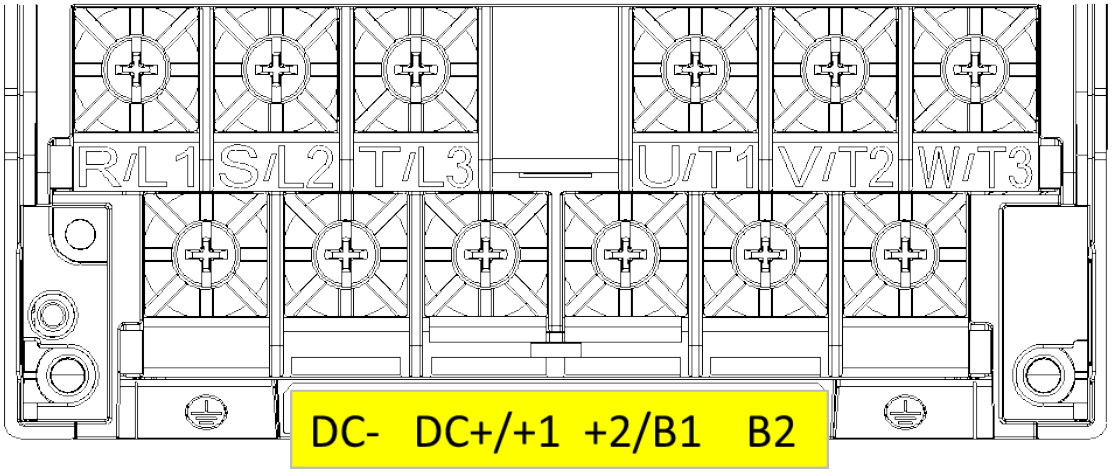
GS20 Frame Size D Main Terminals



GS20 Frame Size E Main Terminals

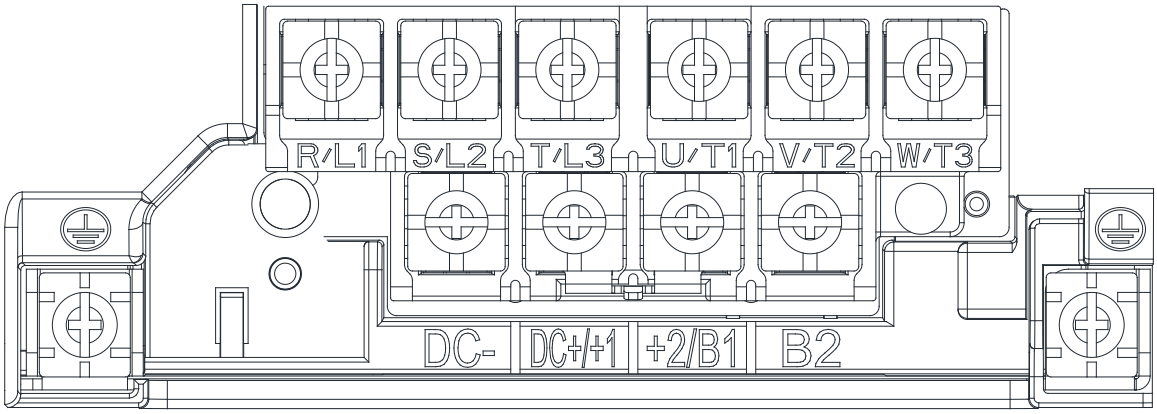


GS20 Frame Size F Main Terminals

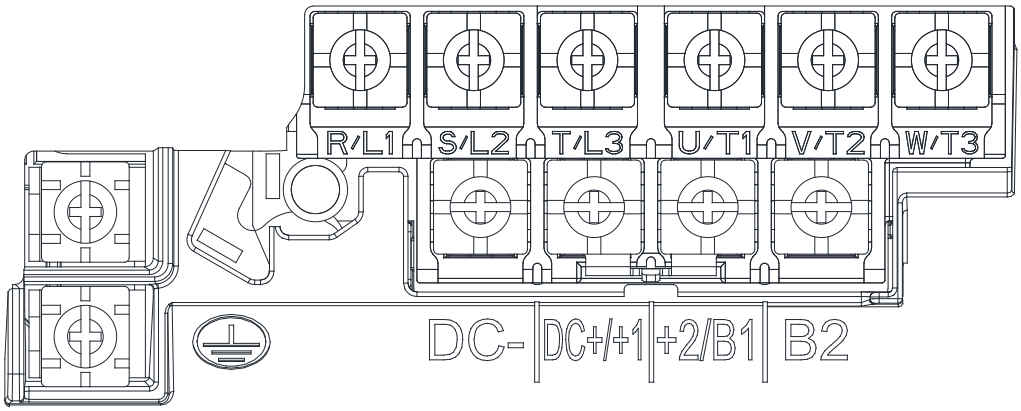


Main Terminal Diagrams (continued)

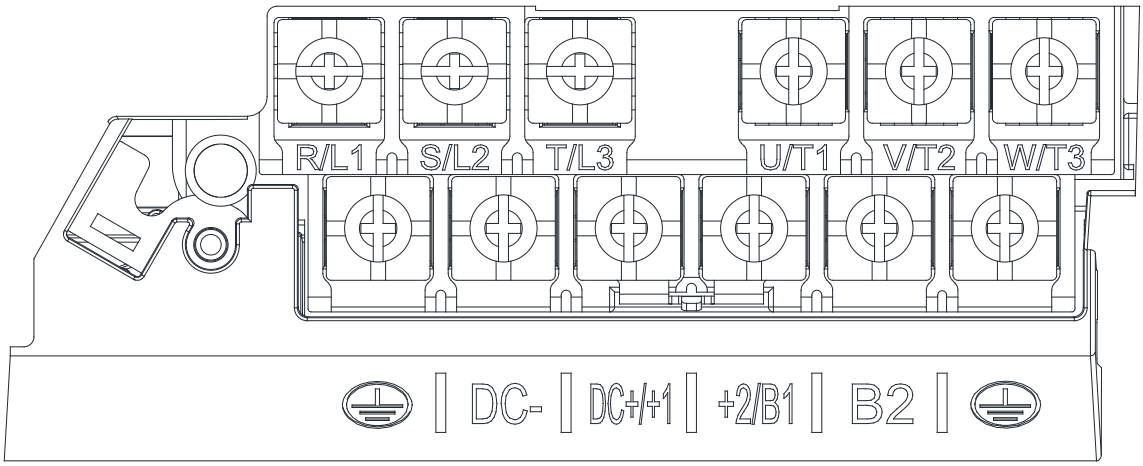
GS20X Frame Size A Main Terminals



GS20X Frame Size B Main Terminals



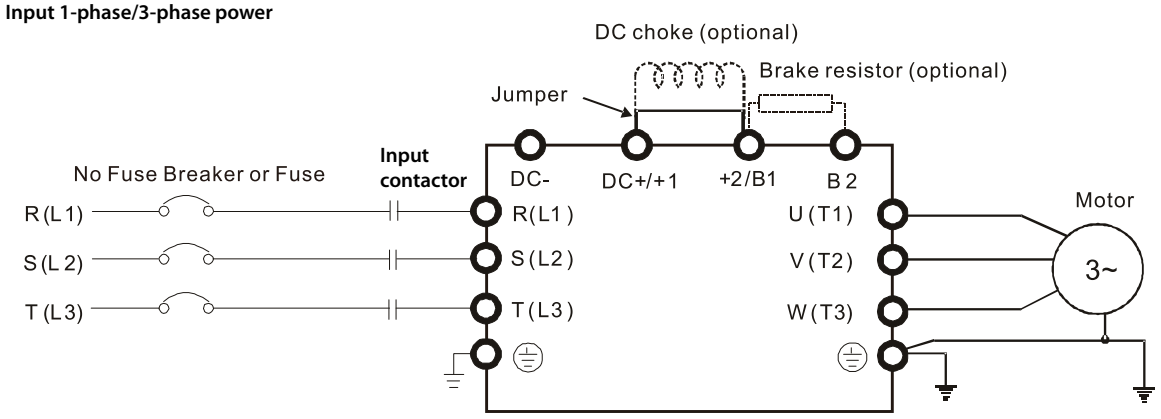
GS20X Frame Size C Main Terminals



Main Circuit Wiring Diagrams

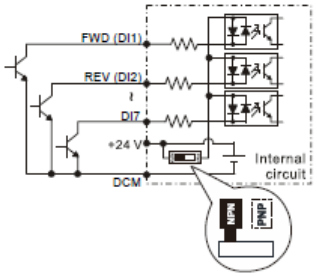
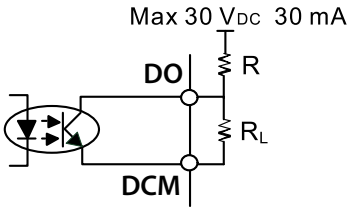
GS20 & GS20X All Frame Sizes

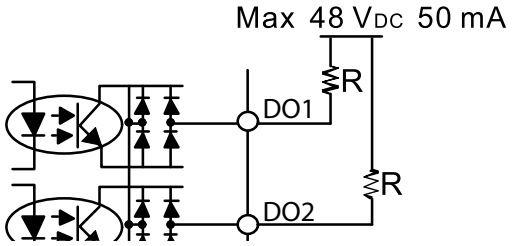
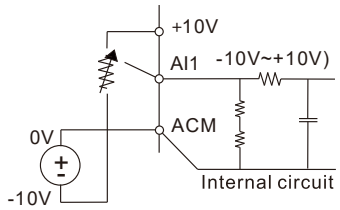
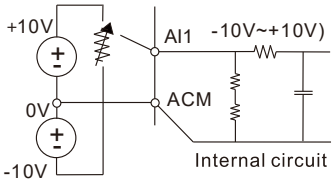
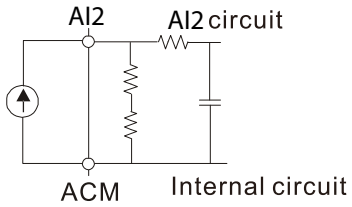
Input 1-phase/3-phase power

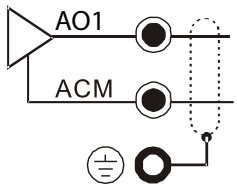


Control Circuit Wiring Terminals

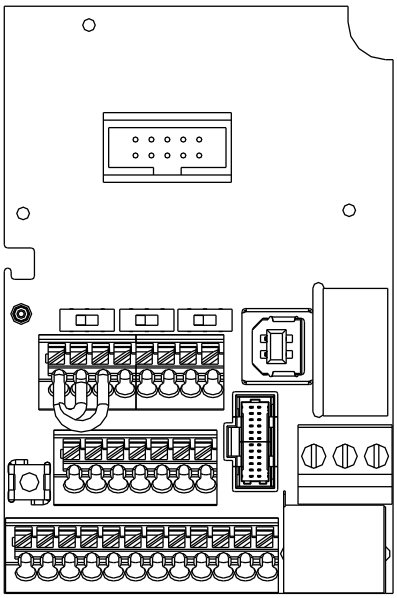
GS20 & GS20X Control Terminal Specifications

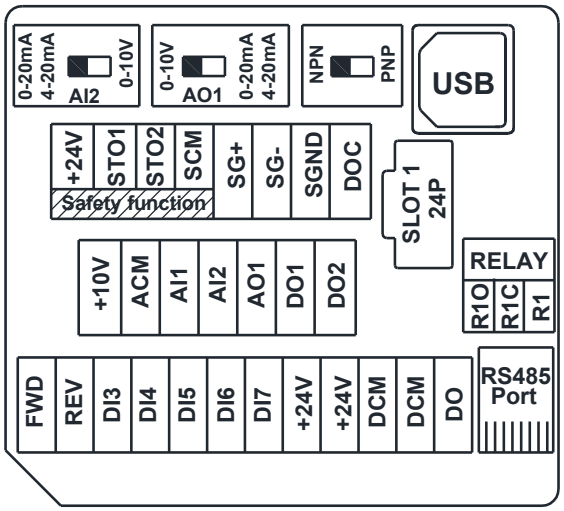
Control Circuit Terminals		
Terminal Symbol	***Terminal Function***	***Description***
+24V	Digital control signal common (Source)	+24V ± 10% 100 mA
FWD (DI1) ***REV (DI2)*** ***DI3 - DI7***	Digital input 1–7 ① Sink Mode with internal power (+24 Vdc)  See page 2–36 for sinking/ sourcing wiring examples.	**Source Mode:** ON: activation current 3.3 mA ≥ 11 VDC OFF: cut-off voltage ≤ 5 VDC **Sink Mode:** ON: activation current 3.3 mA ≤ 13 VDC OFF: cut-off voltage ≥ 19 VDC DI7: Single pulse input, maximum input frequency=33kHz. Digital inputs can be configured by the user for many different functions. Refer to P02.01–P02.07 to program the digital inputs FWD (DI1), REV (DI2), DI3–DI7. • When P02.00=0, FWD (DI1) and REV (DI2) can be programmed. • When P02.00≠0, the functions of FWD (DI1) and REV (DI2) act according to P02.00 setting. • When P02.07=0, DI7 is pulse input terminal. • DI7 uses pulse input can be used as frequency command source or connect it to the encoder for motor closed-loop control. • DI7 motor closed-loop control only supports VFPG control mode.
DO	Digital frequency signal output  	DO uses pulse voltage as an output monitoring signal; Duty-cycle: 50 % Min. load impedance RL: 1 kΩ / 100 pF Max. current endurance: 30 mA Max. voltage: 30 VDC ± 1 % (when 30 VDC / 30 mA / RL=100 pF) Max. output frequency: 33 kHz Current-limiting resistor R: ≥ 1 KΩ Output load impedance RL Capacitive load ≤ 100 pF Resistive load ≥ 1 kΩ, resistance determines the output voltage value. DO-DCM voltage = external voltage * (RL/ (RL+R))
DCM	Digital control / Frequency signal common (Sink)	
(continued next page)		

Control Circuit Terminals (continued)		
Terminal Symbol	**Terminal Function**	**Description**
DO1	Digital Output 1 (photo coupler)	The AC motor drive outputs various monitoring signals, such as drive in operation, frequency reached, and overload indication through a transistor (open collector). These can be wired as sinking or sourcing (see Appendix D-3). 
DO2	Digital Output 2 (photo coupler)	
DOC	Digital Output Common (photo coupler)	
R1O	Relay Output 1 (N.O.) a	**Resistive Load** • 3 A (N.O.) / 3 A (N.C.) 250 VAC • 5 A (N.O.) / 3 A (N.C.) 30 VDC **Inductive Load (COS 0.4)** • 1.2 A (N.O.) / 1.2 A (N.C.) 250 VAC • 2.0 A (N.O.) / 1.2 A (N.C.) 30 VDC To output different kinds of monitoring signals such as motor drive in operation, frequency reached, and overload indication.
R1C	Relay Output 1 (N.C.) b	
R1	Relay Output 1 Common	
+10V	Potentiometer power supply	Power supply for analog frequency setting: +10.5 ± 0.5 VDC / 20 mA
AI1	Analog voltage frequency command  	Circuit Impedance: 20kΩ Potentiometer Rating: 5kΩ (for full frequency range) Range: 0–10 V / -10–10 V = 0–Maximum Operation Frequency (P01.00) Mode switching by setting P03.00, P03.28 AI1 resolution=10 bits
AI2	Analog current frequency command 	Impedance: Current mode=250 Ω, Voltage mode=20 kΩ Range: 0–20 mA / 4–20 mA / 0–10 V = 0–Maximum Operation Frequency (P01.00) Mode switching by setting P03.01, P03.29 Switch: The AI2 default is 0–20 mA / 4–20 mA (current mode) AI2 resolution = 12 bits
(continued next page)		

Control Circuit Terminals (continued)		
Terminal Symbol	**Terminal Function**	**Description**
AO1	Multi-function analog voltage output  	Switch: The AO1 default is 0–10 V (voltage mode). To switch to the current mode, two steps are required: 1) A dip switch must be configured (follow the instructions on the inner side of the front cover or see page 2–34. 2) Change P03.31 to 1 or 2 (see page 4–110). **Voltage mode** Range: 0–10 V (P03.31=0) corresponds to the maximum operating range of the control target Max. output current: 2 mA Max. Load: 5 kΩ **Current mode** Range: 0–20 mA (P03.31=1) / 4–20 mA (P03.31=2) corresponds to the maximum operating range of the control target, maximum load 500 Ω AO1 resolution=10 bits
ACM	Analog Signal Common	Analog signal common terminal
STO1, STO2	Default: STO1 / STO2 short-circuited to +24 V Rated voltage: 24 VDC ± 10 %; maximum voltage: 30 VDC ±10 % Rated current: 6.67 mA ± 10 % **STO activation mode** Input voltage level: 0 VDC < STO1-SCM or STO2-SCM < 5 VDC STO response time ≤ 20 ms (STO1 / STO2 operates until the AC motor drive stops outputting current) **STO cut-off mode** Input voltage level: 11 VDC < STO1-SCM and STO2-SCM < 30 VDC Power removal safety function per EN 954-1 and IEC / EN 61508 **Note:** Refer to Appendix E SAFE TORQUE OFF FUNCTION for details.	
SCM		
SG+	Modbus RS-485 **Note:** Refer to Chapter 4, parameter group 09 Communication Parameters for details.	
SG-		
SGND		
RJ45	PIN 1, 2, 6: Reserved PIN 3, 7: SGND PIN 4: SG- PIN 5: SG+ PIN 8: +10V supply GS4-KPD (provides (optional) power supply)	The RJ45 port provides a serial communications connection. Max Baud Rate = 115.2 kbps

GS20 & GS20X Control Terminal Block Diagram & Wiring Specifications





Wiring Specifications					
Terminal	**Wiring Type**	**Stripping Length (mm)**	**Maximum Wire Guage**	**Minimum Wire Gauge**	**Tightening Torque (kg·cm [lb·in])**
Relay	**Solid**	**6-7**	1.31 mm^2 (16 AWG)	0.21 mm^2 (24 AWG)	5 kg·cm (4.3 lb·in)
	Strand				
Control	**Solid**	**9**	0.82 mm^2 (18 AWG)	0.21 mm^2 (24 AWG)	n/a (spring terminals)
	Strand				
	Stranded with ferrules with plastic sleeves		0.5 mm^2 (20 AWG)		

Control Terminal Wiring Instructions

Digital Inputs

- *When using contacts or switches to control the digital inputs, use high quality components to avoid contact bounce.*

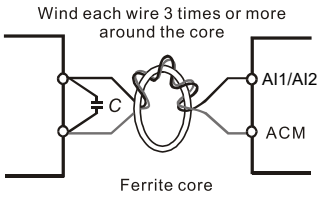
Wiring Multiple Drives Together – Digital Inputs

- *With drive Digital Inputs in SINKING mode: When connecting a single device to the Digital Inputs of multiple drives (Run, Stop, Reverse, etc.), the DCM (Digital Signal Common) terminals from each drive should be connected together. [Otherwise, do NOT connect the different drive DCM terminals together if the drive DI are sourcing.]*
- *With drive Digital Inputs in SOURCING mode (and the connected field devices are sinking): Do NOT connect the different drive DCM terminals together. [If the DCM terminals of multiple drives are connected together with the drive DI in sourcing mode, the inputs of some of the drives may inadvertently turn ON if another drive is powered OFF.]*
  Example: A switch is tied to Digital Input 1 of Drives A, B, C, and D. The Drive inputs are all set to Source current out to the field devices. If Drives A, B and C lose power, their Digital Inputs may sink enough current to inadvertently turn ON Digital Input 1 on Drive D.

WARNING: With drive Digital Inputs in SOURCING mode Do NOT connect the different drive DCM terminals together.

Analog Inputs

- *Analog input signals are easily affected by external noise. Use shielded wiring and keep it as short as possible (<20m) with proper grounding. If the noise is inductive, connect the shield to terminal ACM.*
- *Use twisted-pair wire*
- *If the analog input signals are affected by noise from the AC motor drive, please connect a capacitor and ferrite core as indicated in the diagram at right.*
  (Wind each wire around the core 3 times or more.)



Control Terminal Wiring Instructions (continued)

Transistor Outputs (DO1, DO2, DOC)

- *Make sure to connect the digital outputs to the correct polarity.*
- *When connecting a relay to the digital outputs, connect a surge absorber across the coil and check the polarity.*

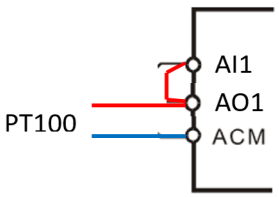
Analog Output

- *When setting dip switch AO1 and using it as a current source, ensure P03.31 AO1 0~20mA/4~20mA selection is set appropriately.*

PT100

PT100 RTD circuits should be wired and configured as folows:

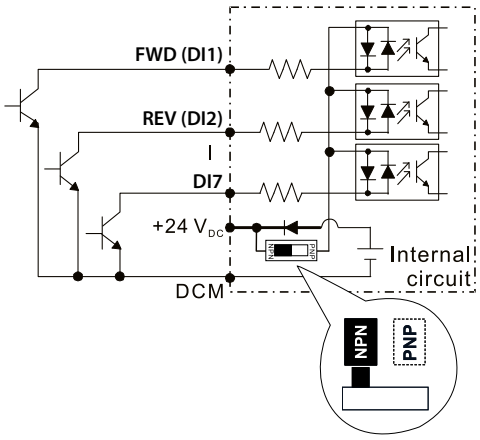
- *Set P03.00 = 1 (PT100 input)*
- *If using AI2, set dip switch to 0-10V, set P03.01=11, and P03.29=1.*



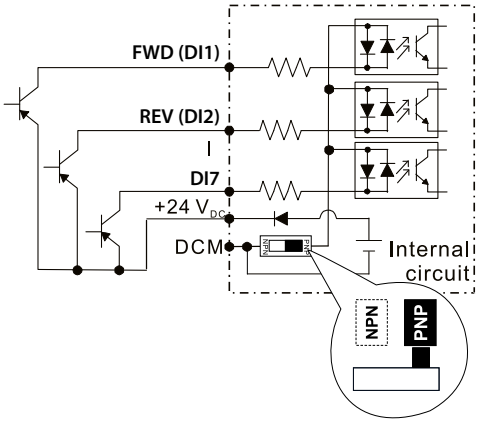
Control Circuit Wiring Diagrams

Digital Inputs

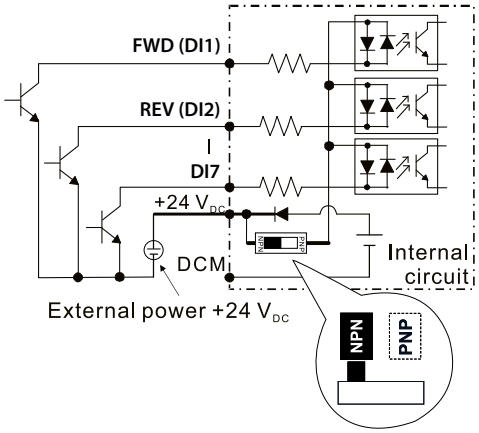
① Sink Mode
with internal power (+24 V_{DC})



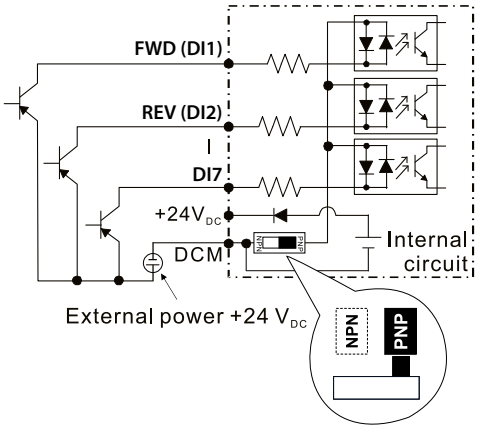
② Source Mode
with internal power (+24 V_{DC})



③ Sink Mode
with external power

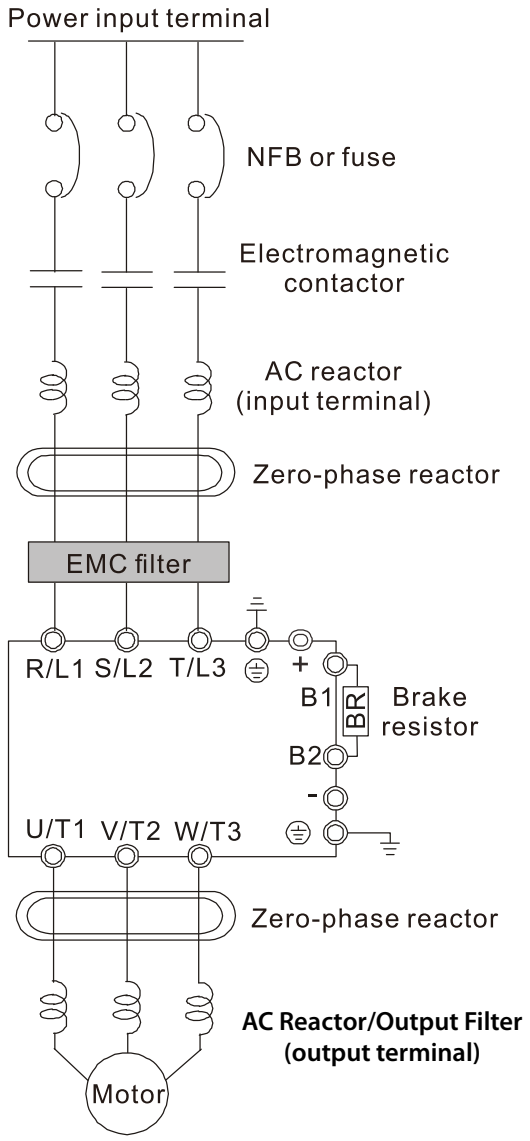


④ Source Mode
with external power



Control Circuit Wiring Diagrams (continued)

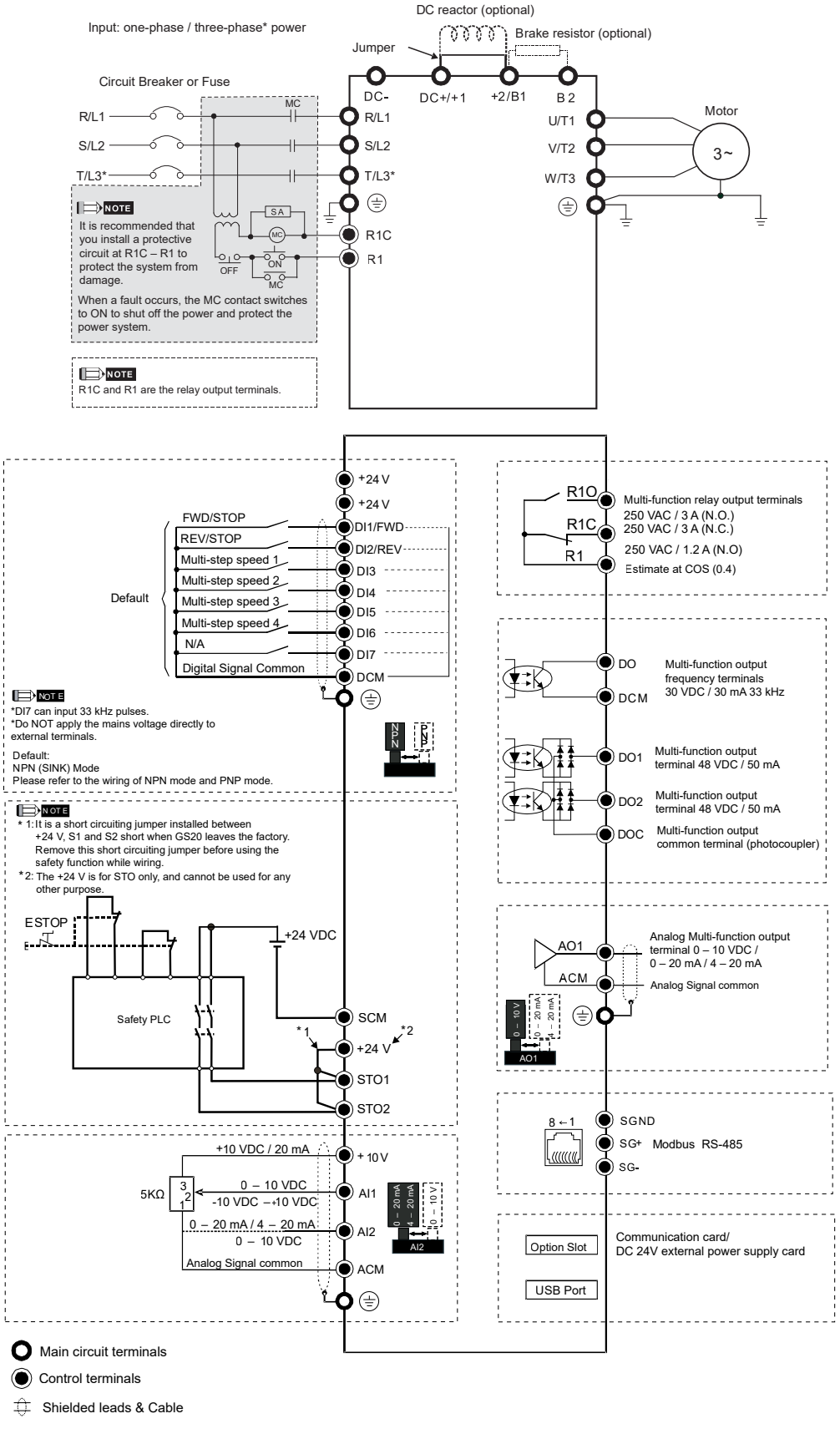
System Wiring Diagram



System Wiring Components	
Component	***Function***
Power input terminal	Supply power according to the rated power specifications indicated in the manual
NFB or fuse	There may be a large inrush current during power on. Select a suitable NFB (Non Fuse Breaker or Circuit Breaker) or Fuse.
Electromagnetic contactor	Switching the power ON/OFF on the primary side of the electromagnetic contactor can turn the drive ON/OFF, but frequent switching can cause machine failure. Do not switch ON/OFF more than once an hour. Do not use the electromagnetic contactor as the power switch for the drive; doing so shortens the life of the drive.
AC reactor (input terminal)	When the main power supply capacity is greater than 500 kVA, or when it switches into the phase capacitor, the instantaneous peak voltage and current generated may destroy the internal circuit of the drive. It is recommended that you install an input side AC reactor in the drive. This also improves the power factor and reduces power harmonics. The wiring distance should be within 10 m.
Zero phase reactor	Used to reduce radiated interference, especially in environments with audio devices, and reduce input and output side interference. The effective range is AM band to 10 MHz.
EMC filter	Can be used to reduce electromagnetic interference.
Brake module and Brake resistor (BR)	Used to shorten the deceleration time of the motor.
AC reactor or Filter (output terminal)	The motor cable length affects the size of the reflected wave on the motor end. For motor distances greater than 100 feet, the VTF series dV/dT filter is recommended.

Control Circuit Wiring Diagrams (continued)

Full I/O Wiring Diagram



Keypad Operation and Quick-Start

Table of Contents

Chapter 3: Keypad Operation and Quickstart

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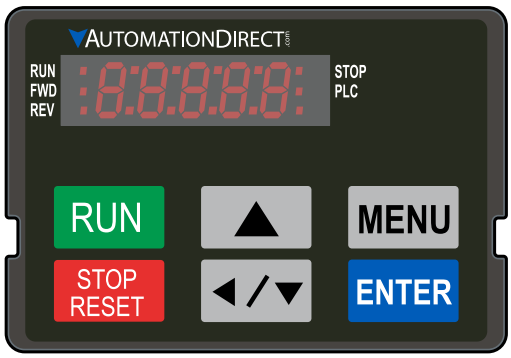
Reference Table for Digital LED Character Display 3–9

The DURApulse GS20 & GS20X Digital Keypad

The GS20 and GS20X drives come with a digital keypad equipped with six buttons. The GS20 series drives also have a potentiometer, while the GS20X drives do not. You can use the digital keypad to control the drive, set parameters, change drive modes, etc. For more detailed control options, you can use GSoft2 software by connecting to a computer via USB (see Chapter 7).

It is also possible to use the GS4-KPD with the GS20 for expanded keypad functionality. For more about using the GS4-KPD, please see "Optional Advanced Keypad" on page A–49.

GS20 Digital Keypad



GS20X Digital Keypad

Descriptions of Keypad Functions	
RUN	**RUN Key** • Valid only when the source of operation command is from the keypad. • RUN can be pressed even when drive is in process of stopping. • When in "LOCAL" mode, RUN is valid only when the source of operation command is from the keypad.
STOP RESET	**STOP/RESET Key** *This key has the highest processing priority in any situation.* • When the drive receives a STOP command, whether the drive is in operation or stop status, the drive will execute a "STOP" command. • The RESET key can be used to reset the drive after a fault occurs. For those faults that can't be reset by the RESET key, see the fault records after pressing MENU key for details. *NOTE: The ability to STOP the drive from the keypad is effective ONLY if the drive is configured to RUN and/or STOP from the keypad. Keypad STOP can be disabled by parameter 00.32, Digital Keypad STOP Function.*
ENTER	**ENTER Key** Press ENTER to go to the next menu level or accept parameter entry. If it is the last level, then press ENTER to execute the command.
MENU	**MENU Key** Press MENU to return to the Main Menu or cycle through the available menu options.
▲	**Direction: Up** Press to make the value set on the current menu/parameter higher.
◀/▼	**Direction: Left/Down** • Press to make the value set on the current menu/parameter lower. • In the menu/text selection mode, the arrows are used for item selection. Long press the MENU key to use the left direction function.
	Frequency Setting Dial (Potentiometer)(GS20 ONLY) The dial can be set as the main frequency input. Set Parameter 00-20 or 00-30 to equal '7-Digital Keypad Dial'.

Keypad Indicator LEDs

The left and right sides of the digital display contain a series of LEDs that light up to indicate certain drive functions.

Descriptions of LED Functions	
RUN	**Steady ON**: Drive is running. **Blinking**: Drive is stopping or in base block. **Steady OFF**: Drive is not running.
FWD	**Steady ON**: Drive is operating in Forward mode. **Blinking**: Drive is changing direction. **Steady OFF**: Drive is operating in Reverse mode.
REV	**Steady ON**: Drive is operating in Reverse mode. **Blinking**: Drive is changing direction. **Steady OFF**: Drive is operating in Forward mode.
STOP	**Steady ON**: Drive is stopped or in the process of stopping. **Blinking**: Drive is in standby (run but does not output). **Steady OFF**: Drive is not currently executing an operational (STOP) command. *NOTE: The ability to STOP the drive from the keypad is effective ONLY if the drive is configured to RUN and/or STOP from the keypad. Keypad STOP can be disabled by parameter 00.32, Digital Keypad STOP Function.*
PLC	**Steady ON**: PLC STOP (PLC 2) initiated. **Blinking**: PLC Run (PLC1) initiated. **Steady OFF**: No PLC functions implemented (PLC 0).

GS20(X) Keypad Operation

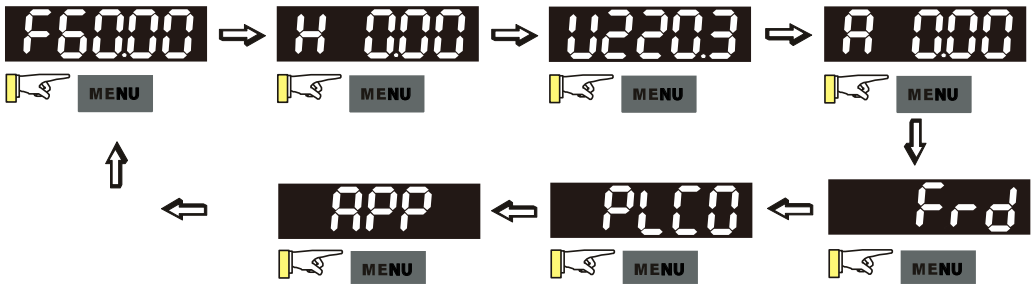
The following section details digital keypad operation for the GS20(X) series drives.

GS20(X) Keypad Function Examples

Instruction	Press Key	Display Will Show	
First menu to display after power up.	n/a	Displays the present frequency setting of the drive	
Press MENU once from startup.	MENU	Displays the actual output frequency of the drive	
Press MENU twice from startup.	MENU	Displays user defined output	
Press MENU three times from startup.	MENU	Displays output current	
Press MENU four times from startup. Displays Frd if the drive is currently configured for Forward operation. Press the UP or DOWN key to change to Reverse. Press ENTER to confirm the change.	MENU, UP/ DOWN ENTER	Displays the Forward command if configured for Forward operation.	
		Displays the Reverse command if configured for Reverse operation.	
Press MENU five times from startup. Displays the current PLC setting. Press the UP or DOWN arrow keys to change the PLC setting, then press ENTER to confirm.	MENU, UP/ DOWN ENTER	Displays the current PLC setting.	
Enable the counter by setting parameter 00.04 to 1. See the user manual for full instructions on using the counter.	MENU	Displays the counter value	
After selecting the desired menu option, press ENTER to bring up the parameter number (Format XX.YY). Use the UP and DOWN arrow keys to change the parameter number as needed, then press ENTER to adjust the parameter value.	ENTER, UP/ DOWN, ENTER	Displays the parameter number	
From the parameter number screen, press ENTER to bring up the current value of the selected parameter. Use the UP and DOWN arrows to adjust the value. Press ENTER again to confirm the choice.	ENTER, UP/ DOWN	Displays the value of the selected parameter	
Once a desired parameter value has been set using the UP and DOWN arrow keys, press ENTER to save the choice and display End message.	ENTER	End message. Displays when data has been accepted and stored	
Displays when an external fault is detected.	n/a	External fault message	
Displays when data is not accepted or the value exceeded	n/a	Error message.	

Main Page

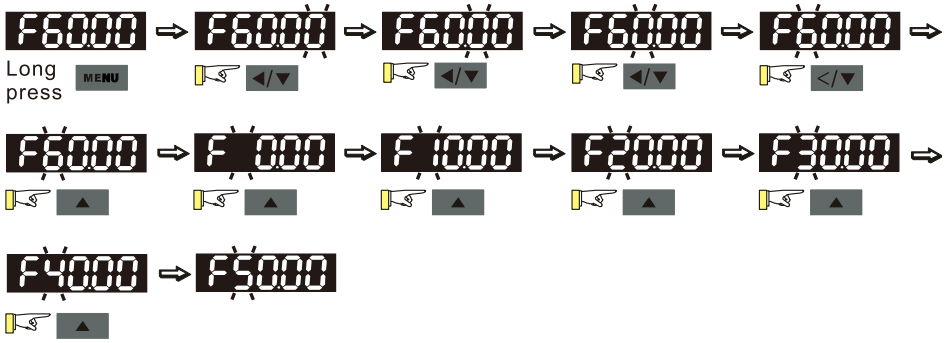
When the drive first starts up, it will display the present frequency setting of the drive. To access the other main pages of the keypad, press the MENU button to cycle through the options.



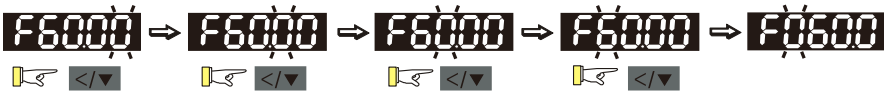
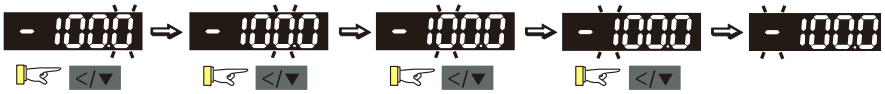
NOTE: In screen selection mode, press ENTER to set the parameters.

NOTE: APP only displays when parameter 13.00 does not equal 0.

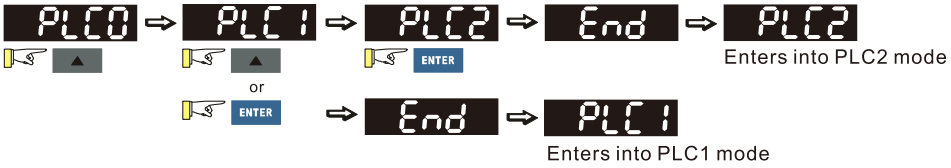
Frequency Command Settings

Frequency Command Instructions	
Change Frequency Setting	The default maximum frequency setting (parameter 01.00) is 60.00 Hz. The command frequency on the drive can not be set higher than the maximum frequency value. To set the command frequency value, follow the instructions below: 1) Press the MENU key until F60.00 is displayed (see "Parameter Settings" on page 3–6.). 2) Hold down MENU until the final digit of the value begins to blink. 3) Press the LEFT/DOWN button to select the digits you wish to change. Press the UP button to cycle through the values available. 4) Press and hold MENU until no digits are blinking.  Note: To change the value to something greater than 99.99, follow the steps above but press the LEFT/DOWN button until the left-most digit (normally blank) switches to a blinking 0. Then use the UP button to change to the desired value. The maximum frequency value is 599.00. If a higher value is chosen, the parameter screen will display Err, followed by 599.00 (the maximum possible), then revert to the previous good value.

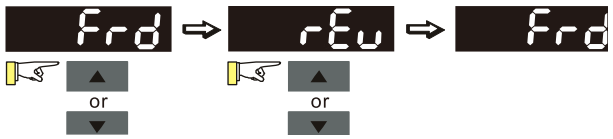
Parameter Settings

Parameter Setting Instructions	
Setting Parameters	1) Press MENU until the parameter screen appears (typically H 0.00). 2) Press ENTER to switch to the parameter group, then press the UP button to select the desired group number. 3) Press ENTER to switch to the parameter number, then press the UP button to select the desired number. 4) Press ENTER to switch to the parameter value, then press the UP or LEFT/DOWN button to cycle through the available options. 5) Press ENTER. If END displays, the parameter was successfully updated. If Err displays, the chosen configuration is not viable.
Unsigned Parameter Settings	To set an unsigned parameter value, follow the steps for "Setting Parameters" above, until you reach the parameter value. Then: 1) Press and hold the MENU button until the last digit of the parameter value begins to blink. 2) Change the value by pressing the UP button. 3) Press the LEFT/DOWN button to move to the next digit, and change its value using the UP button. Repeat the process until all digits have been configured as desired. 4) Press and hold the MENU button to disable the left shift function of the LEFT/DOWN button. 
Setting a negative parameter value	Follow the normal steps for setting a parameter as above. To set the parameter value to negative: 1) Press and hold the MENU button while on the parameter value until the final digit begins to blink. 2) Use the LEFT/DOWN button to navigate all the way to the left of the screen. 3) Use the UP button to cycle through the available digits. For parameters cable of being set to negative, the value will cycle from 0 to - instead of 0 to 9.  For parameter values with three digits and two decimal places and a positive/negative setting, the keypad only displays four digits (-100.0, not -100.00).

PLC Settings

PLC Setting Instructions	
Setting the PLC Mode	The GS20(X) drive can be set to three PLC modes - PLC0 (Disable), PLC1 (Run), and PLC2 (Stop). To set the PLC mode, follow the steps below: 1) From the startup screen, press MENU until the keypad displays PLCx (where x=0, 1, or 2, depending on your current setting). 2) Press the UP button to select the desired PLC mode, then press ENTER. The screen will display End, and the chosen PLC mode is set. 

Setting Direction

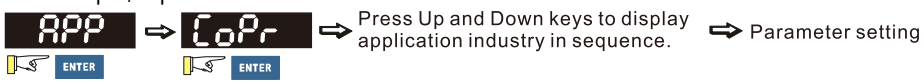
Setting Direction Instructions	
Setting to Forward or Reverse Mode	The GS20(X) drive can be configured to run in forward (Frd) or reverse (rEu) mode. To set the drive direction: 1) From the startup screen, press the MENU button until Frd or rEu appears. 2) Press the UP or LEFT/DOWN button to cycle through the options. The option is selected as soon as it displays. 3) Press MENU to return to the other screens. 

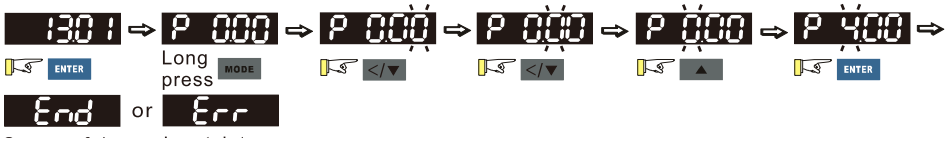
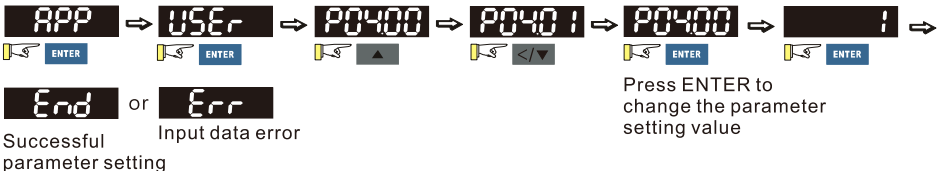
Application Settings

The APP setting can be used to provide a shortcut to application specific parameters for easier access through the keypad. The application selection page does not display unless parameter 13.00 is set to a value other than zero. By default, parameter 13.00 is set to 0.

Application Settings Instructions	
Enabling the APP keypad screen	To enable the APP keypad screen, set parameter 13.00 to a value other than 0. Use the instructions under "Parameter Settings" on page 3–6 to navigate to parameter 13.00 and set a value. The following options are available:

Value	Keypad Display	Description
0	n/a	APP is off and does not display.
1	USEr	User-defined application.
2	CoPr	Compressor application
3	FAn	Fan application
4	PUNP	Pump application
5	CnYr	Conveyer application
6	CnC	Machine tool application
7	PAC	Packing application
8	tiLE	Textile application

Using the APP setting	To verify the current APP setting of the drive, press the MENU button until APP appears, then press ENTER to display the current APP setting. If APP does not appear, parameter 13.00 is set to 0 and APP is disabled. If APP is enabled, press ENTER again to access a list of application appropriate parameters. Use the UP and LEFT/DOWN keys to view parameter numbers. Press the ENTER key to select a parameter, then modify per the standard parameter setting instructions. For example, if parameter 13.00 is set to 2: 

Application Settings Instructions	
Configuring the User-defined Parameter Set	The user-defined APP setting (USEr) allows you to configure your own list of parameters for quick access. Up to 50 parameters can be set by configuring parameters 13.01–13.50. 1) Navigate to the parameter settings and select parameter 13.01 2) Press and hold the MENU button until the last digit of the value (default will be 0.00) blinks, then use the UP and LEFT/DOWN buttons to set the parameter number you wish to reference. 3) Press ENTER to accept. 4) Repeat as needed using parameters 13.02 and up until all desired parameters are referenced. For example, if the first user-defined parameter you wish to appear is 04.00:  User-defined parameters must use parameter 13.xx in sequence or an Err will occur. The first user-defined parameter must be under 13.01, the second under 13.02, etc. If you wish to remove user-defined parameters, they must also be removed in order, starting with the highest 13.xx configured and working down.
Modifying User-defined Parameter Set Values	The APP page can be used to modify the values of parameters in the user-defined parameter set rather than needing to go to the parameter page. To modify the value of a parameter in the user-defined set, follow the steps below: 1) Press MENU until APP appears, then press ENTER. 2) When USEr displays, press ENTER to bring up the list of user-defined parameters. 3) Use the UP and LEFT/DOWN buttons to select the desired parameter, then press ENTER. 4) Use the UP and LEFT/DOWN buttons to select the desired parameter value, then press ENTER. 5) If the value is valid, End will display. If it is not valid, Err will display. Press MENU to return to the main page. 

Reference Table for Digital LED Character Display

The table below shows how characters display on the LED screen with the number or letter represented above it. This can helpful for characters such as "V" that do not display normally on the LED.

Number	0	1	2	3	4	5	6	7	8	9
Display	0	1	2	3	4	5	6	7	8	9
Number	A	a	B	b	C	c	D	d	E	e
Display	A	-	-	b	C	c	-	d	E	-
Number	F	f	G	g	H	h	I	i	J	j
Display	F	-	G	-	H	h	-	i	J	j
Number	K	k	L	l	M	m	N	n	O	o
Display	K	-	L	-	-	-	-	n	-	o
Number	P	p	Q	q	R	r	S	s	T	t
Display	P	-	-	q	-	r	S	-	-	t
Number	U	u	V	v	W	w	X	x	Y	y
Display	U	u	-	v	-	-	-	-	y	-
Number	Z	z								
Display	Z	-								

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AC Drive Parameters

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Introduction

This chapter covers all the parameters available for use with the GS20(X) series drives. The first section provides a summary of the parameters and some basic information. The second section provides detailed information about each parameter.

Video Tutorials

Video tutorials for the GS20 family of drives are located here:

- www.automationdirect.com/videos *(random search)*
- www.automationdirect.com/cookbook *(organized by subject/topic)*

DURApulse GS20(X) Parameter Summary

Drive Parameters Summary (P00.xx)

For detailed information about the P0.xx parameter group, please refer to page 4–51.

GS20(X) Parameters Summary – Drive Parameters (P00.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P00.00	GS20 Model ID-Identity Code	102: 120 V, 1 Phase, 0.25 HP 103: 120 V, 1 Phase, 0.5 HP 104: 120 V, 1 Phase, 1 HP 302: 230 V, 1 Phase, 0.25 HP 303: 230 V, 1 Phase, 0.5 HP 304: 230 V, 1 Phase, 1 HP 305: 230 V, 1 Phase, 2 HP 306: 230 V, 1 Phase, 3 HP 202: 230 V, 3 Phase, 0.25 HP 203: 230 V, 3 Phase, 0.5 HP 204: 230 V, 3 Phase, 1 HP 205: 230 V, 3 Phase, 2 HP 206: 230 V, 3 Phase, 3 HP 207: 230 V, 3 Phase, 5 HP 208: 230 V, 3 Phase, 7.5 HP 209: 230 V, 3 Phase, 10 HP 210: 230 V, 3 Phase, 15 HP 211: 230 V, 3 Phase, 20 HP 403: 460 V, 3 Phase, 0.5 HP 404: 460 V, 3 Phase, 1 HP 405: 460 V, 3 Phase, 2 HP 406: 460 V, 3 Phase, 3 HP 407: 460 V, 3 Phase, 5 HP 408: 460 V, 3 Phase, 7.5 HP 409: 460 V, 3 Phase, 10 HP 410: 460 V, 3 Phase, 15 HP 411: 460 V, 3 Phase, 20 HP 412: 460 V, 3 Phase, 25 HP 413: 460 V, 3 Phase, 30 HP 504: 575 V, 3 Phase, 1 HP 505: 575 V, 3 Phase, 2 HP 506: 575 V, 3 Phase, 3 HP 507: 575 V, 3 Phase, 5 HP 508: 575 V, 3 Phase, 7.5 HP 509: 575 V, 3 Phase, 10 HP	Read	0000	40001	~	
P00.01	Rated Current	Display by models	Read	0001	40002	~	
(table continued next page)							

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P00.02	Restore to Default	0: No function 1: Parameter Lock 2: Convert to GS2 mode (Step 1 of 2) 3: Not used 4: Not used 5: Reset kWh Display to 0 6: Reset PLC 8: Disable Keypad Run 9: Reset all parameters to 50Hz defaults 10: Reset all parameters to 60Hz defaults 11: Reset all parameters to 50Hz defaults (retain user-defined parameter values P13.01~P13.50) 12: Reset all parameters to 60Hz defaults (retain user-defined parameter values P13.01~P13.50) 13: Not used 20: Convert to GS2 mode (Step 2 of 2) ***Note:*** Reboot drive after resetting defaults.	R/W	0002	40003	0	
P00.03	Start-up display Selection	0: F – Freq Setpoint 1: H – Output Hz 2: U - User Display P00-04) 3: A – Output Amps	♦R/W	0003	40004	0	
(table continued next page)							

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P00.04	User Display	0: Output Amps (A) (unit: Amp) 1: Counter Value (c) (unit: CNT) 2: Output Frequency (H.) (unit: Hz) 3: DC Bus Voltage (V) (unit: VDC) 4: Output Voltage (E) (unit: VAC) 5: Power Factor (n) (unit: deg) 6: Output Power (P) (unit: kW) 7: Calculated RPM (r) (unit: rpm) 8: Est Output Torque (t) (unit: %) 10: PID Feedback (b) (unit: %) 11: AI1 Analog Input Signal (1.) (unit: %) 12: AI2 Analog Input Signal (2.) (unit: %) 14: IGBT Temperature (i.) (unit: °C) 16: DI Input Status (ON / OFF) (i) 17: DO Output Status (ON / OFF) (o) 18: Multi-Speed Step (S) 19: CPU DI Input Status (d) 20: CPU DO Output Status (0.) 22: Pulse input frequency (S.) 25: Overload count (0.00–100.00%) (o.) (unit: %) 26: Ground fault GFF (G.) (unit: %) 27: DC bus voltage ripple (r.) (unit: VDC) 28: Display PLC register D1043 data (C) 30: Display the output of User-defined (U) 31: Display P00-05 user gain (K) 35: Control mode display 36: Present operating carrier frequency of the drive (J.) (Unit: Hz) 38: Display the drive status (6.) 39: Display the drive's estimated output torque, positive and negative, using N•m as unit (t 0.0: positive torque; -0.0: negative torque) (C.) 40: Torque command (L.) (unit: %) 41: kWh display (J) (unit: kWh) 42: PID target value (h.) (unit: %) 43: PID compensation (o.) (unit: %) 44: PID output frequency (b.) (unit: Hz) 46: Auxiliary frequency value (U.) (unit: Hz) 47: Master frequency value (A) (unit: Hz) 48: Frequency value after addition and subtraction of master and auxiliary frequency (L.) (unit: Hz) 51: PMSVC torque offset 58: P00.05 User gain display (K) (Does not display decimal places.) 62: I2t (o.) (unit: %) 63: Error code (E.) 64: Warning code (n.) 65: Accumulated motor operation record (day) (r.) (refer to P05.32)	♦R/W	0004	40005	3	
P00.05	Coefficient Gain in Actual Output Frequency Display (H Page scale)	0.00–160.00	♦R/W	0005	40006	1.00	
P00.06	Firmware version	Read only	Read	0006	40007	~	
P00.07	Parameter protection password input	0–65535 0–4: the number of password attempts allowed	♦R/W	0007	40008	0	

(table continued next page)

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P00.08	Parameter protection password setting	0–65535 0: No password protection or password entered correctly (P00-07) 1: Parameter has been set	♦R/W	0008	40009	0	
P00.10	Control Method	0: Speed Control mode 2: Torque mode	R/W	000A	40011	0	
P00.11	Speed (Velocity) Control mode	0: IMVF (V/F control) 1: IMVFPG (V/F control + encoder) 2: IM/PM SVC (IM or PM space vector control) 5: IMFOC Sensorless (field-oriented sensorless vector control) **Note:** For option 2 (SVC), see P05.33 for induction motor (IM) or permanent magnent (PM) motor selection.	R/W	000B	40012	0	
P00.16	Torque duty selection	0: Variable Torque (VT) 1: Constant Torque (CT)	R/W	0010	40017	1	
P00.17	Carrier frequency	Variable Torque: 2–15 kHz Constant Torque: 2–15 kHz Note: When P00-11=5 (IMFOC Sensorless), the maximum setting value for the carrier frequency is 10 kHz.	R/W	0011	40018	4	
P00.18	GS Series Number	20: GS20 series drive (GS21 or GS23) 21: GS20X series drive (GS21X or GS23X)	Read	0012	40019	–	
P00.19	PLC command mask	bit 0: Control command is forced by PLC control bit 1: Frequency command is forced by PLC control bit 3: Torque command is forced by PLC control	Read	0013	40020	0	
P00.20	Master frequency command source (AUTO, REMOTE)	0: Digital keypad 1: RS-485 communication input 2: External analog input (Refer to P03.00) 3: External UP / DOWN terminal (digital input terminals) 4: Pulse input (DI7) without direction command (refer to P10.16 for pulse input config) 6: Not used 7: Digital keypad VR/potentiometer dial (GS20 only) 8: Communication card 9: PID controller Note: HOA (Hand-Off-Auto) function is valid only when you use with digital input (DI) function setting 41/42 or 56 or with GS4-KPD (optional).	♦R/W	0014	40021	0	
P00.21	Operation command source (AUTO, REMOTE)	0: Digital keypad 1: External terminals 2: RS-485 communication input 3: Not used 5: Communication card Note: HOA (Hand-Off-Auto) function is valid only when you use with digital input (DI) function settings 41/42 or 56 or with GS4-KPD (optional)	♦R/W	0015	40022	0	
P00.22	Stop method	0: Ramp to stop 1: Coast to stop	♦R/W	0016	40023	0	

(table continued next page)

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P00.23	Motor direction control	0: Enable forward / reverse 1: Disable reverse 2: Disable forward	♦R/W	0017	40024	0	
P00.24	Digital operator (keypad) frequency command memory	Read only	Read	0018	40025	60	
P00.25	User-defined characteristics (COEFF ATT)	bit 0–3: user-defined decimal places 0000h,0000b: no decimal place 0001h,0001b: one decimal place 0002h,0010b: two decimal places 0003h,0011b: three decimal places bit 4–15: user-defined unit 000xh: Hz 001xh: rpm 002xh: % 003xh: kg 004xh: m/s 005xh: kW 006xh: HP 007xh: ppm 008xh: 1/m 009xh: kg/s 00Axh: kg/m 00Bxh: kg/h 00Cxh: lb/s 00Dxh: lb/m 00Exh: lb/h 00Fxh: ft/s 010xh: ft/m 011xh: m 012xh: ft 013xh: degC 014xh: degF 015xh: mbar 016xh: bar 017xh: Pa 018xh: kPa 019xh: mWG 01Axh: inWG 01Bxh: ftWG 01Cxh: psi 01Dxh: atm 01Exh: L/s 01Fxh: L/m 020xh: L/h 021xh: m3/s 022xh: m3/h 023xh: GPM 024xh: CFM	♦R/W	0019	40026	0	
P00.26	User-defined maximum value (COEFF MAX)	0: Disable 0–65535 (when P00.25 is set to no decimal place) 0.0–6553.5 (when P00.25 is set to one decimal place) 0.00–655.35 (when P00.25 is set to two decimal places) 0.000–65.535 (when P00.25 is set to three decimal places)	RW	001A	40027	0	
P00.27	User-defined value (COEFF SET)	Read only	Read	001B	40028	0	

(table continued next page)

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P00.29	LOCAL / REMOTE selection	0: Standard HOA function 1: When switching between local and remote, the drive stops. 2: When switching between local and remote, the drive runs with REMOTE settings for frequency and operating status. 3: When switching between local and remote, the drive runs with LOCAL settings for frequency and operating status. 4: When switching between local and remote, the drive runs with LOCAL settings when switched to Local and runs with REMOTE settings when switched to Remote for frequency and operating status.	R/W	001D	40030	4	
P00.30	Master frequency command source (HAND, LOCAL)	0: Digital keypad 1: RS-485 communication input 2: External analog input (refer to P03.00) 3: External UP / DOWN terminal (digital input terminals) 4: Pulse input without direction command (refer to P10.16 for pulse input config) 6: Not used 7: Digital keypad VR/potentiometer dial (GS20 only) 8: Communication card 9: PID controller Note: HOA (Hand-Off-Auto) function is valid only when you use with digital input (DI) function setting 41/42 or 56 or with GS4-KPD (optional).	♦R/W	001E	40031	0	
P00.31	Operation command source (HAND, LOCAL)	0: Digital keypad 1: External terminal 2: RS-485 communication input 3: Not used 5: Communication card Note: HOA (Hand-Off-Auto) function is valid only when you use with digital input (DI) function setting 41/42 or 56 or with GS4-KPD (optional).	♦R/W	001F	40032	0	
P00.32	Digital keypad STOP function	0: STOP key disabled 1: STOP key enabled	♦R/W	0020	40033	0	
P00.35	Auxiliary frequency source	0: Master and auxiliary frequency function disabled 1: Digital keypad 2: RS-485 communication input 3: Analog input 4: External UP / DOWN key input (digital input terminals) 5: Pulse input without direction command (refer to P10.16 for pulse input config) 6: Not used 7: Digital keypad VR/potentiometer dial (GS20 only) 8: Communication card	R/W	0023	40036	0	

(table continued next page)

GS20(X) Parameters Summary – Drive Parameters (P00.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P00.36	Master and auxiliary frequency command selection	0: Master + auxiliary frequency 1: Master - auxiliary frequency 2: Auxiliary - master frequency	R/W	0024	40037	0	
P00.48	Display filter time (current)	0.001–65.535 sec.	♦R/W	0030	40049	0.100	
P00.49	Display filter time (keypad)	0.001–65.535 sec.	♦R/W	0031	40050	0.100	
P00.50	Date Code of Firmware version (date)	Read only	Read	0032	40051	0	

Basic Parameters Summary (P01.xx)

For detailed information about the P01.xx parameter group, please refer to page 4–72.

GS20(X) Parameters Summary – Basic Parameters (P01.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P01.00	Maximum operation frequency	0.00–599.00 Hz	R/W	0100	40257	60.00 / 50.00	
P01.01	Motor 1 Fbase	0.00–599.00 Hz	R/W	0101	40258	60.00 / 50.00	
P01.02	Motor 1, Rated Voltage (Nameplate)	120V / 230V models: 0.0–255.0 V 460V models: 0.0–510.0 V 575V models: 0.0–637.0 V	R/W	0102	40259	220.0 440.0 575.0	
P01.03	Motor 1, Mid-point frequency 1	0.00–599.00 Hz	R/W	0103	40260	3.00	
P01.04	Motor 1, Mid-point voltage 1	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0104	40261	11.0 22.0 40.0	
P01.05	Motor 1, Mid-point frequency 2	0.00–599.00 Hz	R/W	0105	40262	1.50	
P01.06	Motor 1, Mid-point voltage 2	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0106	40263	5.0 10.0 26.1	
P01.07	Motor 1, Minimum output frequency	0.00–599.00 Hz	R/W	0107	40264	0.50	
P01.08	Motor 1, Minimum output voltage	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0108	40265	1.0 2.0 16.7	
P01.09	Start-up frequency	0.00–599.00 Hz	R/W	0109	40266	0.50	
P01.10	Output frequency upper limit	0.00–599.00 Hz	♦R/W	010A	40267	599.00	
P01.11	Output frequency lower limit	0.00–599.00 Hz	♦R/W	010B	40268	0.00	
P01.12	Acceleration time 1	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	010C	40269	10.00 10.0	
P01.13	Deceleration time 1	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	010D	40270	10.00 10.0	
P01.14	Acceleration time 2	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	010E	40271	10.00 10.0	
P01.15	Deceleration time 2	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	010F	40272	10.00 10.0	
P01.16	Acceleration time 3	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0110	40273	10.00 10.0	
P01.17	Deceleration time 3	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0111	40274	10.00 10.0	
P01.18	Acceleration time 4	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0112	40275	10.00 10.0	
P01.19	Deceleration time 4	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0113	40276	10.00 10.0	
P01.20	JOG acceleration time	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0114	40277	10.00 10.0	
P01.21	JOG deceleration time	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	♦R/W	0115	40278	10.00 10.0	
P01.22	JOG frequency	0.00–599.00 Hz	♦R/W	0116	40279	6.00	
(table continued next page)							

GS20(X) Parameters Summary – Basic Parameters (P01.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P01.23	TRANS ACC/DEC1-4 Switch frequency between first and fourth Accel./Decel.	0.00–599.00 Hz	♦R/W	0117	40280	0.00	
P01.24	S-curve for acceleration begin time 1	P01.45 = 0: 0.00–25.00 sec. P01.45 = 1: 0.0–250.0 sec.	♦R/W	0118	40281	0.20 0.2	
P01.25	S-curve for acceleration arrival time 2	P01.45 = 0: 0.00–25.00 sec. P01.45 = 1: 0.0–250.0 sec.	♦R/W	0119	40282	0.20 0.2	
P01.26	S-curve for deceleration begin time 1	P01.45 = 0: 0.00–25.00 sec. P01.45 = 1: 0.0–250.0 sec.	♦R/W	011A	40283	0.20 0.2	
P01.27	S-curve for deceleration arrival time 2	P01.45 = 0: 0.00–25.00 sec. P01.45 = 1: 0.0–250.0 sec.	♦R/W	011B	40284	0.20 0.2	
P01.28	Skip frequency 1 (upper limit)	0.00–599.00 Hz	R/W	011C	40285	0.00	
P01.29	Skip frequency 1 (lower limit)	0.00–599.00 Hz	R/W	011D	40286	0.00	
P01.30	Skip frequency 2 (upper limit)	0.00–599.00 Hz	R/W	011E	40287	0.00	
P01.31	Skip frequency 2 (lower limit)	0.00–599.00 Hz	R/W	011F	40288	0.00	
P01.32	Skip frequency 3 (upper limit)	0.00–599.00 Hz	R/W	0120	40289	0.00	
P01.33	Skip frequency 3 (lower limit)	0.00–599.00 Hz	R/W	0121	40290	0.00	
P01.34	Zero-speed mode	0: Output waiting 1: Zero-speed operation 2: Fmin (refer to P01.07 and P01.41)	R/W	0122	40291	0	
P01.35	Motor 2, Output frequency (Base frequency / Motor's rated frequency)	0.00–599.00 Hz	R/W	0123	40292	60.00 / 50.00	
P01.36	Motor 2, Output voltage (Base voltage / Motor's rated voltage)	120V / 230V models: 0.0–255.0 V 460V models: 0.0–510.0 V 575V models: 0.0–637.0 V	R/W	0124	40293	220.0 440.0 575.0	
P01.37	Motor 2, Mid-point frequency	0.00–599.00 Hz	R/W	0125	40294	3.0	
P01.38	Motor 2, Mid-point voltage 1	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0126	40295	11.0 22.0 40.0	
P01.39	Motor 2, Mid-point frequency 2	0.00–599.00 Hz	R/W	0127	40296	1.50	
P01.40	Motor 2, Mid-point voltage 2	120V / 230V models: 0.0–240.0 V 460V models:0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0128	40297	5.0 10.0 26.1	
P01.41	Motor 2, Minimum output frequency	0.00–599.00 Hz	R/W	0129	40298	0.50	
P01.42	Motor 2, Minimum output voltage	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	012A	40299	1.0 2.0 16.7	
P01.43	V/F curve selection	0: V/F curve determined by P01.00–P01.08 1: V/F curve to the power of 1.5 2: V/F curve to the power of 2	R/W	012B	40300	0	

(table continued next page)

GS20(X) Parameters Summary – Basic Parameters (P01.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P01.44	Auto-acceleration and auto-deceleration setting	0: Linear acceleration and deceleration 1: Auto-acceleration and linear deceleration 2: Linear acceleration and auto-deceleration 3: Auto-acceleration and auto-deceleration 4: Stall prevention by auto-acceleration and auto-deceleration (limited by P01.12 –P01.21)	♦R/W	012C	40301	0	
P01.45	Time unit for acceleration / deceleration and S-curve	0: Unit 0.01 sec. 1: Unit 0.1 sec.	R/W	012D	40302	0	
P01.49	Regenerative energy restriction control (decel method)	0: Disable 1: Over voltage energy restriction 2: Traction energy control (TEC)	R/W	0131	40306	0	
P01.52	Motor 2, Maximum operation frequency	0.00–599.00 Hz	R/W	0134	40309	60.00 / 50.00	
P01.53	Motor 3, Maximum operation frequency	0.00–599.00 Hz	R/W	0135	40310	60.00 / 50.00	
P01.54	Motor 3, Output frequency (Base frequency / Motor's rated frequency)	0.00–599.00 Hz	R/W	0136	40311	60.00 / 50.00	
P01.55	Motor 3, Output voltage (Base voltage / Motor's rated voltage)	120V / 230V models: 0.0–255.0 V 460V models: 0.0–510.0 V 575V models: 0.0–637.0 V	R/W	0137	40312	220.0 440.0 575.0	
P01.56	Motor 3, Mid-point frequency 1	0.00–599.00 Hz	R/W	0138	40313	3.00	
P01.57	Motor 3, Mid-point voltage 1	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0139	40314	11.0 22.0 40.0	
P01.58	Motor 3, Mid-point frequency 2	0.00–599.00 Hz	R/W	013A	40315	1.50	
P01.59	Motor 3, Mid-point voltage 2	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	013B	40316	5.0 10.0 26.1	
P01.60	Motor 3, Minimum output frequency	0.00–599.00 Hz	R/W	013C	40317	0.50	
P01.61	Motor 3, Minimum output voltage	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	013D	40318	1.0 2.0 16.7	
P01.62	Motor 4, Maximum operation frequency	0.00–599.00 Hz	R/W	013E	40319	60.00 / 50.00	
P01.63	Motor 4, Output frequency (Base frequency / Motor's rated frequency)	0.00–599.00 Hz	R/W	013F	40320	60.00 / 50.00	
P01.64	Motor 4, Output voltage (Base voltage / Motor's rated voltage)	120V / 230V models: 0.0–255.0 V 460V models: 0.0–510.0 V 575V models: 0.0–637.0 V	R/W	0140	40321	220.0 440.0 575.0	
P01.65	Motor 4, Mid-point frequency 1	0.00–599.00 Hz	R/W	0141	40322	3.00	
P01.66	Motor 4, Mid-point voltage 1	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0142	40323	11.0 22.0 40.0	

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GS20(X) Parameters Summary – Basic Parameters (P01.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P01.67	Motor 4, Mid-point frequency 2	0.00–599.00 Hz	R/W	0143	40324	1.50	
P01.68	Motor 4, Mid-point voltage 2	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0144	40325	5.0 10.0 26.1	
P01.69	Motor 4, Minimum output frequency	0.00–599.00 Hz	R/W	0145	40326	0.50	
P01.70	Motor 4, Minimum output voltage	120V / 230V models: 0.0–240.0 V 460V models: 0.0–480.0 V 575V models: 0.0–600.0 V	♦R/W	0146	40327	1.0 2.0 16.7	

Digital Input/Output Parameters Summary (P02.xx)

For detailed information about the P02.xx parameter group, please refer to page 4–83.

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P02.00	Two-wire / three-wire operation control	Note: On the drive, DI1 is labeled FWD, and DI2 is labeled REV. 0: No function 1: Two-wire mode 1, power on for operation control (DI1: FWD/STOP, DI2: REV/STOP) 2: Two-wire mode 2, power on for operation control (DI1: RUN/STOP, DI2: REV/FWD) 3: Three-wire, power on for operation control (DI1: RUN, DI2: REV/FWD, DI3: STOP) 4: Two-wire mode 1, Quick Start (DI1: FWD/STOP, DI2: REV/STOP) 5: Two-wire mode 2, Quick Start (DI1: RUN/STOP, DI2: REV/FWD) 6: Three-wire, Quick Start (DI1: RUN, DI2: REV/FWD, DI3: STOP) **IMPORTANT** 1) In the QuickStart function, terminal output remains in ready status, and the drive responds to the start command immediately. 2) When using the Quick Start function, output terminals U, V, and W are powered immediately. To avoid electric shock hazard, do not touch the terminals or modify the motor wiring.	R/W	0200	40513	1	
(table continued next page)							

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx) – (continued)							
Parameter		**Range**	**Run Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P02.01	Multi-function input command 1 (FWD/DI1)	0: No function 1: Multi-step speed command 1 2: Multi-step speed command 2 3: Multi-step speed command 3 4: Multi-step speed command 4 5: Reset 6: JOG [by external control or GS4-KPD (optional)] 7: Acceleration / deceleration speed inhibit 8: 1st and 2nd acceleration / deceleration time selection 9: 3rd and 4th acceleration / deceleration time selection 10: External Fault (EF) Input (P07.20) 11: Base Block (B.B.) input from external source 12: Output stop 13: Cancel the setting of auto-acceleration / auto-deceleration time 15: Frequency command from AI1 16: Frequency command from AI2 18: Force to stop (P07.20) 19: Digital up command 20: Digital down command 21: PID function disabled 22: Clear the counter 23: Input the counter value (DI6) 24: FWD JOG command 25: REV JOG command 26: TQC / Field Oriented Control (FOC) mode selection 27: ASR1 / ASR2 selection 28: Emergency stop (EF1) 29: Signal confirmation for Y-connection 30: Signal confirmation for Δ-connection 31: High torque bias (P11.30) 32: Middle torque bias (P11.31) 33: Low torque bias (P11.32) 38: Disable writing EEPROM function 39: Torque command direction 40: Force coasting to stop 41: HAND switch 42: AUTO switch 48: Mechanical gear ratio switch 49: Enable drive 50: Slave dEb action to execute 51: Selection for PLC mode bit 0 52: Selection for PLC mode bit 1 56: Local / Remote selection	R/W	0201	40514	0	
(table continued next page)							

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx) – (continued)							
Parameter		**Range**	**Run Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P02.01 (cont'd)	Multi-function input command 1 (FWD/DI1) (continued)	58: Enable fire mode (with RUN command) 59: Enable fire mode (without RUN command) 70: Force auxiliary frequency return to 0 71: Disable PID function, force PID output return to 0 72: Disable PID function, retain the output value before disabled 73: Force PID integral gain return to 0, disable integral 74: Reverse PID feedback 81: Simple positioning zero point position signal input 82: OOB loading balance detection 83: Multi-motor (IM) selection bit 0 84: Multi-motor (IM) selection bit 1	R/W	0201	40514	0	
P02.02	Multi-function input command 2 (REV/DI2)	See P02.01 for values.	R/W	0202	40515	0	
P02.03	Multi-function input command 3 (DI3)	See P02.01 for values.	R/W	0203	40516	1	
P02.04	Multi-function input command 4 (DI4)	See P02.01 for values.	R/W	0204	40517	2	
P02.05	Multi-function input command 5 (DI5)	See P02.01 for values.	R/W	0205	40518	3	
P02.06	Multi-function input command 6 (DI6)	See P02.01 for values.	R/W	0206	40519	4	
P02.07	Multi-function input command 7 (DI7)	See P02.01 for values. For pulse input, use selection 0 - No function.	R/W	0207	40520	0	
P02.09	UP / DOWN key mode	0: UP / DOWN by the acceleration / deceleration time 1: UP / DOWN constant speed (P02.10) 2: Pulse signal (P02.10) 3: External terminals UP / DOWN mode	♦R/W	0209	40522	0	
P02.10	Constant speed, acceleration / deceleration speed of the UP/DOWN Key	0.001–1.000 Hz/ms	♦R/W	020A	40523	0.001	
P02.11	Multi-function input response time	0.000–30.000 sec.	♦R/W	020B	40524	0.005	
P02.12	Multi-function input mode selection	0000h–FFFFh (0: N.O.; 1: N.C.)	♦R/W	020C	40525	0000	

(table continued next page)

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx) – (continued)							
Parameter		**Range**	**Run Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P02.13	Multi-function output 1 (R1)	0: No function 1: Indication during RUN 2: Operation speed reached 3: Desired frequency reached 1 (P02.22) 4: Desired frequency reached 2 (P02.24) 5: Zero speed (Frequency command) 6: Zero speed including STOP (Frequency command) 7: Over-torque 1 (P06.06–06.08) 8: Over-torque 2 (P06.09–06.11) 9: Drive is ready 10: Low voltage warning (Lv) (P06.00) 11: Malfunction indication 13: Overheat warning (P06.15) 14: Software brake signal indicator (P07.00) 15: PID feedback error (P08.13, P08.14) 16: Slip error (oSL) 17: Count value reached, does not return to 0 (P02.20) 18: Count value reached, return to 0 (P02.19) 19: External interrupt B.B. input (Base Block) 20: Warning output 21: Over-voltage 22: Over-current stall prevention 23: Over-voltage stall prevention 24: Operation mode 25: Forward command 26: Reverse command 29: Output when frequency ≥ P02.34 30: Output when frequency < P02.34 31: Y-connection for the motor coil 32: Δ-connection for the motor coil 33: Zero speed (actual output frequency) 34: Zero speed including STOP (actual output frequency) 35: Error output selection 1 (P06.23) 36: Error output selection 2 (P06.24) 37: Error output selection 3 (P06.25) 38: Error output selection 4 (P06.26) 40: Speed reached (including STOP) 42: Crane function 43: Motor speed detection 44: Low current output (use with P06.71–06.73) 45: UVW output electromagnetic valve switch 46: Master dEb output	♦R/W	020D	40526	11	
(table continued next page)							

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx) – (continued)							
Parameter		**Range**	**Run Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P02.13 (cont'd)	Multi-function output 1 (R1) (continued)	51: Digital output control for serial modbus 52: Digital output control for communication card 53: Fire mode indication 66: SO output logic A 67: Analog input level reached 68: SO output logic B 73: Over-torque 3 74: Over-torque 4 75: Forward RUN status 76: Reverse RUN status	♦R/W	020D	40526	11	
P02.16	Multi-function output 2 (DO1)	See P02.13 for values.	♦R/W	0210	40529	0	
P02.17	Multi-function output 3 (DO2)	See P02.13 for values.	♦R/W	0211	40530	0	
P02.18	Multi-function output direction ACT	0000h–FFFFh (0: N.O.; 1: N.C.)	♦R/W	0212	40531	0000h	
P02.19	Terminal counting value reached (returns to 0)	0–65500	♦R/W	0213	40532	0	
P02.20	Preliminary (Middle) counting value reached (does not return to 0)	0–65500	♦R/W	0214	40533	0	
P02.21	Digital output gain (DO)	1–55	♦R/W	0215	40534	1	
P02.22	Desired frequency reached 1	0.00–599.00 Hz	♦R/W	0216	40535	60.00 / 50.00	
P02.23	The bandwidth of the desired frequency reached 1	0.00–599.00 Hz	♦R/W	0217	40536	2.00	
P02.24	Desired frequency reached 2	0.00–599.00 Hz	♦R/W	0218	40537	60.00 / 50.00	
P02.25	The bandwidth of the desired frequency reached 2	0.00–599.00 Hz	♦R/W	0219	40538	2.00	
P02.34	Output frequency setting for digital output terminal	0.00–599.00 Hz (Motor speed when using PG Card)	♦R/W	0222	40547	0.00	
P02.35	External operation control selection after fault reset and reboot	0: Disable 1: Drive runs if the RUN command remains after reset or reboot	♦R/W	0223	40548	0	
P02.47	Motor RPM zero-speed level	0–65535 rpm	♦R/W	022F	40560	0	
P02.50	Display the status of multi-function input terminals DI1-DI7	Monitor the status of multi-function input terminals	Read	0232	40563	0	
P02.51	Display the status of multi-function output terminals R1, DO1, DO2	Monitor the status of digital output terminals	Read	0233	40564	0	
P02.52	Display the external multi-function input terminals DI1-DI7 used by PLC	Monitor which inputs are controlled by the PLC	Read	0234	40565	0	

(table continued next page)

GS20(X) Parameters Summary – Digital Input/Output Parameters (P02.xx) – (continued)							
Parameter		**Range**	**Run Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P02.53	Display the external multi-function output terminals R1, DO1, DO2 used by PLC	Monitor which outputs are controlled by the PLC	Read	0235	40566	0	
P02.54	Display the frequency command executed by external terminal (EXT Speed REC)	0.00–599.00 Hz (Read only)	Read	0236	40567	0	
P02.58	Multi-function output terminal (function 42): brake frequency check point	0.00–599.00 Hz	♦R/W	023A	40571	0.00	
P02.78	Motor deceleration gear ratio	4.0–1000.0	R/W	024E	40591	200.0	
P02.79	Automatic index positioning angle setting	0.0–6480.0	R/W	024F	40592	180.0	
P02.80	Automatic index positioning deceleration time	0.00: Disable the function 0.01–100.00 sec.	♦R/W	0250	40593	0.00	
P02.81	EF activates when the terminal count value reached	0: Terminal count value reached, no EF displays (continues to operate) 1: Terminal count value reached, EF activates	♦R/W	0251	40594	0	
P02.82	Initial Frequency com-mand (F) mode after stop	0: Use current Frequency command 1: Use zero Frequency Command 2: Refer to P02.83 to set up	♦R/W	0252	40595	0	
P02.83	Initial Frequency com-mand (F) setting after stop	0.00–599.00 Hz	♦R/W	0253	40596	60.00	

Analog Input/Output Parameters Summary (P03.xx)

For detailed information about the P03.xx parameter group, please refer to page 4–104.

GS20(X) Parameters Summary – Analog Input/Output Parameters (P03.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using using P00.02.							
P03.00	Analog input selection (AI1)	0: No function 1: Frequency command 2: Torque command (torque limit under speed mode) 3: Torque compensation command 4: PID target value 5: PID feedback signal 6: Thermistor (PTC) input value 7: Positive torque limit 8: Negative torque limit 9: Regenerative torque limit 10: Positive / negative torque limit 11: PT100 RTD input value 12: Auxiliary frequency input 13: PID compensation value	♦R/W	0300	40769	1	
P03.01	Analog input selection (AI2)		♦R/W	0301	40770	0	
P03.03	Analog input bias (AI1)	-100.0–100.0%	♦R/W	0302	40771	0	
P03.04	Analog input bias (AI2)	-100.0–100.0%	♦R/W	0303	40772	0	
P03.07	Positive / negative bias mode (AI1)	0: No bias 1: Lower than or equal to bias 2: Greater than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center	♦R/W	0304	40773	0	
P03.08	Positive / negative bias mode (AI2)		♦R/W	0308	40777	0	
P03.10	Reverse setting when analog signal input is negative frequency	0: Negative frequency input is not allowed. The digital keypad or external terminal controls the forward and reverse direction. 1: Negative frequency input is allowed. Positive frequency = run in a forward direction; negative frequency = run in a reverse direction. The digital keypad or external terminal control cannot change the running direction.	♦R/W	030A	40779	0	
P03.11	Analog input gain (AI1)	-500.0–500.0%	♦R/W	030B	40780	100.0	
P03.12	Analog input gain (AI2)	-500.0–500.0%	♦R/W	030C	40781	100.0	
P03.15	Analog input filter (LPF) time (AI1)	0.00–20.00 sec.	♦R/W	030F	40784	0.01	
P03.16	Analog input filter (LPF) time (AI2)	0.00–20.00 sec.	♦R/W	0310	40785	0.01	
P03.18	Analog input addition function	0: Disable (AI1, AI2) 1: Enable	♦R/W	0312	40787	0	
P03.19	Signal loss selection for analog input 4–20 mA	0: Disable 1: Continue operation at the last frequency 2: Decelerate to 0 Hz 3: Stop immediately and display "ACE"	R/W	0313	40788	0	
(table continued next page)							

GS20(X) Parameters Summary – Analog Input/Output Parameters (P03.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P03.20	Multi-function output (A01)	0: Output frequency (Hz) 1: Frequency command (Hz) 2: Motor speed (Hz) 3: Output current (rms) 4: Output voltage 5: DC bus voltage 6: Power factor 7: Power 8: Output torque 9: AI1 10: AI2 12: Iq current command 13: Iq feedback value 14: Id current command 15: Id feedback value 16: Vq-axis voltage command 17: Vd-axis voltage command 18: Torque command 19: PG2 (DI7) frequency command 21: RS-485 analog output 22: Communication card analog output 23: Constant voltage output	♦R/W	0314	40789	0	
P03.21	Analog output gain (A01)	0.0–500.0%	♦R/W	0315	40790	100.0	
P03.22	Analog output in REV direction (A01)	0: Absolute value in output voltage 1: Reverse output 0 V; forward output 0–10 V 2: Reverse output 5–0 V; forward output 5–10 V	♦R/W	0316	40791	0	
P03.27	A01 output bias	-100.00–100.00%	♦R/W	031B	40796	0.00	
P03.28	AI1 terminal input selection	0: 0–10 V (only P03.63–P03.68 are valid) 3: -10–10 V (only P03.63–P03.74 are valid)	♦R/W	031C	40797	0	
P03.29	AI2 terminal input selection	0: 4–20 mA 1: 0–10 V 2: 0–20 mA	♦R/W	031D	40798	0	
P03.30	PLC analog output terminal status	Monitor the status of the PLC analog output terminals bit 0: A01 status	Read	031E	40799	0	
P03.31	A01 output selection	0: 0–10 V output 1: 0–20 mA output 2: 4–20 mA output	♦R/W	031F	40800	0	
P03.32	A01 DC output setting level	0.00–100.00%	♦R/W	0320	40801	0.00	
P03.35	A01 output filter time	0.00–20.00 sec.	♦R/W	0323	40804	0.01	
P03.39	VR (keypad dial) input selection	0: Disable 1: Frequency command	♦R/W	0327	40808	1	
P03.40	VR (keypad dial) input bias	-100.0–100.0%	♦R/W	0328	40809	0.0	
P03.41	VR (keypad dial) positive / negative bias	0: No bias 1: Lower than or equal to bias 2: Greater than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center	♦R/W	0329	40810	0	
P03.42	VR (keypad dial) gain	-500.0–500.0%	♦R/W	032A	40811	100.0	
P03.43	VR (keypad dial) filter time	0.00–2.00 sec.	♦R/W	032B	40812	0.01	

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GS20(X) Parameters Summary – Analog Input/Output Parameters (P03.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P03.44	Multi-function output (DO) by AI level source	0: AI1 1: AI2	♦R/W	032C	40813	0	
P03.45	AI upper level	-100–100%	♦R/W	032D	40814	50	
P03.46	AI lower level	-100–100%	♦R/W	032E	40815	10	
P03.47	AI1%	-100–100%	Read	032F	40816	0	
P03.48	AI2%	-100–100%	Read	0330	40817	0	
P03.50	Analog input curve calculation selection	0: Normal curve 1: Three-point curve of AI1 2: Three-point curve of AI2 3: Three-point curve of AI1 & AI2	♦R/W	0332	40819	0	
P03.57	AI2 lowest point	P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA	♦R/W	0339	40826	4.00	
P03.58	AI2 proportional lowest point	-100.00–100.00%	♦R/W	033A	40827	0.00	
P03.59	AI2 mid-point	P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA	♦R/W	033B	40828	12.00	
P03.60	AI2 proportional mid-point	-100.00–100.00%	♦R/W	033C	40829	50.00	
P03.61	AI2 highest point	P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA	♦R/W	033D	40830	20.00	
P03.62	AI2 proportional highest point	-100.00–100.00%	♦R/W	033E	40831	100.00	
P03.63	AI1 voltage lowest point	0.00–10.00 V	♦R/W	033F	40832	0.00	
P03.64	AI1 proportional lowest point	-100.00–100.00%	♦R/W	0340	40833	0.00	
P03.65	AI1 voltage mid-point	0.00–10.00 V	♦R/W	0341	40834	5.00	
P03.66	AI1 proportional mid-point	-100.00–100.00%	♦R/W	0342	40835	50.00	
P03.67	AI1 voltage highest point	0.00–10.00 V	♦R/W	0343	40836	10.00	
P03.68	AI1 proportional highest point	-100.00–100.00%	♦R/W	0344	40837	100.00	
P03.69	Negative AI1 voltage highest point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	♦R/W	0345	40838	0.00	
P03.70	Negative AI1 proportional highest point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	♦R/W	0346	40839	0.00	
P03.71	Negative AI1 voltage mid-point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	♦R/W	0347	40840	-5.00	
P03.72	Negative AI1 proportional mid-point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	♦R/W	0348	40841	-50.00	
P03.73	Negative AI1 voltage lowest point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	♦R/W	0349	40842	-10.00	
P03.74	Negative AI1 proportional lowest point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	♦R/W	034A	40843	-100.00	

Multi-Step Speed Parameters Summary (P04.xx)

For detailed information about the P04.xx parameter group, please refer to page 4–139.

GS20(X) Parameters Summary – Multi-Step Speed Parameters (P04.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P04.00	1st step speed frequency	0.00–599.00 Hz	♦R/W	0400	41025	0.00	
P04.01	2nd step speed frequency	0.00–599.00 Hz	♦R/W	0401	41026	0.00	
P04.02	3rd step speed frequency	0.00–599.00 Hz	♦R/W	0402	41027	0.00	
P04.03	4th step speed frequency	0.00–599.00 Hz	♦R/W	0403	41028	0.00	
P04.04	5th step speed frequency	0.00–599.00 Hz	♦R/W	0404	41029	0.00	
P04.05	6th step speed frequency	0.00–599.00 Hz	♦R/W	0405	41030	0.00	
P04.06	7th step speed frequency	0.00–599.00 Hz	♦R/W	0406	41031	0.00	
P04.07	8th step speed frequency	0.00–599.00 Hz	♦R/W	0407	41032	0.00	
P04.08	9th step speed frequency	0.00–599.00 Hz	♦R/W	0408	41033	0.00	
P04.09	10th step speed frequency	0.00–599.00 Hz	♦R/W	0409	41034	0.00	
P04.10	11th step speed frequency	0.00–599.00 Hz	♦R/W	040A	41035	0.00	
P04.11	12th step speed frequency	0.00–599.00 Hz	♦R/W	040B	41036	0.00	
P04.12	13th step speed frequency	0.00–599.00 Hz	♦R/W	040C	41037	0.00	
P04.13	14th step speed frequency	0.00–599.00 Hz	♦R/W	040D	41038	0.00	
P04.14	15th step speed frequency	0.00–599.00 Hz	♦R/W	040E	41039	0.00	
P04.50	PLC buffer 0	0–65535	♦R/W	0432	41075	0	
P04.51	PLC buffer 1	0–65535	♦R/W	0433	41076	0	
P04.52	PLC buffer 2	0–65535	♦R/W	0434	41077	0	
P04.53	PLC buffer 3	0–65535	♦R/W	0435	41078	0	
P04.54	PLC buffer 4	0–65535	♦R/W	0436	41079	0	
P04.55	PLC buffer 5	0–65535	♦R/W	0437	41080	0	
P04.56	PLC buffer 6	0–65535	♦R/W	0438	41081	0	
P04.57	PLC buffer 7	0–65535	♦R/W	0439	41082	0	
P04.58	PLC buffer 8	0–65535	♦R/W	043A	41083	0	
P04.59	PLC buffer 9	0–65535	♦R/W	043B	41084	0	
P04.60	PLC buffer 10	0–65535	♦R/W	043C	41085	0	
P04.61	PLC buffer 11	0–65535	♦R/W	043D	41086	0	
P04.62	PLC buffer 12	0–65535	♦R/W	043E	41087	0	
P04.63	PLC buffer 13	0–65535	♦R/W	043F	41088	0	
P04.64	PLC buffer 14	0–65535	♦R/W	0440	41089	0	
P04.65	PLC buffer 15	0–65535	♦R/W	0441	41090	0	
P04.66	PLC buffer 16	0–65535	♦R/W	0442	41091	0	
P04.67	PLC buffer 17	0–65535	♦R/W	0443	41092	0	
P04.68	PLC buffer 18	0–65535	♦R/W	0444	41093	0	
P04.69	PLC buffer 19	0–65535	♦R/W	0445	41094	0	

Motor Parameters Summary (P05.xx)

For detailed information about the P05.xx parameter group, please refer to page 4–141.

GS20(X) Parameters Summary – Motor Parameters (P05.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P05.00	Motor parameter auto-tuning	0: No function 1: Dynamic test for induction motor (IM) 2: Static test for induction motor (IM) 5: Rolling auto-tuning for PM (IPM / SPM) 6: Simple rolling auto-tuning for induction motor (IM) 12: FOC sensorless inertia estimation (IM) 13: High frequency stall test for PM	R/W	0500	41281	0	
P05.01	Induction Motor 1, Full-load amps	10–120% of the drive's rated current	R/W	0501	41282	Model dependent	
P05.02	Induction Motor 1, Rated power (kW)	0.00–655.35 kW	♦R/W	0502	41283	Model dependent	
P05.03	Induction Motor 1, Rated speed (rpm)	0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz, 4 poles); 1410 (50Hz, 4 poles)	♦R/W	0503	41284	1710	
P05.04	Induction Motor 1, Number of poles	2–20	R/W	0504	41285	4	
P05.05	Induction Motor 1, No-load amps	0.00–P05.01 default	R/W	0505	41286	Model dependent	
P05.06	Induction Motor 1, Stator resistance (Rs)	0.000–65.535 Ω	R/W	0506	41287	Model dependent	
P05.07	Induction Motor 1, Rotor resistance (Rr)	0.000–65.535 Ω	R/W	0507	41288	0.000	
P05.08	Induction Motor 1, Magnetizing inductance (Lm)	0.0–6553.5 mH	R/W	0508	41289	0.0	
P05.09	Induction Motor 1, Stator inductance (Lx)	0.0–6553.5 mH	R/W	0509	41290	0.0	
P05.13	Induction Motor 2, Full-load amps	10–120% of the drive's rated current	R/W	050D	41294	Model dependent	
P05.14	Induction Motor 2, Rated power (kW)	0.00–655.35 kW	♦R/W	050E	41295	Model dependent	
P05.15	Induction Motor 2, Rated speed (rpm)	0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz, 4 poles); 1410 (50Hz, 4 poles)	♦R/W	050F	41296	1710	
P05.16	Induction Motor 2, Number of poles	2–20	R/W	0510	41297	4	
P05.17	Induction Motor 2, No-load amps	0.00–P05.13 default	R/W	0511	41298	Model dependent	
P05.18	Induction Motor 2, Stator resistance (Rs)	0.000–65.535 Ω	R/W	0512	41299	Model dependent	
P05.19	Induction Motor 2, Rotor resistance (Rr)	0.000–65.535 Ω	R/W	0513	41300	0.000	
P05.20	Induction Motor 2, Magnetizing inductance (Lm)	0.0–6553.5 mH	R/W	0514	41301	0.0	
(table continued next page)							

GS20(X) Parameters Summary – Motor Parameters (P05.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P05.21	Induction Motor 2, Stator inductance (Lx)	0.0–6553.5 mH	R/W	0515	41302	0.0	
P05.22	Multi-motor (induction) selection	1: Motor 1 2: Motor 2 3: Motor 3 (VF or SVC control mode only) 4: Motor 4 (VF or SVC control mode only)	R/W	0516	41303	1	
P05.23	Frequency for Y-connection / Δ-connection switch for an induction motor	0.00–599.00 Hz	♦R/W	0517	41304	60.00	
P05.24	Y-connection /Δ-connection switch for an induction motor	0: Disable 1: Enable	R/W	0518	41305	0	
P05.25	Delay time for Y-connection /Δ-connection switch for an induction motor	0.000–60.000 sec.	♦R/W	0519	41306	0.200	
P05.26	Accumulated Watt-second for a motor (W-msec.)	Read only	Read	051A	41307	0	
P05.27	Accumulated Watt-second for a motor (W-sec.)	Read only	Read	051B	41308	0	
P05.28	Accumulated Watt-hour for a motor (W-hour)	Read only	Read	051C	41309	0	
P05.29	Accumulated Watt-hour for a motor (kW-hour)	Read only	Read	051D	41310	0	
P05.30	Accumulated Watt-hour for a motor (MW-hour)	Read only	Read	051E	41311	0	
P05.31	Accumulated motor operation time (Minutes)	0–1439	R/W	051F	41312	0	
P05.32	Accumulated motor operation time (days)	0–65535	R/W	0520	41313	0	
P05.33	Induction motor (IM) or permanent magnet synchronous AC motor (PM) selection	0: IM (Induction motor) 1: SPM (Surface permanent magnet synchronous AC motor) 2: IPM (Interior permanent magnet synchronous AC motor)	R/W	0521	41314	0	
P05.34	Full-load current for a permanent magnet synchronous AC motor	0–120% of the drive's rated current	R/W	0522	41315	Model dependent	
P05.35	Rated power for a permanent magnet synchronous AC motor	0.00–655.35 kW	R/W	0523	41316	Model dependent	
P05.36	Rated speed for a permanent magnet synchronous AC motor	0–65535 rpm	R/W	0524	41317	2000	
P05.37	Number of poles for a permanent magnet synchronous AC motor	0–65535	R/W	0525	41318	10	
P05.39	Stator resistance Rs for a permanent magnet synchronous AC motor	0.000–65.535 Ω	R/W	0527	41320	0.000	

(table continued next page)

GS20(X) Parameters Summary – Motor Parameters (P05.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P05.40	Permanent magnet synchronous AC motor Ld	0.00–655.35 mH	R/W	0528	41321	0.00	
P05.41	Permanent magnet synchronous AC motor Lq	0.00–655.35 mH	R/W	0529	41322	0.00	
P05.43	Ke parameter of a permanent magnet synchronous AC motor	0–65535 (Unit: V / krpm)	R/W	052B	41324	0	
P05.64	Induction Motor 3, Full-load amps	10–120% of the drive's rated current	R/W	0540	41345	Model dependent	
P05.65	Induction Motor 3, Rated power (kW)	0.00–655.35 kW	♦R/W	0541	41346	Model dependent	
P05.66	Induction Motor 3, Rated speed (rpm)	0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz, 4 poles); 1410 (50Hz, 4 poles)	♦R/W	0542	41347	1710	
P05.67	Induction Motor 3, Number of poles	2–20	R/W	0543	41348	4	
P05.68	Induction Motor 3, No-load amps	0.00–P05.64 default	R/W	0544	41349	Model dependent	
P05.69	Induction Motor 3, Stator resistance (Rs)	0.000–65.535 Ω	R/W	0545	41350	Model dependent	
P05.70	Induction Motor 4, Full-load amps	10–120% of the drive's rated current	R/W	0546	41351	Model dependent	
P05.71	Induction Motor 4, Rated power for (kW)	0.00–655.35 kW	♦R/W	0547	41352	Model dependent	
P05.72	Induction Motor 4, Rated speed (rpm)	0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz, 4 poles); 1410 (50Hz, 4 poles)	♦R/W	0548	41353	1710	
P05.73	Induction Motor 4, Number of poles	2–20	R/W	0549	41354	4	
P05.74	Induction Motor 4, No-load amps	0.00–P05.70 default	R/W	054A	41355	Model dependent	
P05.75	Induction Motor 4, Stator resistance (Rs)	0.000–65.535 Ω	R/W	054B	41356	Model dependent	

Protection Parameters Summary (P06.xx)

For detailed information about the P06.xx parameter group, please refer to page 4–150.

GS20(X) Parameters Summary – Protection Parameters (P06.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P06.00	Low voltage level	120V / 230V models: 150.0–220.0 VDC 460V models: 300.0–440.0 VDC 575V models: 375.0–550.0 VDC	♦R/W	0600	41537	180.0 360.0 450.0	
P06.01	Over-voltage stall prevention	0: Disable 120V / 230V models: 0.0–390.0 VDC 460V models: 0.0–900.0 VDC 575V models: 0.0–1000.0 VDC	♦R/W	0601	41538	380.0 760.0 975.0	
P06.02	Selection for over-voltage stall prevention	0: Traditional over-voltage stall prevention 1: Smart over-voltage stall prevention	♦R/W	0602	41539	0	
P06.03	Over-current stall prevention during acceleration (OCA)	VT: 0–150% (100% corresponds to the rated current of the drive) CT: 0–200% (100% corresponds to the rated current of the drive)	♦R/W	0603	41540	120 180	
P06.04	Over-current stall prevention during operation (OCN)	VT: 0–150% (100% corresponds to the rated current of the drive) CT: 0–200% (100% corresponds to the rated current of the drive)	♦R/W	0604	41541	120 180	
P06.05	Acceleration / deceleration time selection for stall prevention at constant speed	0: By current acceleration / deceleration time 1: By the first acceleration / deceleration time 2: By the second acceleration / deceleration time 3: By the third acceleration / deceleration time 4: By the fourth acceleration / deceleration time 5: By Auto-acceleration / auto-deceleration	♦R/W	0605	41542	0	
P06.06	Over-torque detection selection (motor 1)	0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	♦R/W	0606	41543	0	
P06.07	Over-torque detection level (motor 1)	10–250% (100% corresponds to the rated current of the drive)	♦R/W	0607	41544	120	
P06.08	Over-torque detection time (motor 1)	0.1–60.0 sec.	♦R/W	0608	41545	0.1	
(table continued next page)							

GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P06.09	Over-torque detection selection (motor 2)	0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	♦R/W	0609	41546	0	
P06.10	Over-torque detection level (motor 2)	10–250% (100% corresponds to the rated current of the drive)	♦R/W	060A	41547	120	
P06.11	Over-torque detection time (motor 2)	0.1–60.0 sec.	♦R/W	060B	41548	0.1	
P06.12	Current limit	0–250% (100% corresponds to the rated current of the drive)	♦R/W	060C	41549	150	
P06.13	Electronic thermal relay selection 1 (motor 1)	0: Inverter motor (with external forced cooling) 1: Standard motor (motor with fan on the shaft) 2: Disabled	♦R/W	060D	41550	1	
P06.14	Electronic thermal relay action time 1 (motor 1)	30.0–600.0 sec.	♦R/W	060E	41551	60.0	
P06.15	Temperature level overheat (OH) warning	0.0–110.0°C	♦R/W	060F	41552	Model dependent	
P06.16	Stall prevention limit level (Weak magnetic field current stall prevention level)	0–100% (refer to P06.03–P06.04)	♦R/W	0610	41553	100	

(table continued next page)

GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P06.17	Fault record 1	0: No fault record 1: Over-current during acceleration (ocA) 2: Over-current during deceleration (ocd) 3: Over-current during steady operation (ocn) 4: Ground fault (GFF) 6: Over-current at stop (ocS) 7: Over-voltage during acceleration (ovA) 8: Over-voltage during deceleration (ovd) 9: Over-voltage during constant speed (ovn) 10: Over-voltage at stop (ovS) 11: Low-voltage during acceleration (LvA) 12: Low-voltage during deceleration (Lvd) 13: Low-voltage during constant speed (Lvn) 14: Low-voltage at stop (LvS) 15: Phase loss protection (orP) 16: IGBT overheating (oH1) 18: IGBT temperature detection failure (tH1o) 21: Over load (oL) 22: Electronic thermal relay 1 protection (EoL1) 23: Electronic thermal relay 2 protection (EoL2) 24: Motor PTC overheating (oH3) 26: Over torque 1 (ot1) 27: Over torque 2 (ot2) 28: Under current (uC) 31: EEPROM read error (cF2) 33: U-phase error (cd1) 34: V-phase error (cd2) 35: W-phase error (cd3) 36: cc (current clamp) hardware error (Hd0) 37: oc (over-current) hardware error (Hd1) 40: Auto-tuning error (AUE) 41: PID loss AI2 (AFE) 43: PG feedback loss (PGF2) 48: AI2 loss (ACE) 49: External fault (EF) 50: Emergency stop (EF1) 51: External Base Block (bb) 52: Password is locked (Pcod) 54: Illegal command (CE1) 55: Illegal data address (CE2) 56: Illegal data value (CE3) 57: Data is written to read-only address (CE4) 58: Modbus transmission time-out (CE10)	Read	0611	41554	0	

(table continued next page)

GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P06.17 (cont'd)	Fault record 1 (continued)	61: Y-connection / Δ-connection switch error (ydc) 62: Deceleration energy backup error (dEb) 63: Over slip error (oSL) 72: STO Loss (STL1) 76: STO (STo) 77: STO Loss 2 (STL2) 78: STO Loss 3 (STL3) 79: U-phase Over-current before run (Aoc) 80: V-phase Over-current before run (boc) 81: W-phase Over-current before run (coc) 82: Output phase loss U phase (oPL1) 83: Output phase loss V phase (oPL2) 84: Output phase loss W phase (oPL3) 87: Low frequency overload protection (oL3) 89: Rotor position detection error (roPd) 97: Ethernet Card Timeout (CD10) 111: InrCOM time-out error (ictE) 121: Internal communication error (CP20) 123: Internal communication error (CP22) 124: Internal communication error (CP30) 126: Internal communication error (CP32) 127: Internal communication error (CP33) 128: Over-torque 3 (ot3) 129: Over-torque 4 (ot4) 134: Internal communication error (EoL3) 135: Internal communication error (EoL4) 140: Oc hardware error (Hd6) 141: GFF occurs before run (b4GFF) 142: Auto-tune error 1 (DC test stage) (AuE1) 143: Auto-tune error 2 (High frequency test stage) (AuE2) 144: Auto-tune error 3 (Rotary test stage) (AuE3) 149: Auto-tune error 5 (Rotor resistance measure test stage) (AuE5)	Read	0611	41554	0	
P06.18	Fault record 2	See P06.17 for ranges.	Read	0612	41555	0	
P06.19	Fault record 3	See P06.17 for ranges.	Read	0613	41556	0	
P06.20	Fault record 4	See P06.17 for ranges.	Read	0614	41557	0	
P06.21	Fault record 5	See P06.17 for ranges.	Read	0615	41558	0	
P06.22	Fault record 6	See P06.17 for ranges.	Read	0616	41559	0	
P06.23	Fault output option 1	0–65535 (refer to bit table for fault code)	♦R/W	0617	41560	0	
P06.24	Fault output option 2	0–65535 (refer to bit table for fault code)	♦R/W	0618	41561	0	
P06.25	Fault output option 3	0–65535 (refer to bit table for fault code)	♦R/W	0619	41562	0	
P06.26	Fault output option 4	0–65535 (refer to bit table for fault code)	♦R/W	061A	41563	0	
P06.27	Electronic thermal relay selection 2 (motor 2)	0: Inverter motor (with external forced cooling) 1: Standard motor (motor with fan on the shaft) 2: Disabled	♦R/W	061B	41564	1	

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GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P06.28	Electronic thermal relay action time 2 (motor 2)	30.0–600.0 sec.	♦R/W	061C	41565	60.0	
P06.29	PTC detection selection	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning	♦R/W	061D	41566	0	
P06.30	PTC level	0.0–100.0%	♦R/W	061E	41567	50.0	
P06.31	Frequency command at malfunction	0.00–599.00 Hz	Read	061F	41568	0	
P06.32	Output frequency at malfunction	0.00–599.00 Hz	Read	0620	41569	0	
P06.33	Output voltage at malfunction	0.0–6553.5 V	Read	0621	41570	0	
P06.34	DC bus voltage at malfunction	0.0–6553.5 V	Read	0622	41571	0	
P06.35	Output current at malfunction	0.00–655.35 Amp	Read	0623	41572	0	
P06.36	IGBT temperature at malfunction	-3276.7–3276.7°C	Read	0624	41573	0	
P06.38	Motor speed at malfunction	-32767–32767 rpm	Read	0626	41575	0	
P06.39	Torque command at malfunction	-32767–32767%	Read	0627	41576	0	
P06.40	Status of the digital input terminal at malfunction	0000h–FFFFh	Read	0628	41577	0	
P06.41	Status of the digital output terminal at malfunction	0000h–FFFFh	Read	0629	41578	0	
P06.42	Drive status at malfunction	0000h–FFFFh	Read	062A	41579	0	
P06.43	IGBT Temperature	-3276.7–3276.7°C	Read	062B	41580	-	
P06.44	STO latch selection	0: STO latch 1: STO no latch	♦R/W	062C	41581	0	
P06.45	Output phase loss detection action (OPHL)	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning	♦R/W	062D	41582	3	
P06.46	Detection time for output phase loss	0.000–65.535 sec.	♦R/W	062E	41583	0.500	
P06.47	Current detection level for output phase loss	0.00–100.00%	♦R/W	062F	41584	1.00	
P06.48	DC brake time for output phase loss	0.000–65.535 sec.	♦R/W	0630	41585	0.000	
P06.49	LvX auto-reset	0: Disable 1: Enable	R/W	0631	41586	0	
P06.53	Input phase loss detection action (OrP)	0: Fault and ramp to stop 1: Fault and coast to stop	♦R/W	0635	41590	0	

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GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P06.55	Derating protection	0: Constant rated current and limit carrier frequency by load current and temperature 1: Constant carrier frequency and limit load current by setting carrier frequency 2: Constant rated current (same as setting 0), but close current limit	♦R/W	0637	41592	0	
P06.56	PT100 RTD voltage level 1	0.000–10.000 V	♦R/W	0638	41593	5.000	
P06.57	PT100 RTD voltage level 2	0.000–10.000 V	♦R/W	0639	41594	7.000	
P06.58	PT100 RTD level 1 frequency protection	0.00–599.00 Hz	♦R/W	063A	41595	0.00	
P06.59	PT100 RTD activation level 1 protection frequency delay time	0–6000 sec.	♦R/W	063B	41596	60	
P06.60	Software detection GFF current level	0.0–6553.5%	♦R/W	063C	41597	60.0	
P06.61	Software detection GFF filter time	0.00–655.35 sec.	♦R/W	063D	41598	0.10	
P06.63	Operation time of fault record 1 (Days)	0–65535 days	Read	063F	41600	0	
P06.64	Operation time of fault record 1 (Minutes)	0–1439 min.	Read	0640	41601	0	
P06.65	Operation time of fault record 2 (Days)	0–65535 days	Read	0641	41602	0	
P06.66	Operation time of fault record 2 (Minutes)	0–1439 min.	Read	0642	41603	0	
P06.67	Operation time of fault record 3 (Days)	0–65535 days	Read	0643	41604	0	
P06.68	Operation time of fault record 3 (Minutes)	0–1439 min.	Read	0644	41605	0	
P06.69	Operation time of fault record 4 (Days)	0–65535 days	Read	0645	41606	0	
P06.70	Operation time of fault record 4 (Minutes)	0–1439 min.	Read	0646	41607	0	
P06.71	Low current setting level	0.0–100.0%	♦R/W	0647	41608	0.0	
P06.72	Low current detection time	0.00–360.00 sec.	♦R/W	0648	41609	0.00	
P06.73	Low current action	0: No function 1: Fault and coast to stop 2: Fault and ramp to stop by the second deceleration time 3: Warn and continue operation	♦R/W	0649	41610	0	
P06.80	Fire mode	0: Disable 1: Operates in a counterclockwise direction 2: Operates in a clockwise direction	R/W	0650	41617	0	
P06.81	Operating frequency in fire mode	0.00–599.00 Hz	♦R/W	0651	41618	60.00	
P06.88	Operation times in fire mode	0–65535 times	Read			0	

(table continued next page)

GS20(X) Parameters Summary – Protection Parameters (P06.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P06.90	Operation time of fault record 5 (days)	0–65535 days	Read	065A	41627	0	
P06.91	Operation time of fault record 5 (Minutes)	0–1439 min.	Read	065B	41628	0	
P06.92	Operation time of fault record 6 (days)	0–65535 days	Read	065C	41629	0	
P06.93	Operation time of fault record 6 (Minutes)	0–1439 min.	Read	065D	41630	0	

Special Parameters Summary (P07.xx)

For detailed information about the P07.xx parameter group, please refer to page 4–175.

GS20(X) Parameters Summary – Special Parameters (P07.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
*1) ♦ in the Run-*Read*/Write column indicates that the parameter can be set during RUN mode.* R/W *indicates "*Read*/Write." *Read *indicates "*Read*-only."*							
2) Parameters can be restored to their default values using P00.02.							
P07.00	Software brake chopper threshold level	120V / 230V models: 350.0–450.0 VDC 460V models: 700.0–900.0 VDC 575V models: 875.0–1000.0 VDC	♦R/W	0000	41793	370.0 740.0 950.0	
P07.01	DC brake current level	0–100%	♦R/W	0701	41794	0	
P07.02	DC brake time at start-up	0.0–60.0 sec.	♦R/W	0702	41795	0.0	
P07.03	DC brake time at STOP	0.0–60.0 sec.	♦R/W	0703	41796	0.0	
P07.04	DC brake frequency at STOP	0.00–599.00 Hz	♦R/W	0704	41797	0.00	
P07.05	Voltage increasing gain	1–200%	♦R/W	0705	41798	100	
P07.06	Restart after momentary power loss	0: Stop operation 1: Speed tracking by the speed before the power loss 2: Speed tracking by the minimum output frequency	♦R/W	0706	41799	0	
P07.07	Allowed power loss duration	0.0–20.0 sec.	♦R/W	0707	41800	2.0	
P07.08	Base Block time	0.0–60.0 sec.	♦R/W	0708	41801	0.5	
P07.09	Current limit of speed tracking	20–200%	♦R/W	0709	41802	100	
P07.10	Restart after fault action	0: Stop operation 1: Speed tracking by current speed 2: Speed tracking by minimum output frequency	♦R/W	070A	41803	0	
P07.11	Number of times of restart after fault	0–10	♦R/W	070B	41804	0	
P07.12	Speed tracking during start-up	0: Disable 1: Speed tracking by the maximum output frequency 2: Speed tracking by the motor frequency at start-up 3: Speed tracking by the minimum output frequency	♦R/W	070C	41805	0	
P07.13	dEb function selection	0: Disable 1: dEb with auto-acceleration / auto-deceleration, the drive does not output the frequency after the power is restored. 2: dEb with auto-acceleration / auto-deceleration, the drive outputs the frequency after the power is restored. 3: dEb low-voltage control, then the drive's voltage increases to 350 VDC / 700 VDC and ramps to stop after low frequency 4: dEb high-voltage control of 350 VDC / 700 VDC, and the drive ramps to stop	♦R/W	070D	41806	0	

(table continued next page)

GS20(X) Parameters Summary – Special Parameters (P07.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P07.15	Dwell time at acceleration	0.00–600.00 sec.	♦R/W	070F	41808	0.00	
P07.16	Dwell frequency at acceleration	0.00–599.00 Hz	♦R/W	0710	41809	0.00	
P07.17	Dwell time at deceleration	0.00–600.00 sec.	♦R/W	0711	41810	0.00	
P07.18	Dwell frequency at deceleration	0.00–599.00 Hz	♦R/W	0712	41811	0.00	
P07.19	Fan cooling control	0: Fan is always ON 1: Fan is OFF after the AC motor drive stops for one minute. 2: Fan is ON when the AC motor drive runs, fan is OFF when the AC motor drive stops. 3: Fan turns ON when temperature (IGBT) reaches approx 60°C.	♦R/W	0713	41812	3	
P07.20	Emergency stop (EF) & force to stop selection	0: Coast to stop 1: Stop by the first deceleration time 2: Stop by the second deceleration time 3: Stop by the third deceleration time 4: Stop by the fourth deceleration time 5: System deceleration 6: Automatic deceleration	♦R/W	0714	41813	0	
P07.21	Automatic energy-saving setting	0: Disable 1: Enable	♦R/W	0715	41814	0	
P07.22	Energy-saving gain	10–1000%	♦R/W	0716	41815	100	
P07.23	Automatic voltage regulation (AVR) function	0: Enable AVR 1: Disable AVR 2: Disable AVR during deceleration	♦R/W	0717	41816	0	
P07.24	Torque command filter time (V/F and SVC control mode)	0.001–10.000 sec.	♦R/W	0718	41817	0.050	
P07.25	Slip compensation filter time (V/F and SVC control mode)	0.001–10.000 sec.	♦R/W	0719	41818	0.100	
P07.26	Torque compensation gain (V/F and SVC control mode)	IM: 0–10 (when P05.33 = 0) PM: 0–5000 (when P05.33 = 1 or 2)	♦R/W	071A	41819	1	
P07.27	Slip compensation gain (V/F and SVC control mode)	0.00–10.00	♦R/W	071B	41820	0.00 (Default value is 1.00 in SVC mode)	
P07.29	Slip deviation level	0.0–100.0% 0: No detection	♦R/W	071D	41822	0	
P07.30	Over-slip deviation detection time	0.0–10.0 sec.	♦R/W	071E	41823	1.0	
P07.31	Over-slip deviation treatment	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning	♦R/W	071F	41824	0	
P07.32	Motor oscillation compensation factor	0–10000	♦R/W	0720	41825	1000	
P07.33	Auto-restart interval of fault	0.0–6000.0 sec.	♦R/W	0721	41826	60.0	
P07.38	PMSVC voltage feed forward gain	0.50–2.00	R/W	0726	41831	1.00	
P07.46	OOB sampling time	0.1–120.0 sec.	R/W	072E	41839	1.0	

(table continued next page)

GS20(X) Parameters Summary – Special Parameters (P07.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P07.47	Number of OOB sampling times	00–32	R/W	072F	41840	20	
P07.48	OOB average sampling angle	Read only	Read	0730	41841	0	
P07.62	dEb gain (Kp)	0–65535	♦R/W	073E	41855	8000	
P07.71	Torque compensation gain (motor 2)	IM: 0–10 (when P05.33 = 0) PM: 0–5000 (when P05.33 = 1 or 2)	♦R/W	0747	41864	1	
P07.72	Slip compensation gain (motor 2)	0.00–10.00	♦R/W	0748	41865	0.00 (Default value is 1.00 in SVC mode)	
P07.73	Torque compensation gain (motor 3)	IM: 0–10 (when P05.33 = 0) PM: 0–5000 (when P05.33 = 1 or 2)	♦R/W	0749	41866	1	
P07.74	Slip compensation gain (motor 3)	0.00–10.00	♦R/W	074A	41867	0.00 (Default value is 1.00 in SVC mode)	
P07.75	Torque compensation gain (motor 4)	IM: 0–10 (when P05.33 = 0) PM: 0–5000 (when P05.33 = 1 or 2)	♦R/W	074B	41868	1	
P07.76	Slip compensation gain (motor 4)	0.00–10.00	♦R/W	074C	41869	0.00 (Default value is 1.00 in SVC mode)	

High-Function PID Parameters Summary (P08.xx)

For detailed information about the P08.xx parameter group, please refer to page 4–188.

GS20(X) Parameters Summary – High-Function PID Parameters (P08.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P08.00	Terminal selection of PID feedback	0: No function 1: Negative PID feedback: by analog input (P03.00, P03.01) 2: Negative PID feedback: by single-phase input (DI7), without direction (P10.16=5) 4: Positive PID feedback: by analog input (P03.00, P03.01) 5: Positive PID feedback: by single-phase input (DI7), without direction (P10.16=5) 7: Negative PID feedback: by communication protocols 8: Positive PID feedback: by communication protocols	♦R/W	0800	42049	0	
P08.01	Proportional gain (P)	0.0–1000.0 (When P08.23 bit 1=0) 0.00–100.00 (When P08.23 bit 1=1)	♦R/W	0801	42050	1.00	
P08.02	Integral time (I)	0.00–100.00 sec.	♦R/W	0802	42051	1.00	
P08.03	Differential time (D)	0.00–1.00 sec.	♦R/W	0803	42052	0.00	
P08.04	Upper limit of integral control	0.0–100.0%	♦R/W	0804	42053	100.0	
P08.05	PID output command limit (positive limit)	0.0–110.0%	♦R/W	0805	42054	100.0	
P08.06	PID feedback value by communication protocol	-200.00–200.00%	♦R/W	0806	42055	0.00	
P08.07	PID delay time	0.0–2.5 sec.	♦R/W	0807	42056	0.0	
P08.08	Feedback signal detection time	0.0–3600.0 sec.	♦R/W	0808	42057	0.0	
P08.09	Feedback signal fault treatment	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: Warn and operate at last frequency	♦R/W	0809	42058	0	
P08.10	Sleep frequency	0.00–599.00 Hz	♦R/W	080A	42059	0.00	
P08.11	Wake-up frequency	0.00–599.00 Hz	♦R/W	080B	42060	0.00	
P08.12	Sleep time	0.0–6000.0 sec.	♦R/W	080C	42061	0.0	
P08.13	PID feedback signal error deviation level	1.0–50.0%	♦R/W	080D	42062	10.0	
P08.14	PID feedback signal error deviation detection time	0.1–300.0 sec.	♦R/W	080E	42063	5.0	
P08.15	PID feedback signal filter time	0.1–300.0 sec.	♦R/W	080F	42064	5.0	
P08.16	PID compensation selection	0: Parameter setting 1: Analog input	♦R/W	0810	42065	0	
P08.17	PID compensation	-100.0–100.0%	♦R/W	0811	42066	0	
P08.18	Sleep mode function setting	0: Refer to PID output command 1: Refer to PID feedback signal	R/W	0812	42067	0	
P08.19	Wake-up integral limit	0.0–200.0%	♦R/W	0813	42068	50.0	
(table continued next page)							

GS20(X) Parameters Summary – High-Function PID Parameters (P08.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P08.20	PID mode selection	0: Dependent ISA PID structure 1: Independent ISA PID structure	R/W	0814	42069	0	
P08.21	Enable PID to change the operation direction	0: Operation direction cannot be changed 1: Operation direction can be changed	R/W	0815	42070	0	
P08.22	Wake-up delay time	0.00–600.00 sec.	♦R/W	0816	42071	0.00	
P08.23	PID control flag	bit 0 = 1: PID running in reverse follows the setting for P00.23. bit 0 = 0: PID running in reverse refers to PID's calculated value. bit 1 = 1: two decimal places for PID Kp bit 1 = 0: one decimal place for PID Kp	♦R/W	0817	42072	2	
P08.26	PID output command limit (reverse limit)	0.0–100.0%	♦R/W	081A	42075	100.0	
P08.27	Acceleration / deceleration time for PID command	0.00–655.35 sec.	♦R/W	081B	42076	0.00	
P08.29	Frequency base corresponding to 100.00% PID	0: PID control output 100.00% corresponding to maximum operation frequency (P01.00) 1: PID control output 100.00% corresponding to the input value of the auxiliary frequency	♦R/W	081D	42078	0	
P08.31	Proportional gain 2	0.0–1000.0 (when P08.23 setting bit1=0) 0.00–100.00 (when P08.23 setting bit1=1)	♦R/W	081F	42080	1.00	
P08.32	Integral time 2	0.00–100.00 sec.	♦R/W	0820	42081	1.00	
P08.33	Differential time 2	0.00–1.00 sec.	♦R/W	0821	42082	0.00	
P08.65	PID target value source	0: Frequency command (P00.20, P00.30) 1: P08.66 setting 2: RS-485 communication input 3: External analog input (refer to P03.00, P03.01) 6: Communication card 7: Digital keypad potentiometer dial (GS20 only)	♦R/W	0841	42114	0	
P08.66	PID target value setting	-100.00–100.00%	♦R/W	0842	42115	50.00	
P08.67	Master and auxiliary reverse running cutoff frequency	0.0–100.0%	♦R/W	0843	42116	10.0	
P08.68	PID deviation limit	0.00–100.00%	♦R/W	0844	42117	0.00	
P08.69	Integral separation level	0.00–100.00%	♦R/W	0845	42118	0.00	
P08.70	Smart start-up level	0.00–100.00%	R/W	0846	42119	5.00	
P08.71	Smart start-up frequency command	0.00–599.00 Hz	♦R/W	0847	42120	0.00	
P08.72	Smart start-up acceleration time	0.00–600.00 sec.	♦R/W	0848	42121	3.00	
P08.75	PID2 parameter switch condition	0: No switching (refer to P08.01–P08.03) 1: Auto-switch based on the output frequency 2: Auto-switch based on the deviation	♦R/W	084B	42124	0	
P08.76	PID2 parameter switch deviation 1	0.00–P08.77%	♦R/W	084C	42125	10.00	
P08.77	PID2 parameter switch deviation 2	P08.76–100.00%	♦R/W	084D	42126	40.00	
P08.78	Allowed reverse running time after start-up	0.0–6553.5 sec.	♦R/W	084E	42127	0.0	

Communication Parameters Summary (P09.xx)

For detailed information about the P09.xx parameter group, please refer to page 4–203.

GS20(X) Parameters Summary – Communication Parameters (P09.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P09.00	Communication address	1–254	♦R/W	0900	42305	1	
P09.01	COM1 transmission speed	4.8–115.2 Kbps	♦R/W	0901	42306	9.6	
P09.02	COM1 transmission fault treatment	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning, no fault, and continue operation	♦R/W	0902	42307	3	
P09.03	COM1 time-out detection	0.0–100.0 sec.	♦R/W	0903	42308	0.0	
P09.04	COM1 communication protocol	1: 7, N, 2 (ASCII) 2: 7, E, 1 (ASCII) 3: 7, O, 1 (ASCII) 4: 7, E, 2 (ASCII) 5: 7, O, 2 (ASCII) 6: 8, N, 1 (ASCII) 7: 8, N, 2 (ASCII) 8: 8, E, 1 (ASCII) 9: 8, O, 1 (ASCII) 10: 8, E, 2 (ASCII) 11: 8, O, 2 (ASCII) 12: 8, N, 1 (RTU) 13: 8, N, 2 (RTU) 14: 8, E, 1 (RTU) 15: 8, O, 1 (RTU) 16: 8, E, 2 (RTU) 17: 8, O, 2 (RTU)	♦R/W	0904	42309	15	
P09.09	Communication response delay time	0.0–200.0 ms	♦R/W	0909	42314	2.0	
P09.10	Communication main frequency	0.00–599.00 Hz	R/W	090A	42315	60.00	
P09.11	Block transfer 1	0–65535	♦R/W	090B	42316	0	
P09.12	Block transfer 2	0–65535	♦R/W	090C	42317	0	
P09.13	Block transfer 3	0–65535	♦R/W	090D	42318	0	
P09.14	Block transfer 4	0–65535	♦R/W	090E	42319	0	
P09.15	Block transfer 5	0–65535	♦R/W	090F	42320	0	
P09.16	Block transfer 6	0–65535	♦R/W	0910	42321	0	
P09.17	Block transfer 7	0–65535	♦R/W	0911	42322	0	
P09.18	Block transfer 8	0–65535	♦R/W	0912	42323	0	
P09.19	Block transfer 9	0–65535	♦R/W	0913	42324	0	
P09.20	Block transfer 10	0–65535	♦R/W	0914	42325	0	
P09.21	Block transfer 11	0–65535	♦R/W	0915	42326	0	
P09.22	Block transfer 12	0–65535	♦R/W	0916	42327	0	
P09.23	Block transfer 13	0–65535	♦R/W	0917	42328	0	
P09.24	Block transfer 14	0–65535	♦R/W	0918	42329	0	
P09.25	Block transfer 15	0–65535	♦R/W	0919	42330	0	
P09.26	Block transfer 16	0–65535	♦R/W	091A	42331	0	
P09.30	Communication decoding method	0: Decoding method 1 1: Decoding method 2	R/W	091E	42335	0	

GS20(X) Parameters Summary – Communication Parameters (P09.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P09.33	PLC command force to 0	0–65535	♦R/W	0921	42338	0	
P09.35	PLC address	1–254	R/W	0923	42340	2	
P09.60	Communication card identification	0: No communication card 4: Modbus-TCP slave 5: EtherNet/IP slave 10: Backup power supply	Read	093C	42365	0	
P09.61	Firmware version of communication card	Read only (Hex format)	Read	093D	42366	0	
P09.62	Product code	Read only	Read	093E	42367	0	
P09.63	Error code	Read only	Read	093F	42368	0	
P09.74	Set Comm Master Protocol	0: Ethernet IP and Modbus TCP both 1: Ethernet IP 2: Modbus TCP	♦R/W	094A	42379	1	
P09.75	Communication card IP configuration (Ethernet)	0: Static IP 1: Dynamic IP (DHCP)	♦R/W	094B	42380	0	
P09.76	Communication card IP address 1 (Ethernet)	0–255	♦R/W	094C	42381	0	
P09.77	Communication card IP address 2 (Ethernet)	0–255	♦R/W	094D	42382	0	
P09.78	Communication card IP address 3 (Ethernet)	0–255	♦R/W	094E	42383	0	
P09.79	Communication card IP address 4 (Ethernet)	0–255	♦R/W	094F	42384	0	
P09.80	Communication card address mask 1 (Ethernet)	0–255	♦R/W	0950	42385	0	
P09.81	Communication card address mask 2 (Ethernet)	0–255	♦R/W	0951	42386	0	
P09.82	Communication card address mask 3 (Ethernet)	0–255	♦R/W	0952	42387	0	
P09.83	Communication card address mask 4 (Ethernet)	0–255	♦R/W	0953	42388	0	
P09.84	Communication card gateway address 1 (Ethernet)	0–255	♦R/W	0954	42389	0	
P09.85	Communication card gateway address 2 (Ethernet)	0–255	♦R/W	0955	42390	0	
P09.86	Communication card gateway address 3 (Ethernet)	0–255	♦R/W	0956	42391	0	
P09.87	Communication card gateway address 4 (Ethernet)	0–255	♦R/W	0957	42392	0	
P09.88	Communication card password (low word) (Ethernet)	0–99	♦R/W	0958	42393	0	
P09.89	Communication card password (high word) (Ethernet)	0–99	♦R/W	0959	42394	0	
P09.90	Reset communication card (Ethernet)	0: Disable 1: Reset to defaults	♦R/W	095A	42395	0	

GS20(X) Parameters Summary – Communication Parameters (P09.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P09.91	Additional settings for the communication card (Ethernet)	bit 0: Enable IP filter bit 1: Enable internet parameters (1 bit) When the IP address is set, this bit is enabled. After updating the parameters for the communication card, this bit changes to disabled. bit 2: Enable login password (1 bit) When you enter the login password, this bit is enabled. After updating the communication card parameters, this bit changes to disabled.	♦R/W	095B	42396	0	
P09.92	Communication card status (Ethernet)	bit 0: Enable password When the communication card is set with a password, this bit is enabled. When the password is cleared, this bit is disabled.	R/W	095C	42397	0	
P09.93	ENETIP Comm Card Fault Select	0: Warn & Continue Operation 1: Warn & Ramp to Stop 2: Warn & Coast to Stop 3: No Warning & Continue Operation	♦R/W	095D	42398	3	
P09.94	ENETIP Comm Card Time Out Detection	0: Disable 1: Enable	♦R/W	095E	42399	1	
P09.95	ENETIP Comm Card Time Out Duration	0.1 to 100.0 seconds	♦R/W	095F	42400	3.0	

Speed Feedback Control Parameters Summary (P10.xx)

For detailed information about the P10.xx parameter group, please refer to page 4–220.

GS20(X) Parameters Summary – Speed Feedback Control Parameters (P10.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P10.00	Encoder type selection	0: Disabled 5: Pulse input (DI7)	R/W	0A00	42561	0	
P10.01	Encoder pulses per revolution	1–20000	R/W	0A01	42562	600	
P10.02	Encoder input type setting	0: Disable 5: Single-phase input (DI7)	R/W	0A02	42563	0	
P10.04	Electrical gear at load side A1	1–65535	♦R/W	0A04	42565	100	
P10.05	Electrical gear at motor side B1	1–65535	♦R/W	0A05	42566	100	
P10.06	Electrical gear at load side A2	1–65535	♦R/W	0A06	42567	100	
P10.07	Electrical gear at motor side B2	1–65535	♦R/W	0A07	42568	100	
P10.10	Encoder stall level	0: No function 0–120%	♦R/W	0A0A	42571	115	
P10.11	Detection time of encoder stall	0.0–2.0 sec.	♦R/W	0A0B	42572	0.1	
P10.12	Encoder stall action	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop	♦R/W	0A0C	42573	2	
P10.13	Encoder slip range	0: Disable 0–50%	♦R/W	0A0D	42574	50	
P10.14	Detection time of encoder slip	0.0–10.0 sec.	♦R/W	0A0E	42575	0.5	
P10.15	Encoder stall and slip error action	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop	♦R/W	0A0F	42576	2	
P10.16	Pulse input type setting	0: Disabled 5: Single-phase input (DI7)	♦R/W	0A10	42577	0	
P10.17	Electrical gear A	1–65535	♦R/W	0A11	42578	100	
P10.18	Electrical gear B	1–65535	♦R/W	0A12	42579	100	
P10.21	PG2 (DI7) pulse input speed command low pass filter time	0.000–65.535 sec.	♦R/W	0A15	42582	0.100	
P10.24	FOC & TQC function control	0–65535	♦R/W	0A18	42585	0	
P10.25	FOC bandwidth for speed observer	20.0–100.0 Hz	♦R/W	0A19	42586	40.0	
P10.26	FOC minimum stator frequency	0.0–10.0% fN	♦R/W	0A1A	42587	2.0	
P10.27	FOC low pass filter time constant	1–1000 ms	♦R/W	0A1B	42588	50	
P10.28	FOC gain for excitation current rise time	33–100% Tr	♦R/W	0A1C	42589	100	
P10.29	Upper limit of frequency deviation	0.00–200.00 Hz	♦R/W	0A1D	42590	20.00	
P10.31	I/F mode, current command	0–150% rated current of the motor	♦R/W	0A1F	42592	40	
P10.32	PM sensorless speed estimator bandwidth	0.00–600.00 Hz	♦R/W	0A20	42593	5.00	

(table continued next page)

GS20(X) Parameters Summary – Speed Feedback Control Parameters (P10.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P10.34	PM sensorless speed estimator low-pass filter gain	0.00–655.35	♦R/W	0A22	42595	1.00	
P10.35	Active Magnetic Regulator (AMR) (Kp) gain	0.00–3.00	♦R/W	0A23	42596	1.00	
P10.36	Active Magnetic Regulator (AMR) (Ki) gain	0.00–3.00	♦R/W	0A24	42597	0.20	
P10.39	Frequency point to switch from I/F mode to PM sensorless mode	0.00–599.00 Hz	♦R/W	0A27	42600	20.00	
P10.42	Initial angle detection pulse value	0.0–3.0	♦R/W	0A2A	42603	1.0	
P10.49	Zero voltage time during start-up	0.000–60.000 sec.	♦R/W	0A31	42610	0.000	
P10.51	Injection frequency	0–1200 Hz	♦R/W	0A33	42612	500	
P10.52	Injection magnitude	120V / 230V models: 100.0 V 460V models: 200.0 V 575V models: 200.0 V Note: The setting range varies depending on the voltage.	♦R/W	0A34	42613	15.0 30.0 37.5	
P10.53	Angle detection method	0: Disabled 1: Force attracting the rotor to zero degrees 2: High frequency injection 3: Pulse injection	♦R/W	0A35	42614	0	

Advanced Parameters Summary (P11.xx)

For detailed information about the P11.xx parameter group, please refer to page 4–229.

GS20(X) Parameters Summary – Advanced Parameters (P11.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
*1) ♦ in the Run-*Read*/Write column indicates that the parameter can be set during RUN mode.* R/W *indicates "*Read*/Write." *Read *indicates "*Read*-only."*							
2) Parameters can be restored to their default values using P00.02.							
P11.00	System control	bit 0: Auto-tuning for ASR bit 3: Dead time compensation closed bit 7: Save or do not save the frequency	R/W	0B00	42817	0	
P11.01	Per-unit of system inertia	1–65535 (256 = 1 PU)	R/W	0B01	42818	256	
P11.02	ASR1/ASR2 switch frequency	5.00–599.00 Hz	♦R/W	0B02	42819	7.00	
P11.03	ASR1 low-speed bandwidth	1–40 Hz	Read	0B03	42820	0	
P11.04	ASR2 high-speed bandwidth	1–40 Hz	Read	0B04	42821	0	
P11.05	Zero-speed bandwidth	1–40 Hz	Read	0B05	42822	0	
P11.06	ASR1 (Kp) gain	0–40 Hz	♦R/W	0B06	42823	10	
P11.07	ASR1 (Ki) integral time	0.000–10.000 sec.	♦R/W	0B07	42824	0.100	
P11.08	ASR2 (Kp) gain	0–40 Hz	♦R/W	0B08	42825	10	
P11.09	ASR2 (Ki) integral time	0.000–10.000 sec.	♦R/W	0B09	42826	0.100	
P11.10	ASR Kp gain of zero speed	0–40 Hz	♦R/W	0B0A	42827	10	
P11.11	ASR (Ki) integral time of zero speed	0.000–10.000 sec.	♦R/W	0B0B	42828	0.100	
P11.12	Gain for ASR speed feed forward	0–200%	♦R/W	0B0C	42829	0	
P11.13	PDFF gain value	0–200%	♦R/W	0B0D	42830	30	
P11.14	ASR output low pass filter time	0.000–0.350 sec.	♦R/W	0B0E	42831	0.008	
P11.15	Notch filter depth	0–20 db	♦R/W	0B0F	42832	0	
P11.16	Notch filter frequency	0.00–200.00 Hz	♦R/W	0B10	42833	0.00	
P11.17	Forward motor torque limit	0–500%	♦R/W	0B11	42834	500	
P11.18	Forward regenerative torque limit	0–500%	♦R/W	0B12	42835	500	
P11.19	Reverse motor torque limit	0–500%	♦R/W	0B13	42836	500	
P11.20	Reverse regenerative torque limit	0–500%	♦R/W	0B14	42837	500	
P11.21	Flux weakening curve for motor 1 gain value	0–200%	♦R/W	0B15	42838	90	
P11.22	Flux weakening curve for motor 2 gain value	0–200%	♦R/W	0B16	42839	90	
P11.23	Flux weakening area speed response	0–150%	♦R/W	0B17	42840	65	
P11.27	Maximum torque command	0–500%	♦R/W	0B1B	42844	100	
P11.28	Torque offset source	0: Disable 1: Analog signal input 2: RS-485 communication (P11.29) 3: Controlled through external terminals (P11.30–P11.32)	♦R/W	0B1C	42845	0	
P11.29	Torque offset setting	-100.0–100.0%	♦R/W	0B1D	42846	0.0	
P11.30	High torque offset	-100.0–100.0%	♦R/W	0B1E	42847	30.0	
P11.31	Middle torque offset	-100.0–100.0%	♦R/W	0B1F	42848	20.0	

GS20(X) Parameters Summary – Advanced Parameters (P11.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P11.32	Low torque offset	-100.0–100.0%	♦R/W	0B20	42849	10.0	
P11.33	Torque command source	0: Digital keypad 1: RS-485 communication (P11.34) 2: Analog signal input (P03.00) 5: Communication Card	♦R/W	0B21	42850	0	
P11.34	Torque command	-100.0–100.0%	♦R/W	0B22	42851	0.0	
P11.35	Torque command filter time	0.000–1.000 sec.	♦R/W	0B23	42852	0.000	
P11.36	Speed limit selection	0: Set by P11.37 (forward speed limit) and P11.38 (reverse speed limit) 1: Set by P00.20 (Master frequency command (AUTO, REMOTE) source) and P11.37, P11.38 2: Set by P00.20 (master frequency command (AUTO, REMOTE) source)	R/W	0B24	42853	0	
P11.37	Forward speed limit (Torque mode)	0–120%	♦R/W	0B25	42854	10	
P11.38	Reverse speed limit (Torque mode)	0–120%	♦R/W	0B26	42855	10	
P11.41	PWM mode selection	0: Two-phase modulation mode 2: Space vector modulation mode	R/W	0B29	42858	2	
P11.42	System control flag	0000–FFFFh	♦R/W	0B2A	42859	0000	

Macro / User Defined Macro Parameters Summary (P13.xx)

For detailed information about the P13.xx parameter group, please refer to page 4–238.

GS20(X) Parameters Summary – Macro / User-Defined Macro Parameters (P13.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/Write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P13.00	Industry-specific parameter application	00: Disabled 01: User-defined parameter 02: Compressor 03: Fan 04: Pump 05: Conveyor 06: Machine tool 07: Packing 08: Textiles 10: Logistics 11: Tension PID 12: Tension PID + master / auxiliary frequency	R/W	0D0D	43329	00	
P13.01	User-defined parameter			0D01	43330		
P13.02	User-defined parameter			0D02	43331		
P13.03	User-defined parameter			0D03	43332		
P13.04	User-defined parameter			0D04	43333		
P13.05	User-defined parameter			0D05	43334		
P13.06	User-defined parameter			0D06	43335		
P13.07	User-defined parameter			0D07	43336		
P13.08	User-defined parameter			0D08	43337		
P13.09	User-defined parameter			0D09	43338		
P13.10	User-defined parameter			0D0A	43339		
P13.11	User-defined parameter			0D0B	43340		
P13.12	User-defined parameter			0D0C	43341		
P13.13	User-defined parameter			0D0D	43342		
P13.14	User-defined parameter			0D0E	43343		
P13.15	User-defined parameter			0D0F	43344		
P13.16	User-defined parameter			0D10	43345		
P13.17	User-defined parameter			0D11	43346		
P13.18	User-defined parameter			0D12	43347		
P13.19	User-defined parameter			0D13	43348		
P13.20	User-defined parameter			0D14	43349		
P13.21	User-defined parameter			0D15	43350		
P13.22	User-defined parameter			0D16	43351		
P13.23	User-defined parameter			0D17	43352		
P13.24	User-defined parameter			0D18	43353		
P13.25	User-defined parameter			0D19	43354		
P13.26	User-defined parameter			0D1A	43355		
P13.27	User-defined parameter			0D1B	43356		
P13.28	User-defined parameter			0D1C	43357		
P13.29	User-defined parameter			0D1D	43358		
P13.30	User-defined parameter			0D1E	43359		
P13.31	User-defined parameter			0D1F	43360		
P13.32	User-defined parameter			0D20	43361		
P13.33	User-defined parameter			0D21	43362		
P13.34	User-defined parameter			0D22	43363		

GS20(X) Parameters Summary – Macro / User-Defined Macro Parameters (P13.xx) – (continued)							
Parameter		Range	Run* Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default	User
P13.35	User-defined parameter			0D23	43364		
P13.36	User-defined parameter			0D24	43365		
P13.37	User-defined parameter			0D25	43366		
P13.38	User-defined parameter			0D26	43367		
P13.39	User-defined parameter			0D27	43368		
P13.40	User-defined parameter			0D28	43369		
P13.41	User-defined parameter			0D29	43370		
P13.42	User-defined parameter			0D2A	43371		
P13.43	User-defined parameter			0D2B	43372		
P13.44	User-defined parameter			0D2C	43373		
P13.45	User-defined parameter			0D2D	43374		
P13.46	User-defined parameter			0D2E	43375		
P13.47	User-defined parameter			0D2F	43376		
P13.48	User-defined parameter			0D30	43377		
P13.49	User-defined parameter			0D31	43378		
P13.50	User-defined parameter			0D32	43379		

Protection Parameters (2) Summary (P14.xx)

For detailed information about the P14.xx parameter group, please refer to page 4–251.

GS20(X) Parameters Summary – Protection Parameters (2) (P14.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
*1) ♦ in the Run-*Read*/Write column indicates that the parameter can be set during RUN mode.* R/W *indicates "*Read*/Write." *Read *indicates "*Read*-only."* *2) Parameters can be restored to their default values using P00.02.*							
P14.50	Output frequency at malfunction 2	0.00–599.00 Hz	Read	0E32	43635	0	
P14.51	DC bus voltage at malfunction 2	0.0–6553.5 V	Read	0E33	43636	0	
P14.52	Output current at malfunction 2	0.00–655.35 Amp	Read	0E34	43637	0	
P14.53	IGBT temperature at malfunction 2	-3276.7–3276.7°C	Read	0E35	43638	0	
P14.54	Output frequency at malfunction 3	0.00–599.00 Hz	Read	0E36	43639	0	
P14.55	DC bus voltage at malfunction 3	0.0–6553.5 V	Read	0E37	43640	0	
P14.56	Output current at malfunction 3	0.00–655.35 Amp	Read	0E38	43641	0	
P14.57	IGBT temperature at malfunction 3	-3276.7–3276.7°C	Read	0E39	43642	0	
P14.58	Output frequency at malfunction 4	0.00–599.00 Hz	Read	0E3A	43643	0	
P14.59	DC bus voltage at malfunction 4	0.0–6553.5 V	Read	0E3B	43644	0	
P14.60	Output current at malfunction 4	0.00–655.35 Amp	Read	0E3C	43645	0	
P14.61	IGBT temperature at malfunction 4	-3276.7–3276.7°C	Read	0E3D	43646	0	
P14.62	Output frequency at malfunction 5	0.00–599.00 Hz	Read	0E3E	43647	0	
P14.63	DC bus voltage at malfunction 5	0.0–6553.5 V	Read	0E3F	43648	0	
P14.64	Output current at malfunction 5	0.00–655.35 Amp	Read	0E40	43649	0	
P14.65	IGBT temperature at malfunction 5	-3276.7–3276.7°C	Read	0E41	43650	0	
P14.66	Output frequency at malfunction 6	0.00–599.00 Hz	Read	0E42	43651	0	
P14.67	DC bus voltage at malfunction 6	0.0–6553.5 V	Read	0E43	43652	0	
P14.68	Output current at malfunction 6	0.00–655.35 Amp	Read	0E44	43653	0	
P14.69	IGBT temperature at malfunction 6	-3276.7–3276.7°C	Read	0E45	43654	0	
P14.70	Fault record 7	Refer to fault record P06.17–P06.22	Read	0E46	43655	0	
P14.71	Fault record 8	Refer to fault record P06.17–P06.22	Read	0E47	43656	0	
P14.72	Fault record 9	Refer to fault record P06.17–P06.22	Read	0E48	43657	0	
P14.73	Fault record 10	Refer to fault record P06.17–P06.22	Read	0E49	43658	0	

GS20(X) Parameters Summary – Protection Parameters (2) (P14.xx) – (continued)							
Parameter		**Range**	**Run* Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default**	**User**
P14.74	Over-torque detection selection (motor 3)	0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	♦R/W	0E4A	43659	0	
P14.75	Over-torque detection level (motor 3)	10–250% (100% corresponds to the rated current of the drive)	♦R/W	0E4B	43660	120	
P14.76	Over-torque detection time (motor 3)	0.1–60.0 sec.	♦R/W	0E4C	43661	0.1	
P14.77	Over-torque detection selection (motor 4)	0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	♦R/W	0E4D	43662	0	
P14.78	Over-torque detection level (motor 4)	10–250% (100% corresponds the rated current of the drive)	♦R/W	0E4E	43663	120	
P14.79	Over-torque detection time (motor 4)	0.1–60.0 sec.	♦R/W	0E4F	43664	0.1	
P14.80	Electronic thermal relay selection 3 (motor 3)	0: Inverter motor (with external forced cooling) 1: Standard motor (motor with the fan on the shaft) 2: Disable	♦R/W	0E50	43665	2	
P14.81	Electronic thermal relay action time 3 (motor 3)	30.0–600.0 sec.	♦R/W	0E51	43666	60.0	
P14.82	Electronic thermal relay selection 4 (motor 4)	0: Inverter motor (with external forced cooling) 1: Standard motor (motor with the fan on the shaft) 2: Disable	♦R/W	0E52	43667	2	
P14.83	Electronic thermal relay action time 4 (motor 4)	30.0–600.0 sec.	♦R/W	0E53	43668	60.0	

NOTE: For Command and Status addresses (2000h-2200h), refer to page 4-210.

DURApulse GS20(X) Parameter Details

Explanation of Parameter Details format

		Type	Hex Addr	Dec Addr
Pxx.xx	**Descriptive Parameter Name**	♦R/W	xxxx	4xxxx
Range/Units		Default		
xx~xxx.xx		xx		

Where:

- Pxx.xx = Parameter number, followed by descriptive parameter name
- Type = Parameter type (♦R/W)
  ♦ = Parameter can be set while drive is in run mode
  R/W = Read/Write parameter
  Read = Read-only; parameter can be read from, but not written to
- Hex Addr = Hexadecimal parameter address
- Dec Addr = Modbus decimal parameter address
- Range/Units = Range of parameter settings, including units if applicable
- Default = Parameter default setting
  (Parameters can be restored to their default values using P00.02.)

Group P00.xx Details – Drive Parameters

		Type	Hex Addr	Dec Addr
P00.00	**GS20(X) Model ID**	Read	0000	40001
	Range/Units (Format: 16-bit unsigned)	*Default*		
	102: 120 V, 1 Phase, 0.25 HP 103: 120 V, 1 Phase, 0.5 HP 104: 120 V, 1 Phase, 1 HP 302: 230 V, 1 Phase, 0.25 HP 303: 230 V, 1 Phase, 0.5 HP 304: 230 V, 1 Phase, 1 HP 305: 230 V, 1 Phase, 2 HP 306: 230 V, 1 Phase, 3 HP 202: 230 V, 3 Phase, 0.25 HP 203: 230 V, 3 Phase, 0.5 HP 204: 230 V, 3 Phase, 1 HP 205: 230 V, 3 Phase, 2 HP 206: 230 V, 3 Phase, 3 HP 207: 230 V, 3 Phase, 5 HP 208: 230 V, 3 Phase, 7.5 HP 209: 230 V, 3 Phase, 10 HP 210: 230 V, 3 Phase, 15 HP 211: 230 V, 3 Phase, 20 HP 403: 460 V, 3 Phase, 0.5 HP 404: 460 V, 3 Phase, 1 HP 405: 460 V, 3 Phase, 2 HP 406: 460 V, 3 Phase, 3 HP 407: 460 V, 3 Phase, 5 HP 408: 460 V, 3 Phase, 7.5 HP 409: 460 V, 3 Phase, 10 HP 410: 460 V, 3 Phase, 15 HP 411: 460 V, 3 Phase, 20 HP 412: 460 V, 3 Phase, 25 HP 413: 460 V, 3 Phase, 30 HP 504: 575 V, 3 Phase, 1 HP 505: 575 V, 3 Phase, 2 HP 506: 575 V, 3 Phase, 3 HP 507: 575 V, 3 Phase, 5 HP 508: 575 V, 3 Phase, 7.5 HP 509: 575 V, 3 Phase, 10 HP	0		

P00.00 displays a code that corresponds to the voltage, phase, and horsepower rating of the GS20(X) drive.

		Type	Hex Addr	Dec Addr
P00.01	**GS20 Drive Rated Amps**	Read	0001	40002
	Range/Units (Format: 16-bit unsigned)	*Default*		
	Display by models	0		

P00.01 displays rated current in amps for the drive. By default this displays the value for constant torque. Set P00.16=0 to display the variable torque rating instead.

		Type	Hex Addr	Dec Addr
P00.02	**Restore to Default**	R/W	0002	40003
Range/Units (Format: 16-bit binary)		Default		
0: No function 1: Parameter Lock 2: Enter GS2 Mode (Step 1 of 2) 5: Reset kWh Display to 0 6: Reset PLC 7: No function 8: Disable Keypad Run 9: Reset all parameters to 50Hz defaults 10: Reset all parameters to 60Hz defaults 11: Reset all parameters to 50Hz defaults (retain user-defined parameter values P13.01~P13.50) 12: Reset all parameters to 60Hz defaults (retain user-defined parameter values P13.01~P13.50) 20: Enter GS2 Mode (Step 2 of 2)		0		

P00.02 allows the resetting of various parameter sets and drive functions.

Setting Explanations

- *P00.02=1, all parameters are set to read only except for P00.02, P00.07, and P00.08. P00.02 must be changed to 0 to change parameter settings.*
- *P00.02=5, returns the kWh displayed value to 0, even during drive operation. For example, P05.26 accumulated W-s will be set to zero.*
- *P00.02=6, clears the internal PLC program.*
- *P00.02=8, disables the RUN key on the drive keypad.*
- *P00.02=9, resets all parameters to default for base frequency of 50Hz.*
- *P00.02=10, resets all parameters to default for base frequency of 60Hz.*
- *P00.02=11, resets all parameters to default for base frequency of 50Hz, but keeps any user-defined parameter values (P13.01 through P13.50).*
- *P00.02=12, resets all parameters to default for base frequency of 60Hz, but keeps any user-defined parameter values (P13.01 through P13.50).*
- *If a password has been set using P00.08, you must unlock and clear the password (P00.07) before resetting parameters.*

NOTE: For settings 6, 9, 10, 11, and 12 you must reboot the drive after adjusting the setting to enable the change.

- *To convert the drive parameter set to GS2 Mode:*
  a) Step 1 - P00.02 = 2
  b) Step 2 - P00.02 = 20

  This sequence reverts the GS20 parameter set to the reduced parameter set of a GS2 drive. To revert back to GS20 mode after the drive is in GS2 mode, set P09.08 to 20 (see GS2 Mode appendix). All parameter values will reset to default with these actions.

		Type	Hex Addr	Dec Addr
P00.03	**Start-up Display Selection**	♦R/W	0003	40004
Range/Units (Format: 16-bit binary)		*Default*		
0: F – Freq Setpoint 1: H – Output Hz 2: U - User Display P00-04) 3: A – Output Amps		0		

P00.03 determines the start-up display page when the drive is powered on. The user-defined contents display according to the P00.04 settings.

		Type	Hex Addr	Dec Addr
P00.04	***User Display***	♦R/W	0004	40005
Range/Units (Format: 16-bit binary)		*Default*		
0: Output Amps (A) (unit: Amp)		3		

1: Counter Value (c) (unit: CNT)
2: Output Frequency (H.) (unit: Hz)
3: DC Bus Voltage (V) (unit: VDC)
4: Output Voltage (E) (unit: VAC)
5: Power Factor (n) (unit: deg)
6: Output Power (P) (unit: kW)
7: Calculated RPM (r) (unit: rpm)
8: Est Output Torque (t) (unit: %)
10: PID Feedback (b) (unit: %)
11: AI1 Analog Input Signal (1.) (unit: %)
12: AI2 Analog Input Signal (2.) (unit: %)
14: IGBT Temperature (i.) (unit: °C)
16: DI Input Status (ON / OFF) (i)
17: DO Output Status (ON / OFF) (o)
18: Multi-Speed Step (S)
19: CPU DI Input Status (d)
20: CPU DO Output Status (0.)
22: Pulse input frequency (S.)
25: Overload count (0.00–100.00%) (o.) (unit: %)
26: Ground fault GFF (G.) (unit: %)
27: DC bus voltage ripple (r.) (unit: VDC)
28: Display PLC register D1043 data (C)
30: Display the output of User-defined (U)
31: Display P00.05 user gain (K)
35: Control mode display:
0 = Speed control mode (SPD) (t.)
1 = Torque control mode (TQR) (t.)
36: Present operating carrier frequency of the drive (J.) (Unit: Hz)
38: Display the drive status (6.)
39: Display the drive's estimated output torque, positive and negative, using Nt-m as unit (t 0.0: positive torque; -0.0: negative torque) (C.)
40: Torque command (L.) (unit: %)
41: kWh display (J) (unit: kWh)
42: PID target value (h.) (unit: %)
43: PID compensation (o.) (unit: %)
44: PID output frequency (b.) (unit: Hz)
46: Auxiliary frequency value (U.) (unit: Hz)
47: Master frequency value (A.) (unit: Hz)
48: Frequency value after addition and subtraction of master and auxiliary frequency (L.) (unit: Hz)
51: PMSVC torque offset (t.)
58: P00.05 User gain display (K)
(Does not display decimal places.)
62: I2t (o.) (unit: %)
63: Error code (E.)
64: Warning code (n.)
65: Accumulated motor operation record (day) (r.) (refer to P05.32)

P00.04 is used to configure the user display.

Explanation 1:

It can also display negative values when setting analog input bias (P03.03 to P03.10).

Example: Assume that AI1 input voltage is 0V, P03.03 is 10.0%, P03.07 is 4 (bias serves as center).

Explanation 2:

Example: If DI1 and DI2 are ON, the following table shows the status of the terminals.

Normally opened contact (N.O.): (0: OFF, 1:ON)

Terminal	DI7	DI6	DI5	DI4	DI3	DI2	DI1
Status	0	1	0	0	0	0	1

- *The value is 0000 0000 0010 0001 in binary and 0021H in HEX. When P00.04 is set to 16 or 19, the User Defined Display on the keypad displays 0021h.*
- *Setting 16 is the ON/OFF status of digital input according to P02.12 setting, and setting 19 is the corresponding CPU pin ON/OFF status of the digital input.*
- *When DI1/DI2 default setting is two-wire/three-wire operation control (P02.00≠0) and DI3 is set to three-wire, it is not affected by P02.12.*
- *You can use setting 16 to monitor the digital input ON/OFF status, and then set 19 to check if the circuit is normal.*

Explanation 3:

Example: Assume that RY:P02.13 is set to 9 (Drive is ready). After the drive is powered on, if there is no other abnormal status, the contact is ON. The display status is shown below:

Normally opened contact (N.O.):

Terminal	D02	D01	R1
Status	0	0	1

- *If P00.04 is set to 17 or 20, it displays in hexadecimal "0001h" and the User Defined Display shows ON in the keypad.*
- *Setting 17 is the ON/OFF status of digital output according to P02.18 setting, and setting 20 is the corresponding CPU pin ON/OFF status of the digital output.*
- *You can use setting 17 to monitor the digital output ON/oFF status, and then set 20 to check if the circuit is normal.*

Explanation 4:

For setting 8, 100% represents the motor's rated torque.

Motor rated torque = (motor rated power x 60/2π) / motor rated speed

Explanation 5:

For setting 25, when the displayed value reaches 100.00%, the drive shows "oL" as an overload warning.

Explanation 6:

When set to 38, the bits are defined as follows:

- *Bit 0: The drive is running forward*
- *Bit 1: The drive is running backward*
- *Bit 2: The drive is ready*
- *Bit 3: Errors occured on the drive*
- *Bit 4: The drive is running*
- *Bit 5: Warnings occured on the drive*

		Type	Hex Addr	Dec Addr
P00.05	**Coefficient gain in actual output frequency**	R/W	0005	40006
Range/Units (Format: 16-bit unsigned)		Default		
0.00–160.00		1.00		

P00.05 is used to set the user-defined coefficient gain. Set P00.04=31 to display the calculation result on the screen (calculation = output frequency x P00.05).

		Type	Hex Addr	Dec Addr
P00.06	**Firmware Version**	Read	0006	40007
Range/Units (Format: 16-bit unsigned)		Default		
Read only		0		

P00.06 displays the current firmware version of the drive. Also, check parameter 00.50 for FW date code. Minor updates may only increment a change in date code.

		Type	Hex Addr	Dec Addr
P00.07	**Parameter Protection Password Input**	♦R/W	0007	40008
Range/Units (Format: 16-bit unsigned)		Default		
0–65535		0		
0–4: the number of password attempts allowed				

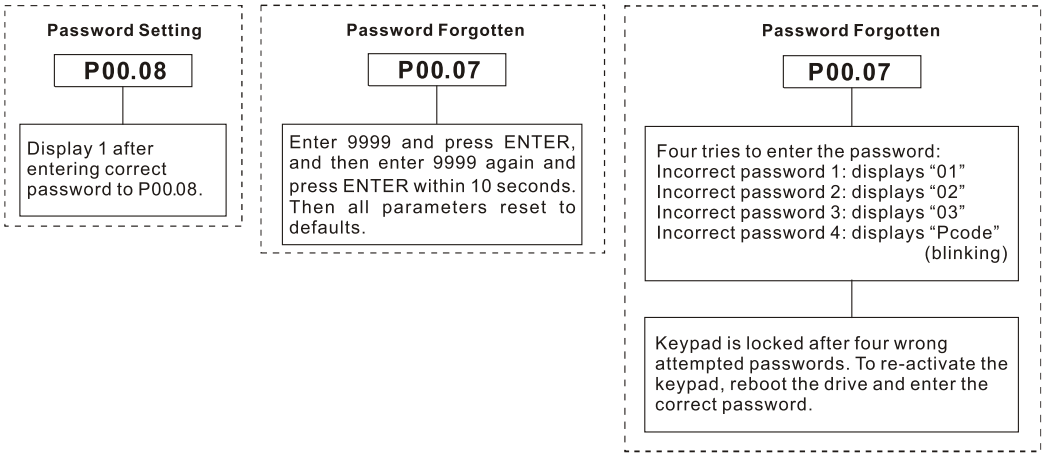
P00.07 allows you to enter the password set via P00.08 to unlock parameter protection and make changes to parameters.

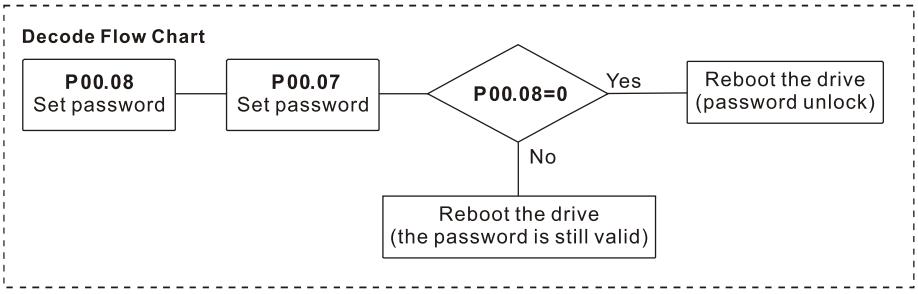
- *P00.07 and P00.08 are used to prevent personnel from accidentally changing parameter values.*
- *When password protection is on, all parameters will read 0 except for P00.08.*
- *Incorrect passwords can be entered up to four times. Each time an incorrect password is entered, the keypad will display the number of incorrect attemps (01, 02, 03). When the final incorrect password is entered, the keypad will flash "Pcode" and the keypad will lock. To re-activate the keypad, reboot the drive and either enter the correct password or reset it.*
- *To reset a forgotten password, input 9999 and press ENTER, then input 9999 again and press ENTER again within 10 seconds. All settings will return to default.*

		Type	Hex Addr	Dec Addr
P00.08	**Parameter Protection Password Setting**	♦R/W	0008	40009
Range/Units (Format: 16-bit unsigned)		Default		
0–65535		0		
0: No password protection or password entered correctly (P00.07)				
1: Parameter has been set				

P00.08 allows you to set a password to protect parameter settings. If P00.08=1, password protection is active. If P00.08=0, password protection is disabled.

- *To change parameters once a password has been set, you must enter the correct password using P00.07 which temporarily deactivates parameter protection and sets P00.08=0. Once parameter changes are complete, reboot the drive and P00.08 will reset to 1.*
- *To permanently disable the password, manually change P00.08 to 0. Otherwise, password protection is always reactivated after you reboot the motor drive.*
- *The keypad copy function works only when the password protection is deactivated (temporarily or permanently), and the password set in P00.08 cannot be copied to the keypad. So when copying parameters from the keypad to the motor drive, set the password manually again in the motor drive to activate password protection.*





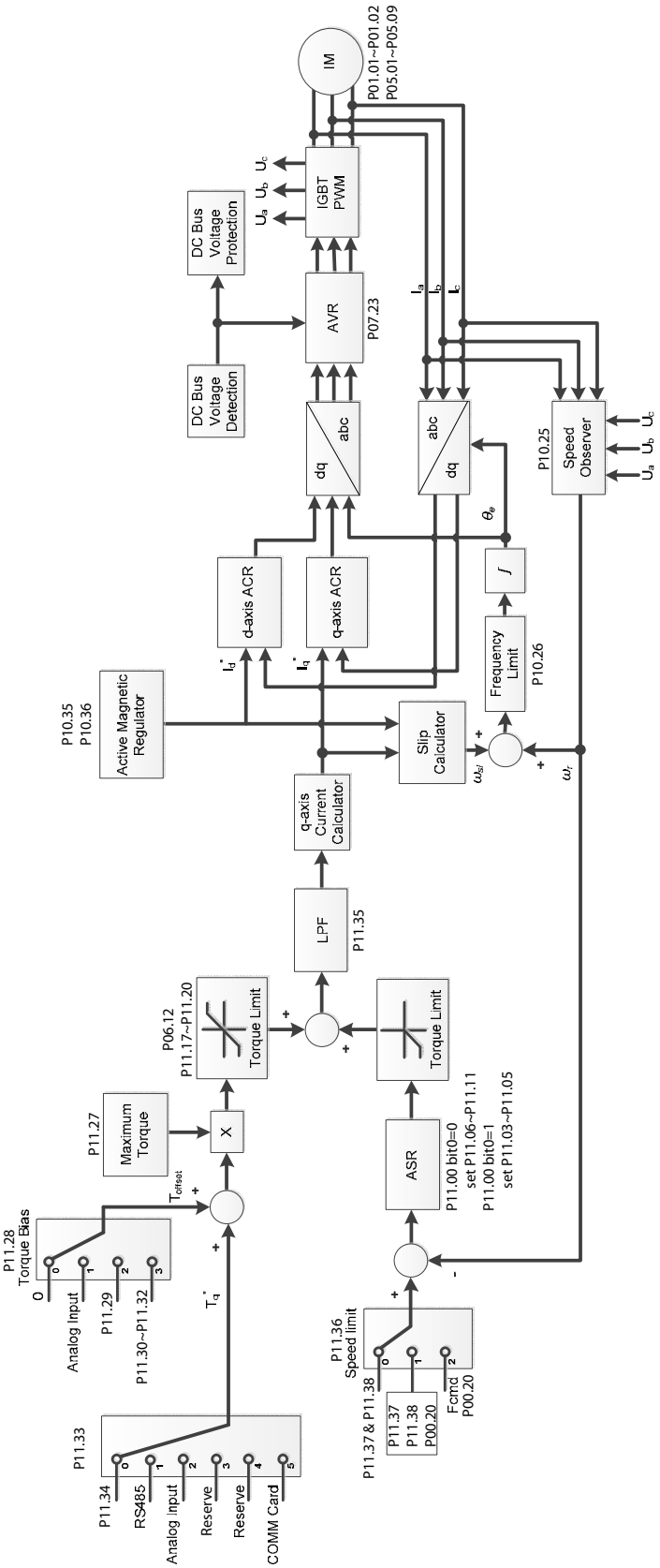
		Type	Hex Addr	Dec Addr
P00.10	**Control Mode**	R/W	000A	40011
Range/Units (Format: 16-bit binary)		Default		
0: Speed control mode 2: Torque mode (TQC Sensorless Mode)		0		

P00.10 determines the control mode of the GS20(X) drive.

- *If P00.10=0: Speed Control mode, use parameter P00.11 to set the specific speed control format.*
- *If P00.10=2: Torque mode, the drive is in TQC sensorless mode. P00.11 is not used. This mode supports induction motors only.*

See Adjustments and Applications section on page 4–257 for further info on setting up this mode.
See the next page for the torque mode control diagram.

Torque mode control diagram:



		Type	Hex Addr	Dec Addr
P00.11	**Speed Control Mode**	R/W	000B	40012
Range/Units (Format: 16-bit binary)		Default		
0: IMVF (IM V/F control) 1: IMVFPG (IM V/F control + encoder) 2: IM/PM SVC (IM / PM space vector control) 5: IMFOC Sensorless (IM field-oriented sensorless vector control)		0		

P00.11 determines the speed control mode of the GS20 drive.

P00.10 must be set to 0:Speed Control mode to enable this parameter.

Speed control abbreviations:

- *IM = Induction Motor*
- *PM = Permanent Magnet Motor*
- *SVC = Sensorless Vector Control*
- *VF = Volt/Frequency*
- *PG = Pulse Generator (encoder)*
- *FOC = Field Oriented Control*

Setting Explanations

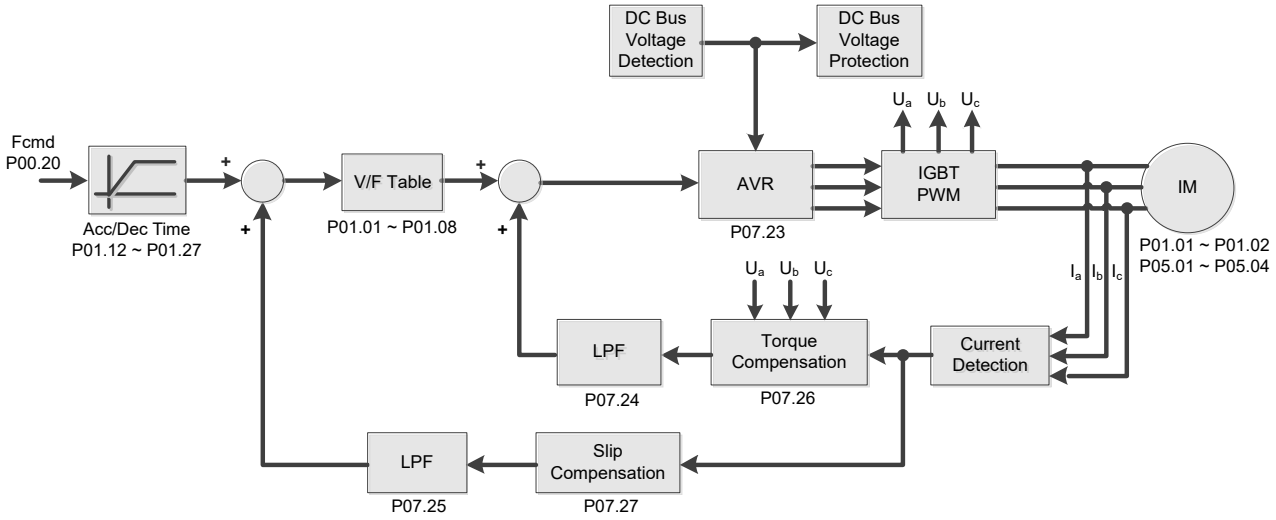
- *P00.11=0, drive is set to IM V/F control. You can configure the proportion of V/F as required and control multiple motors simultaneously.*
- *P00.11=1, drive is set to IM V/F control with Pulse Generator (PG) input (encoder). The encoder can be used for closed-loop speed control.*
- *P00.11=2, drive is set to IM/PM space vector control. This auto-tunes motor parameters for optimal control. This is the only control mode that supports permanent magnet motors (IPM or SPM). Set P05.33=1 or 2 for PM motors.*
- *P00.11=5, drive is set to IM FOC sensorless: IM field-oriented sensorless vector control. Field oriented control (FOC) provides the most precise vector control algorithm for induction motors. This control method can separately control the motor's magnetic field and torque. When controlling the torque, the magnetic field won't be interfered and quick feedback from torque wresults in more stable operation. With optimized current control, the maximum torque can be reached with the minimum current. The motor's temperature will decrease and system efficiency will increase. FOC sensorless control is suitable for applications which require activation of torque at low frequency, quick feedback on speed chasing, and stable rotation speed and torque force.*
- *See Adjustments and Applications section on page 4–257 for further info on setting up various speed modes.*

NOTE: *If DI7 single-phase pulse input is used as speed feedback, the following settings must be used:*
P00.11 speed control mode must be set to 1:IMVFPG only
P02.07 must be set to 0
P10.00 and P10.02 must be set to 5

Control Diagrams

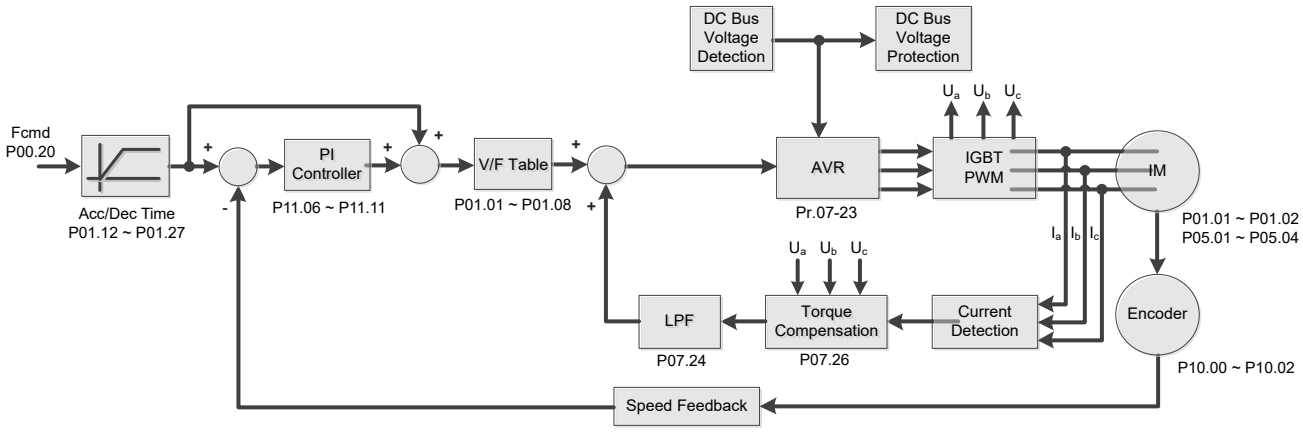
IM V/F Control (IMVF)

When P00.10=0 and P00.11 is set to 0:IMVF, the V/F control diagram is:



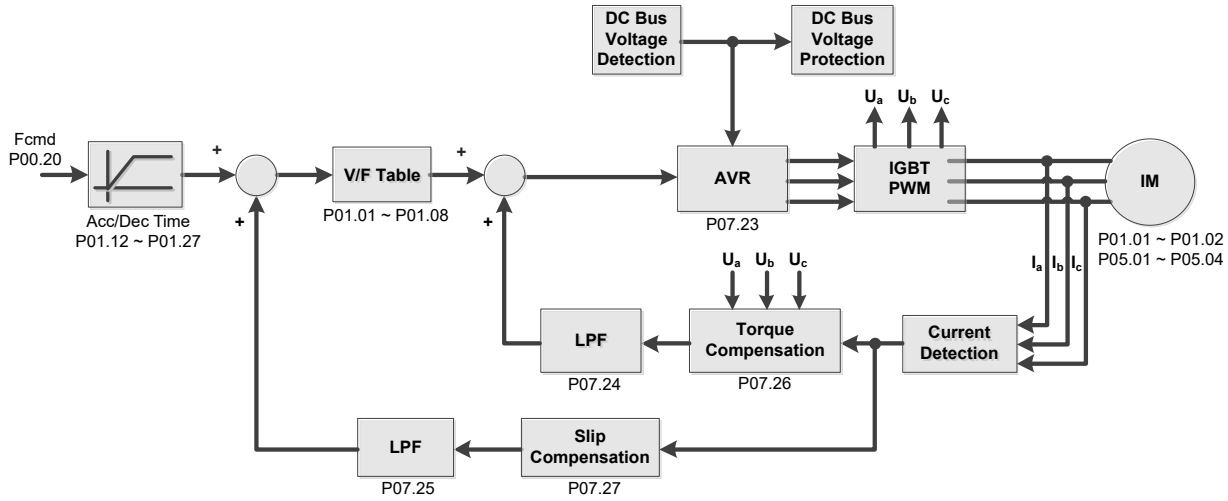
IM V/F control + encoder (IMVFPG)

When P00.10=0 and P00.11 is set to 1:IMVFPG, the V/F control + encoder diagram is:



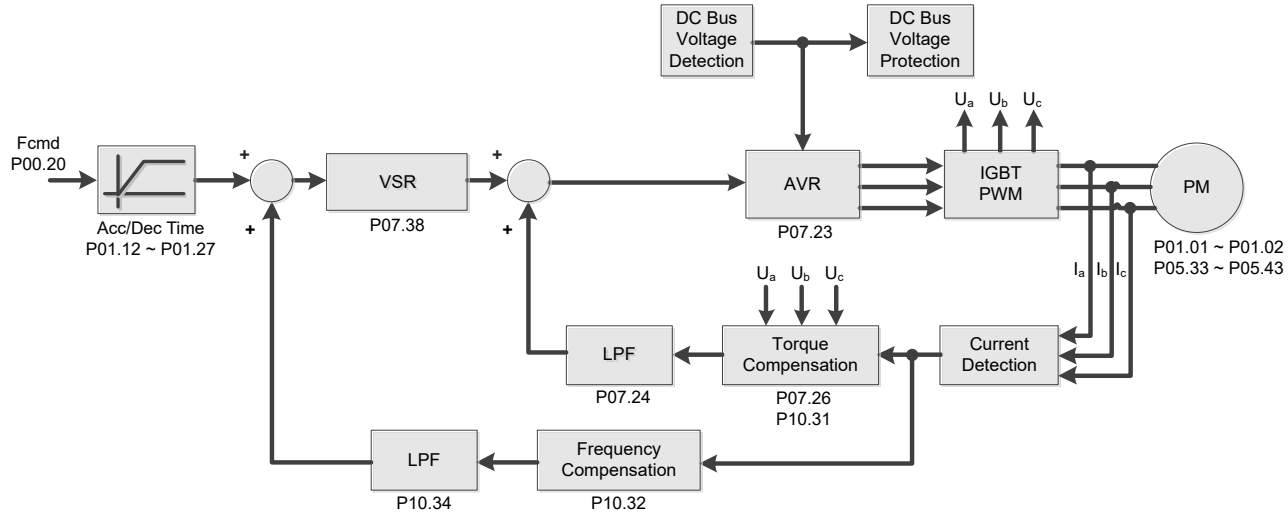
IM Space Vector Control (IMSVC)

When P00.10=0 and P00.11 is set to 2:IM/PM SVC for an IM motor (P05.33=0), the sensorless vector control diagram is:



PM Space Vector Control (PMSVC)

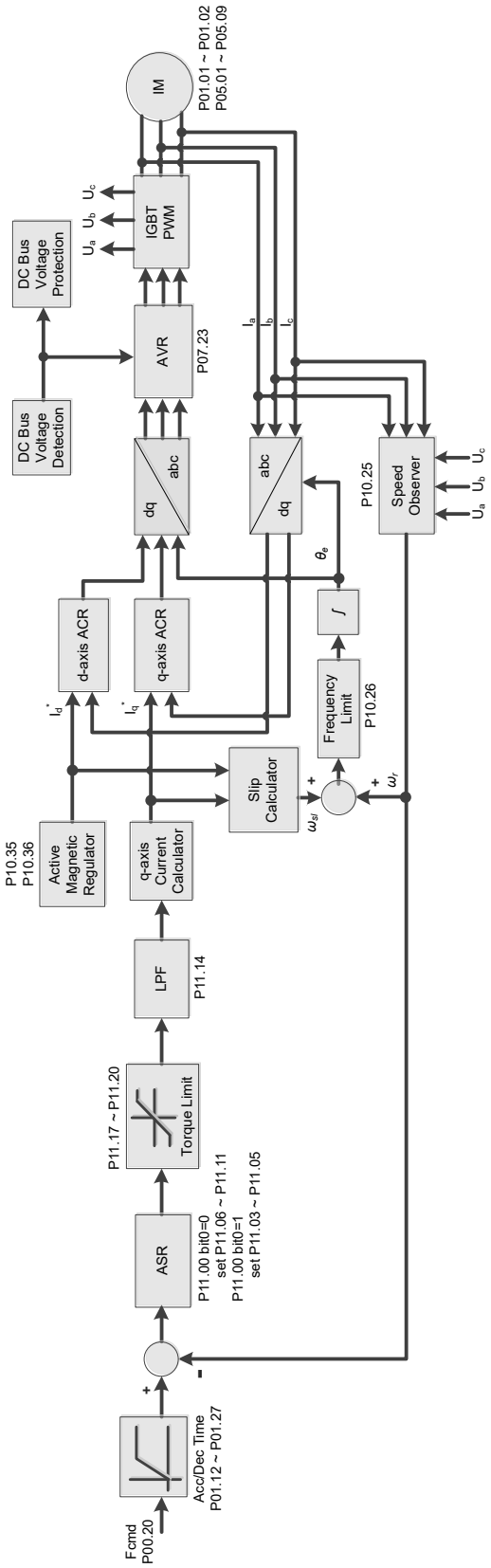
When P00.10=0 and P00.11 is set to 2:IM/PM SVC for a PM motor (P05.33=1 or 2), the sensorless vector control diagram is:



See Adjustments and Applications section on page 4–257 for further info on setting up this mode.

IMFOC Sensorless

When P00.10=0 and P00.11 is set to 5:IMFOC Sensorless, the IMFOC sensorless control diagram is:



See Adjustments and Applications section on page 4–257 for further info on setting up this mode.

		Type	Hex Addr	Dec Addr
P00.16	**Torque Duty Selection**	R/W	0010	40017
Range/Units (Format: 16-bit binary)		Default		
0: Variable Torque 1: Constant Torque		1		

P00.16 is used to configure the GS20(X) drive for variable torque or constant torque load.

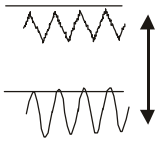
- *Variable Torque (VT): overload rated output current 150% in 3 seconds. (120%, 1 minute). Refer to P00.17 for the setting for the carrier frequency. Refer to Chapter 1 or P00.01 for the rated current.*
- *Constant Torque (CT): overload rated output current 200% in 3 seconds. (150%,1 minute) Refer to P00.17 for the setting for the carrier frequency. Refer to Chapter 1 or P00.01 for the rated current.*
- *P00.01 varies with the set value of P00.16. The default value and maximum of P06.03 and P06.04 also vary with the value of P00.16.*
- *In VT mode, the default setting of P06.03 and P06.04 is 120%, and the maximum is 150%.*
- *In CT mode, the default setting of P06.03 and P06.04 is 180%, and the maximum is 200%.*

		Type	Hex Addr	Dec Addr
P00.17	**Carrier Frequency**	R/W	0011	40018
Range/Units (Format: 16-bit unsigned)		Default		
VT: 2–15 kHz CT: 2–15 kHz Note: When P00.11=5 (IMFOC Sensorless), the maximum setting value for the carrier frequency is 10 kHz.		4		

P00.17 is used to set the PWM carrier frequency for the GS20(X) drive. Note that the maximum value is dependent on the horsepower and voltage ratings of the drive.

Model	Range
120V, 1/4–1 hp	2–15 kHz
230V, 1/4–15 hp	2–15 kHz
230V, 20–30 hp	2–10 kHz
460V, 1/2–20 hp	2–15 kHz
460V, 25–40 hp	2–10 kHz
575V, 1–10 hp	2–15 kHz

The table below shows that the PWM carrier frequency has significant influences on the electromagnetic noise, the AC motor drive heat dissipation, and the motor acoustic noise. Therefore, if the surrounding noise is greater than the motor noise, lower the carrier frequency to reduce the temperature rise. Although the motor has quiet operation in the higher carrier frequency, consider the entire wiring and interference.

Carrier Frequency	Acoustic Noise	Electromagnetic Noise or Leakage Current	Heat Dissipation	Current Wave
2 kHz	Significant	Minimal	Minimal	
8 kHz	↕	↕	↕	
15 kHz	Minimal	Significant	Significant	

When the carrier frequency is higher than the default, decrease the carrier frequency to protect the drive. Refer to P06.55 for the related setting and details.

		Type	Hex Addr	Dec Addr
P00.18	**GS Series Number**	Read	0012	40019
Range/Units (Format: 16-bit binary)		Default		
20: GS20 series drive (GS21 or GS23) 21: GS20X series drive (GS21X or GS23X)		–		

GS drive series is a read only value that indicates whether the drive is a GS21/GS23 hardware model, GS21X/GS23X NEMA4X hardware model, or other Durapulse GS model drive.

		Type	Hex Addr	Dec Addr
P00.19	**PLC Command Mask**	Read	0013	40020
Range/Units (Format: 16-bit binary)		Default		
bit 0: Control command is forced by PLC control bit 1: Frequency command is forced by PLC control bit 3: Torque command is forced by PLC control		0		

P00.19 determines if the frequency command, control command or torque command is locked by PLC.

		Type	Hex Addr	Dec Addr
P00.20	**Master Frequency Command Source (AUTO, REMOTE)**	♦R/W	0014	40021
Range/Units (Format: 16-bit binary)		Default		
0: Digital keypad 1: RS-485 communication input 2: External analog input (Refer to P03.00) 3: External UP / DOWN terminal (multi-function input terminals) 4: Pulse Input (DI7) without direction command (refer to P10.16 without considering direction) 6: No function 7: Digital Keypad VR/Potentiometer Dial (GS20 only) 8: Communication card 9: PID controller Note: HOA (Hand-Off-Auto) function is valid only when you use with DI function setting 41/42 or 56 or with GS4-KPD (optional).		0		

P00.20 determines the master frequency source in the “AUTO, REMOTE" mode. The default is AUTO mode.

- *You can switch the AUTO, REMOTE mode with the keypad GS4-KPD (optional) or the multi-function input terminal (DI) to set the master frequency source.*
- *The drive returns to AUTO or REMOTE mode whenever you cycle the power. If you use a multi-function input terminal to switch between HAND (LOCAL) and AUTO (REMOTE) mode, the highest priority is the multi-function input terminal.*
- *The pulse of P00.20=4 (Pulse input without direction command) is input by DI7 (pulse generator).*
- *If P00.20 is set to 9-PID, P08.65 will automatically set to 1. To change P00.20 from 9 to another value, P08.65 must be changed first (to a value other than 1). We recommend setting P08.65 to 1 first - this will automatically lock P00.20 to a value of 9.*

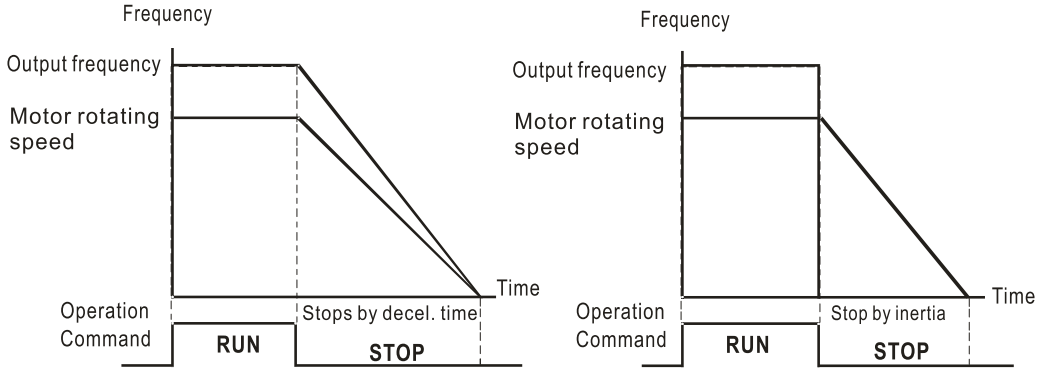
		Type	Hex Addr	Dec Addr
P00.21	**Operation Command Source (AUTO, REMOTE)**	♦R/W	0015	40022
Range/Units (Format: 16-bit binary)		Default		
0: Digital keypad 1: External terminals 2: RS-485 communication input 3: No function 5: Communication card Note: HOA (Hand-Off-Auto) function is valid only when you use with DI function setting 41/42 or 56 or with GS4-KPD (optional)		0		

P00.21 determines the operation frequency source in the "AUTO, REMOTE" mode.

- *When Parameter 00.29 is in 0: HOA function, if the multi-function input terminal (DI) function setting 41 and 42 are OFF, the drive does not receive any operation command and JOG is invalid.*
- *The digital keypad is not capable of switching between AUTO and REMOTE. When P00.21=0, the ability to switch is essentially disabled.*

		Type	Hex Addr	Dec Addr
P00.22	**Stop Method**	♦R/W	0016	40023
Range/Units (Format: 16-bit binary)		Default		
0: Ramp to stop 1: Coast to stop		0		

P00.22 determines how the motor is stopped when the drive receives the Stop command.



1) **Ramp to stop:** According to the set deceleration time, the AC motor drive decelerates to 0 Hz or the minimum output frequency (P01-07), and then stop.
2) **Coast to stop:** According to the load inertia, the AC motor drive stops output immediately, and the motor coasts to stop.

Use "ramp to stop" for the safety of personnel or to prevent material from being wasted in applications where the motor must stop immediately after the drive stops. You must set the deceleration time accordingly.

If idling is allowed or the load inertia is large, use "coast to stop". For example, blowers, punching machines and pumps.

		Type	Hex Addr	Dec Addr
P00.23	**Motor Direction Control**	♦R/W	0017	40024
Range/Units (Format: 16-bit binary)		Default		
0: Enable forward / reverse 1: Disable reverse 2: Disable forward		0		

P00.23 enables the motor to run in the forward and reverse direction. You can use it to prevent a motor from running in a direction that would cause injury or damage to the equipment, especially when only one running direction is allowed for the motor load.

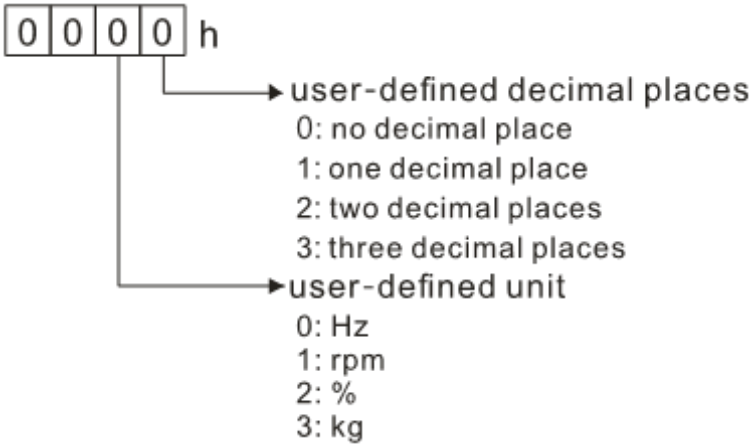
		Type	Hex Addr	Dec Addr
P00.24	**Digital Operator (Keypad) Frequency Command Memory**	Read	0018	40025
	Range/Units (Format: 16-bit unsigned)	Default		
	Read only	0		

If the kepyad is the frequency command source, P00.24 stores the current frequency command when Lv or fault occurs.

		Type	Hex Addr	Dec Addr
P00.25	**User-Defined Characteristics**	♦R/W	0019	40026
Range/Units (Format: 16-bit binary)		*Default*		
bit 0–3: user-defined decimal places 0000h,0000b: no decimal place 0001h,0001b: one decimal place 0002h,0010b: two decimal places 0003h,0011b: three decimal places bit 4–15: user-defined unit 000xh: Hz 001xh: rpm 002xh: % 003xh: kg 004xh: m/s 005xh: kW 006xh: HP 007xh: ppm 008xh: 1/m 009xh: kg/s 00Axh: kg/m 00Bxh: kg/h 00Cxh: lb/s 00Dxh: lb/m 00Exh: lb/h 00Fxh: ft/s 010xh: ft/m 011xh: m 012xh: ft 013xh: degC 014xh: degF 015xh: mbar 016xh: bar 017xh: Pa 018xh: kPa 019xh: mWG 01Axh: inWG 01Bxh: ftWG 01Cxh: psi 01Dxh: atm 01Exh: L/s 01Fxh: L/m 020xh: L/h 021xh: m3/s 022xh: m3/h 023xh: GPM 024xh: CFM xxxxh: Hz		0		

P00.25 configures the decimal places and units of displayed data.

- *bit 0–3:*
  The displayed units for the control frequency F page and user-defined (P00.04 = d10, PID feedback), and the displayed number of decimal places for P00.26 (support up to three decimal places).
- *bit 4–15:*
  The displayed units for the control frequency F page, user-defined (P00.04 = d10, PID feedback) and P00.26.



- *You must convert the setting value to decimal when using the keypad to set parameters.*

Example:

Assume that the user-defined unit is inWG and user-defined decimal place is the third decimal point. According to the information above, the corresponding unit to inWG is 01Axh (x is the set decimal point), and the corresponding unit to the third decimal place is 0003h, then inWG and the third decimal point displayed in hexadecimal is 01A3h, that is 419 in decimal value. Thus, set P00.25 = 419 to complete the setting.

		Type	*Hex Addr*	*Dec Addr*
P00.26	***Maximum User-Defined Value***	R/W	001A	40027
Range/Units (Format: 16-bit unsigned)		*Default*		
0: Disable 0–65535 (when P00.25 is set to no decimal place) 0.0–6553.5 (when P00.25 is set to one decimal place) 0.00–655.35 (when P00.25 is set to two decimal places) 0.000–65.535 (when P00.25 is set to three decimal places)		0		

When P00.26 is NOT set to 0, the user-defined value is enabled. After selecting the displayed unit and number of decimal places with P00.25, the setting value of P00.26 corresponds to P01.00 (drive's maximum operating frequency).

Example:

When the frequency set in P01.00 = 60.00 Hz, the maximum user-defined value for P00.26 is 100.0%. This also means that P00.25 is set at 33 (0021h) to select % as the unit.

Set P00.25 before using P00.26. After you finish setting, when P00.26 is not 0, the displayed unit on the keypad shows correctly according to P00.25 settings.

		Type	*Hex Addr*	*Dec Addr*
P00.27	***User-Defined Value***	Read	001B	40028
Range/Units (Format: 16-bit signed)		*Default*		
Read only		0		

P00.27 displays the user-defined value when P00.26 is not set to 0.

The user-defined value is valid only when P00.20 (frequency source) is set to the digital keypad or to RS-485 communication.

		Type	Hex Addr	Dec Addr
P00.29	**LOCAL / REMOTE Selection**	R/W	001D	40030
Range/Units (Format: 16-bit binary)		Default		
0: Standard HOA function 1: When switching between local and remote, the drive stops. 2: When switching between local and remote, the drive runs with REMOTE settings for frequency and operating status. 3: When switching between local and remote, the drive runs with LOCAL settings for frequency and operating status. 4: When switching between local and remote, the drive runs with LOCAL settings when switched to Local and runs with REMOTE settings when switched to Remote for frequency and operating status.		4		

The default for P00.29 is 4, Local/Remote maintain.. Set the Local and Remote frequency and operation source with P00.20, P00.21 and P00.30, P00.31. The external terminal function (DI) = 56 for LOC / REM mode selection is disabled when P00.29=0.

- *If P00.29 is not set to 0, the top right corner of digital keypad GS4-KPD (optional) displays LOC or REM. Set the REMOTE and LOCAL frequency and operation source with P00.20, P00.21 and P00.30, P00.31. Set the multi-function input terminal (DI) = 56 to set the LOC / REM selection. The AUTO key on the GS4-KPD (optional) is the REMOTE function; the HAND key is the LOCAL function.*
- *If P00.29 is not set to 0, the AUTO / HAND keys are disabled. In this case, the external terminal (DI) setting = 56 (local / remote selection) has the highest command priority.*

		Type	Hex Addr	Dec Addr
P00.30	**Master Frequency Command Source (HAND, LOCAL)**	♦R/W	001E	40031
Range/Units (Format: 16-bit binary)		Default		
0: Digital keypad 1: RS-485 communication input 2: External analog input (refer to P03.00) 3: External UP / DOWN terminal (multi-function input terminals) 4: Pulse input (DI7) without direction command (refer to P10.16 without considering direction) 6: No function 7: Digital Keypad VR/Potentiometer Dial (GS20 only) 8: Communication card 9: PID controller Note: HOA (Hand-Off-Auto) function is valid only when you use with DI function setting 41/42 or 56 or with GS4-KPD (optional).		0		

P00.30 determines the master frequency source in the "HAND, LOCAL" mode.

- *You can switch the HAND, LOCAL mode with the keypad GS4-KPD (optional) or the multi-function input terminal (DI) to set the master frequency source.*
- *It returns to AUTO or REMOTE mode whenever you cycle the power. If you use a multi-function input terminal to switch between HAND (LOCAL) and AUTO (REMOTE) mode, the highest priority is the multi-function input terminal.*
- *The pulse of P00.20=4 (Pulse input without direction command) is input by DI7 (pulse generator).*
- *If P00.30 is set to 9-PID, P08.65 will automatically set to 1 and P00.20 will set to 9. To change P00.30 from 9 to another value, P08.65 must be changed first (to a value other than 1). Setting P00.30 to 9 only allows PID control frequency from P08.65 and P08.66 for both local and remote drive mode.*

		Type	Hex Addr	Dec Addr
P00.31	**Operation Command Source (HAND, LOCAL)**	♦R/W	001F	40032
Range/Units (Format: 16-bit binary)		Default		
0: Digital keypad 1: External terminal 2: RS-485 communication input 3: No function 5: Communication card Note: HOA (Hand-Off-Auto) function is valid only when you use with DI function setting 41/42 or 56 or with GS4-KPD (optional).		0		

P00.31 determines the operation frequency source in the "HAND, LOCAL" mode.

In the HOA mode, if the multi-function input terminal (DI) function setting 41 and 42 are OFF, the drive does not receive any operation command and JOG is invalid

		Type	Hex Addr	Dec Addr
P00.32	**Digital Keypad STOP Function**	♦R/W	0020	40033
Range/Units (Format: 16-bit binary)		Default		
0: STOP key disabled 1: STOP key enabled		0		

P00.32 disables or enables the STOP key.

Valid when the operation command source is not the digital keypad (P00.21≠ 0). When P00.21=0, the STOP key on the digital keypad is not affected by this parameter.

		Type	Hex Addr	Dec Addr
P00.35	**Auxiliary Frequency Source**	R/W	0023	40036
Range/Units (Format: 16-bit binary)		Default		
0: Master and auxiliary frequency function disabled 1: Digital keypad 2: RS-485 communication input 3: Analog input 4: External UP / DOWN key input (multi-function input terminals) 5: Pulse input (DI7) without direction command (refer to P10.16) 6: No function 7: Digital Keypad VR/Potentiometer Dial (GS20 only) 8: Communication card		0		

P00.35 determines the source for auxiliary frequency control.

		Type	Hex Addr	Dec Addr
P00.36	**Master and Auxiliary Frequency Command Selection**	R/W	0024	40037
Range/Units (Format: 16-bit binary)		Default		
0: Master + auxiliary frequency 1: Master - auxiliary frequency 2: Auxiliary - master frequency		0		

P00.36 sets the master frequency source according to P00.20, and sets the auxiliary frequency source according to P00.35. This parameter determines the addition and subtraction of the master and auxiliary frequency.

- *When P00.36 = 0, 1, 2, the control command comes after adding or subtracting the master / auxiliary frequency and the acceleration and deceleration (including S-curve).*

- *If the value is negative after adding or subtracting the master / auxiliary frequency, P03.10 determines whether to change the running direction.*
- *If you set the master frequency source (P00.20 = 0) or the auxiliary frequency source (P00.35 = 1) using the keypad, the F page of the keypad displays the setting frequency that you can use to set the master frequency or the auxiliary frequency. If the master frequency source or the auxiliary frequency source is NOT set by the keypad (P00.20 ≠ 0 and P00.35 ≠ 1), the F page of the keypad displays the value after adding or subtracting the master / auxiliary frequency.*
- *When setting the master frequency source and auxiliary frequency source, P00.35 cannot be set to the same value as P00.20 or P00.30*

		Type	Hex Addr	Dec Addr
P00.48	**Display Filter Time (Current)**	♦R/W	0030	40049
Range/Units (Format: 16-bit unsigned)		*Default*		
0.001–65.535 sec.		0.100		

P00.48 minimizes the current fluctuation displayed by the digital keypad.

		Type	Hex Addr	Dec Addr
P00.49	**Display Filter Time (User Display)**	♦R/W	0031	40050
Range/Units (Format: 16-bit unsigned)		*Default*		
0.001–65.535 sec.		0.100		

P00.49 minimizes the value fluctuation displayed by the digital keypad configurable user display. The filtering applies to P00.04 selections 0, 2, 4, 6, and 7 only. The default value of 0.100 disables the filtering.

		Type	Hex Addr	Dec Addr
P00.50	**Firmware Version (Date) Code**	Read	0032	40051
Range/Units (Format: 16-bit unsigned)		*Default*		
Read only		0		

P00.50 displays the current drive firmware version by date.

Group P01.xx Details – Basic Parameters

		Type	Hex Addr	Dec Addr
P01.00	**Maximum Operation Frequency of Motor 1**	R/W	0100	40257
P01.52	**Maximum Operation Frequency of Motor 2**	R/W	0134	40309
P01.53	**Maximum Operation Frequency of Motor 3**	R/W	0135	40310
P01.62	**Maximum Operation Frequency of Motor 4**	R/W	013E	40319

Range/Units (Format: 16-bit unsigned)	Default
0.00–599.00 Hz	60.00 / 50.00

These parameters determine the AC motor drive's maximum operation frequency. All the AC motor drive frequency command sources (analog inputs 0–10 V, 4–20 mA, 0–20 mA, ±10 V) are scaled to correspond to the output frequency range.

		Type	Hex Addr	Dec Addr
P01.01	**Output Frequency of Motor 1 (Base frequency / Motor's rated frequency)**	R/W	0101	40258
P01.35	**Output Frequency of Motor 2 (Base frequency / Motor's rated frequency)**	R/W	0123	40292
P01.54	**Output Frequency of Motor 3 (Base frequency / Motor's rated frequency)**	R/W	0136	40311
P01.63	**Output Frequency of Motor 4 (Base frequency / Motor's rated frequency)**	R/W	013E	40319

Range/Units (Format: 16-bit unsigned)	Default
0.00–599.00 Hz	60.00 / 50.00

Set these parameters according to the motor's rated frequency on the motor nameplate. If the motor's rated frequency is 60Hz, set this parameter to 60. If the motor's rated frequency is 50Hz, set this parameter to 50.

		Type	Hex Addr	Dec Addr
P01.02	**Output Voltage of Motor 1 (Base voltage / Motor's rated voltage)**	R/W	0102	40259
P01.36	**Output Voltage of Motor 2 (Base voltage / Motor's rated voltage)**	R/W	0124	40293
P01.55	**Output Voltage of Motor 3 (Base voltage / Motor's rated voltage)**	R/W	0137	40312
P01.64	**Output Voltage of Motor 4 (Base voltage / Motor's rated voltage)**	R/W	0140	40321

Range/Units (Format: 16-bit unsigned)	Default
120V / 230V models: 0.0–255.0 V	220.0
460V models: 0.0–510.0 V	440.0
575V models: 0.0–637.0 V	575.0

Set these parameters according to the rated voltage on the motor nameplate. If the motor's rated voltage is 220V, set this parameter to 220.0. If the motor's rated voltage is 200V, set this parameter to 200.0.

		Type	Hex Addr	Dec Addr
P01.03	**Mid-point Frequency 1 of Motor 1**	R/W	0103	40260
P01.37	**Mid-point Frequency 1 of Motor 2**	R/W	0125	40294
P01.56	**Mid-point Frequency 1 of Motor 3**	R/W	0138	40313
P01.65	**Mid-point Frequency 1 of Motor 4**	R/W	0141	40322

Range/Units (Format: 16-bit unsigned)	Default
0.00–599.00 Hz	3.00

		Type	Hex Addr	Dec Addr
P01.04	**Mid-point Voltage 1 of Motor 1**	♦R/W	0104	40261
P01.38	**Mid-point Voltage 1 of Motor 2**	♦R/W	0126	40295
P01.57	**Mid-point Voltage 1 of Motor 3**	♦R/W	0139	40314
P01.66	**Mid-point Voltage 1 of Motor 4**	♦R/W	0142	40323
	Range/Units (Format: 16-bit unsigned)	*Default*		
	120V / 230V models: 0.0–240.0 V	11.0		
	460V models: 0.0–480.0 V	22.0		
	575V models: 0.0–600.0 V	40.0		

		Type	Hex Addr	Dec Addr
P01.05	**Mid-point Frequency 2 of Motor 1**	R/W	0105	40262
P01.39	**Mid-point Frequency 2 of Motor 2**	R/W	0127	40296
P01.58	**Mid-point Frequency 2 of Motor 3**	R/W	013A	40315
P01.67	**Mid-point Frequency 2 of Motor 4**	R/W	0143	40324
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	1.50		

		Type	Hex Addr	Dec Addr
P01.06	**Mid-point Voltage 2 of Motor 1**	♦R/W	0106	40263
P01.40	**Mid-point Voltage 2 of Motor 2**	♦R/W	0128	40297
P01.59	**Mid-point Voltage 2 of Motor 3**	♦R/W	013B	40316
P01.68	**Mid-point Voltage 2 of Motor 4**	♦R/W	0144	40325
	Range/Units (Format: 16-bit unsigned)	*Default*		
	120V / 230V models: 0.0–240.0 V	5.0		
	460V models: 0.0–480.0 V	10.0		
	575V models: 0.0–600.0 V	26.1		

		Type	Hex Addr	Dec Addr
P01.07	**Minimum Output Frequency of Motor 1**	R/W	0107	40264
P01.41	**Minimum Output Frequency of Motor 2**	R/W	0129	40298
P01.60	**Minimum Output Frequency of Motor 3**	R/W	013C	40317
P01.69	**Minimum Output Frequency of Motor 4**	R/W	0145	40326
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	0.50		

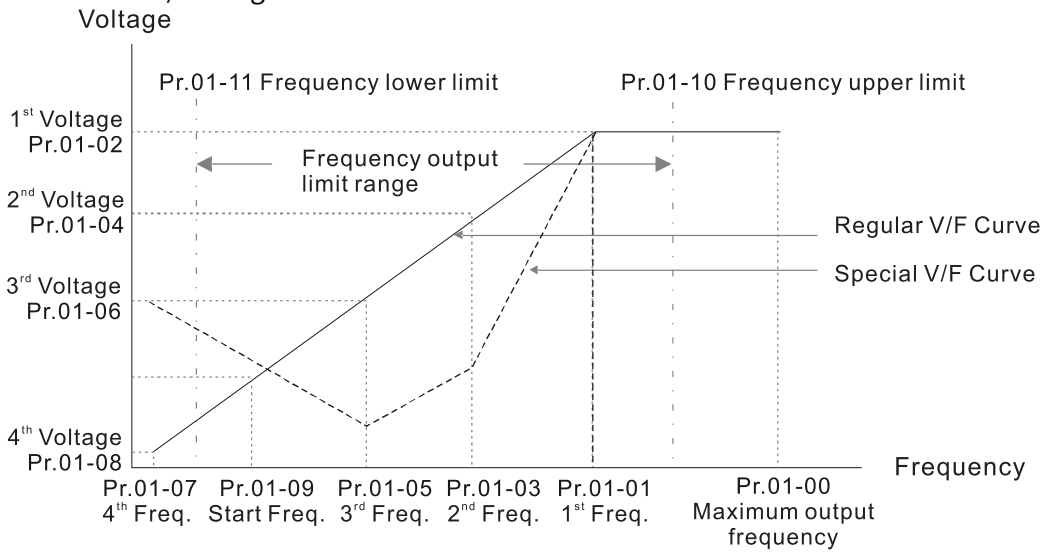
NOTE: P01.07 will set the V/F mode minimum frequency only. Use P01.11 to set the minimum frequency of the drive for any control mode.

		Type	Hex Addr	Dec Addr
P01.08	**Minimum Output Voltage of Motor 1**	♦R/W	0108	40265
P01.42	**Minimum Output Voltage of Motor 2**	♦R/W	012A	40299
P01.61	**Minimum Output Voltage of Motor 3**	♦R/W	013D	40318
P01.70	**Minimum Output Voltage of Motor 4**	♦R/W	0146	40327
	Range/Units (Format: 16-bit unsigned)	*Default*		
	120V / 230V models: 0.0–240.0 V	1.0		
	460V models: 0.0–480.0 V	2.0		
	575V models: 0.0–600.0 V	16.7		

You usually set the V/F curve according to the motor's allowable loading characteristics. Pay special attention to the motor's heat dissipation, dynamic balance, and bearing lubrication when the loading characteristics exceed the loading limit of the motor.

There is no limit for the voltage setting, but a high voltage at a low frequency may cause motor damage, overheating, and trigger the stall prevention or the over-current protection; therefore, use low voltage at low frequency to prevent motor damage or drive error.

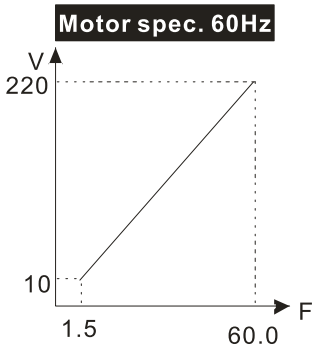
The diagram below shows the V/F curve for motor 1. You can use the same V/F curve for motor 2, motor 3, and motor 4. For multi-motor selections, refer to the multi-function input terminal (P02.01–P02.07) settings 83 and 84.



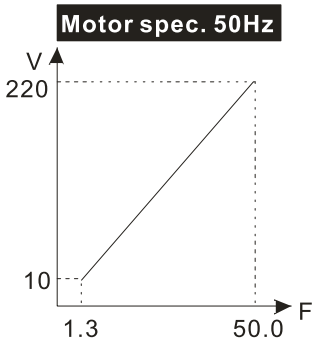
V/F Curve

Common settings for the V/F curve:

1) General purpose:

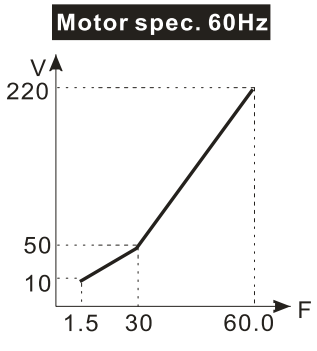


Pr.	Setting
01-00	60.0
01-01	60.0
01-02	220.0
01-03 01-05	1.50
01-04 01-06	10.0
01-07	1.50
01-08	10.0

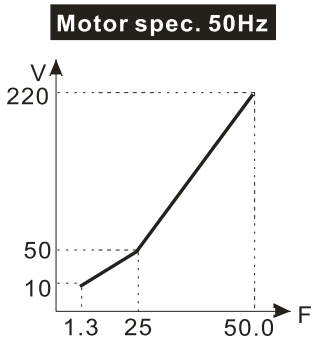


Pr.	Setting
01-00	50.0
01-01	50.0
01-02	220.0
01-03 01-05	1.30
01-04 01-06	10.0
01-07	1.30
01-08	10.0

2) For fan and hydraulic machinery:



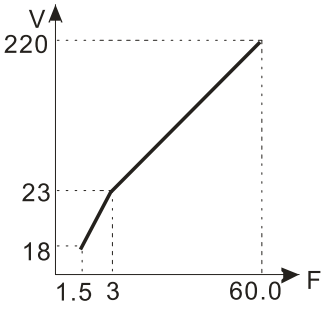
Pr.	Setting
01-00	60.0
01-01	60.0
01-02	220.0
01-03 01-05	30.0
01-04 01-06	50.0
01-07	1.50
01-08	10.0



Pr.	Setting
01-00	50.0
01-01	50.0
01-02	220.0
01-03 01-05	25.0
01-04 01-06	50.0
01-07	1.30
01-08	10.0

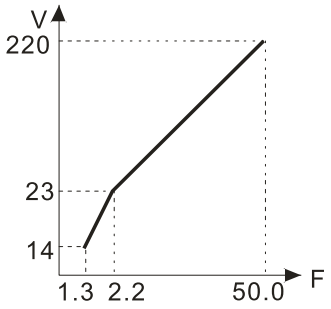
3) High starting torque:

Motor spec. 60Hz



Pr.	Setting
01-00	60.0
01-01	60.0
01-02	220.0
01-03 01-05	3.00
01-04 01-06	23.0
01-07	1.50
01-08	18.0

Motor spec. 50Hz

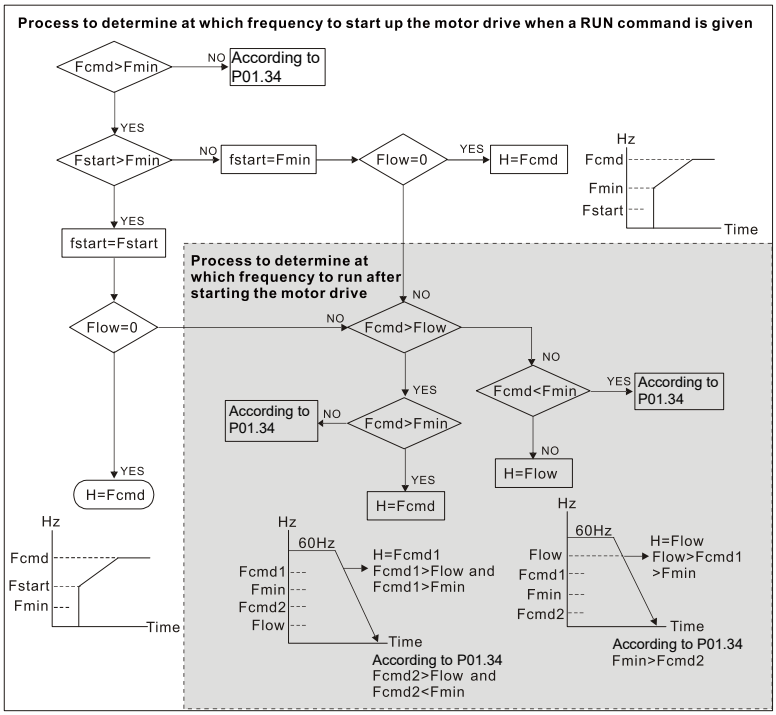


Pr.	Setting
01-00	50.0
01-01	50.0
01-02	220.0
01-03 01-05	2.20
01-04 01-06	23.0
01-07	1.30
01-08	14.0

		Type	*Hex Addr*	*Dec Addr*
P01.09	***Start-up Frequency***	R/W	0109	40266
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–599.00 Hz		0.50		

P01.09 is used to set the starting frequency of the drive.

- *When the starting frequency (P01.09) is larger than the minimum output frequency (P01.11), the drive's frequency output starts when the starting frequency (P01.09) reaches the F command. Refer to the diagram below for details.*
- *Fcmd = frequency command;*
  Fstart = start-up frequency (P01.09);
  fstart = actual start-up frequency of the drive;
  Fmin = 4th output frequency setting (P01.07 / P01.41);
  Flow = output frequency lower limit (P01.11)
- *When Fcmd > Fmin and Fcmd < Fstart:*
  If Flow < Fcmd, the drive runs directly with Fcmd.
  If Flow ≥ Fcmd, the drive runs with Fcmd, and then rises to Flow according to acceleration time.
- *The drive's output frequency goes directly to 0 when decelerating to Fmin.*

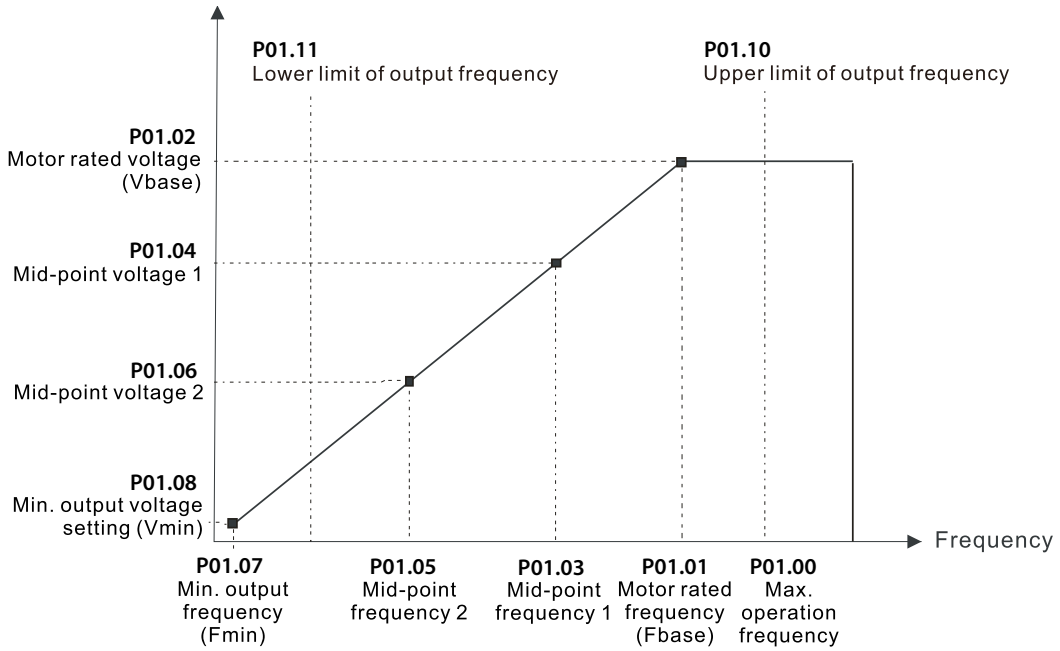


		Type	Hex Addr	Dec Addr
P01.10	**Output Frequency Upper Limit**	♦R/W	010A	40267
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–599.00 Hz		599.0		

		Type	Hex Addr	Dec Addr
P01.11	**Output Frequency Lower Limit**	♦R/W	010B	40268
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–599.00 Hz		0.00		

Use the upper and lower limit output frequency settings to limit the actual output frequency. If the output frequency setting is higher than the upper limit (P01.10), the drive runs with the upper limit frequency. If the output frequency setting is lower than the lower limit (P01.11) but higher than the minimum output frequency (P01.07), the drive runs with the lower limit frequency. Set the upper limit frequency > the lower limit frequency (P01.10 setting value must be > P01.11 setting value).

- *The upper output frequency limits the drive's maximum output frequency. If the frequency setting for the Frequency command is higher than P01.10, the drive runs with the P01.10 setting.*
- *If the PID feedback control is enabled for the drive, the drive's output frequency may exceed the Frequency command but is still limited by this setting.*
- *Related parameters: P01.00 Maximum Operation Frequency, P01.11 Output Frequency Lower Limit.*



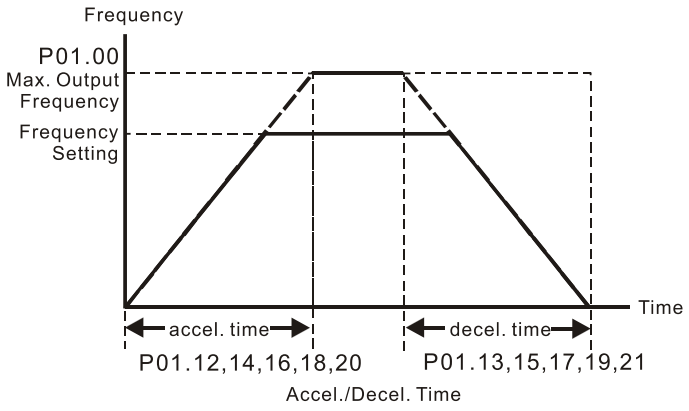
- *The lower output frequency limits the drive's minimum output frequency. If the frequency setting for the Frequency command is lower than P01.11, the drive runs with the P01.11 setting.*
- *When the drive starts, it operates according to the V/F curve and accelerates from the minimum output frequency (P01.07) to the setting frequency. It is not limited by the lower output frequency settings.*
- *Use the output frequency upper and lower limit settings to prevent operator misuse, overheating caused by the motor's operating at a too low frequency, or mechanical wear due to a too high speed.*
- *If the output frequency upper limit setting is 50Hz and the frequency setting is 60Hz, the maximum output frequency is 50Hz.*
- *If the output frequency lower limit setting is 10Hz and the minimum output frequency setting (P01.07) is 1.5 Hz, then the drive operates at 10Hz when the Frequency command is higher than P01.07 but lower than 10Hz. If the Frequency command is lower than P01.07, the drive is in ready status without output.*

- *If the frequency output upper limit is 60Hz and the frequency setting is also 60Hz, only the Frequency command is limited at 60Hz. The actual output frequency may be higher than 60Hz if used for slip compensation.*

		Type	Hex Addr	Dec Addr
P01.12	**Acceleration Time 1**	♦R/W	010C	40269
P01.13	**Deceleration Time 1**	♦R/W	010D	40270
P01.14	**Acceleration Time 2**	♦R/W	010E	40271
P01.15	**Deceleration Time 2**	♦R/W	010F	40272
P01.16	**Acceleration Time 3**	♦R/W	0110	40273
P01.17	**Deceleration Time 3**	♦R/W	0111	40274
P01.18	**Acceleration Time 4**	♦R/W	0112	40275
P01.19	**Deceleration Time 4**	♦R/W	0113	40276
P01.20	**JOG Acceleration Time**	♦R/W	0114	40277
P01.21	**JOG Deceleration Time**	♦R/W	0115	40278
	Range/Units (Format: 16-bit unsigned)	*Default*		
	P01.45 = 0: 0.00–600.00 sec. P01.45 = 1: 0.0–6000.0 sec.	10.00 / 10.0		

The acceleration time determines the time required for the AC motor drive to ramp from 0.00 Hz to the maximum operation frequency (P01.00). The deceleration time determines the time required for the AC motor drive to decelerate from the maximum operation frequency (P01.00) down to 0.00 Hz.

- *The acceleration and deceleration time are invalid when using P01.44 Auto-acceleration and Auto-deceleration Setting.*
- *Select the Acceleration/Deceleration Time 1, 2, 3, 4 with the multi-function input terminal settings. The defaults are Acceleration Time 1 and Deceleration Time 1.*
- *With the enabled torque limits and stall prevention functions, the actual acceleration and deceleration time are longer than the above action time.*
- *Note that setting the acceleration and deceleration time too short may trigger the drive's protection function (P06.03 Over-current Stall Prevention during Acceleration or P06.01 Over-voltage Stall Prevention), and the actual acceleration and deceleration time are longer than this setting.*
- *Note that setting the acceleration time too short may cause motor damage or trigger drive protection due to over-current during the drive's acceleration.*
- *Note that setting the deceleration time too short may cause motor damage or trigger drive protection due to over-current during the drive's deceleration or over-voltage.*
- *Use suitable braking resistors (refer to Appendix A: Accessories) to decelerate in a short time and prevent over-voltage.*
- *When you enable P01.24–P01.27 (S-curve acceleration and deceleration begin and arrival time), the actual acceleration and deceleration time are longer than the setting.*



		Type	Hex Addr	Dec Addr
P01.22	**JOG Frequency**	♦R/W	0116	40279
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		6.00		

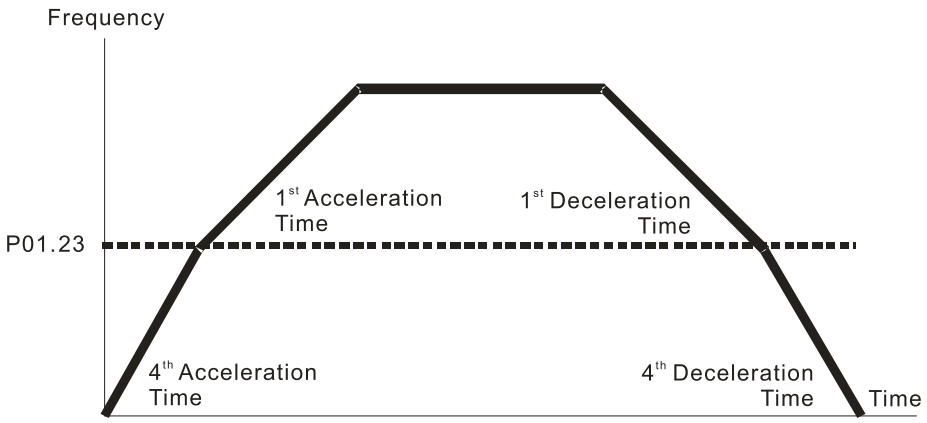
You can use both the external terminal JOG and F1 key on the optional keypad GS4-KPD (optional) to set the JOG function. When the JOG command is ON, the AC motor drive accelerates from 0 Hz to the JOG frequency (P01.22). When the JOG command is OFF, the AC motor drive decelerates from the JOG frequency to stop. The JOG acceleration and deceleration time (P01.20, P01.21) are the time to accelerate from 0.00 Hz to the JOG frequency (P01.22). You cannot execute the JOG command when the AC motor drive is running. When the JOG command is executing, other operation commands are invalid.

		Type	Hex Addr	Dec Addr
P01.23	**Switch Frequency between First and Fourth Accel./Decel.**	♦R/W	0117	40280
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		0.00		

This function does not require the external terminal switching function; it switches the acceleration and deceleration time automatically according to the P01.23 setting. If you set the external terminal, the external terminal has priority over P01.23.

When using this function, set the S-curve acceleration time to 0 if the fourth acceleration time is short.

1) If P01.12=10s, P 01.18=6s, then the acceleration time is 3s for 0–40 Hz and 5s for 40–80 Hz.
2) If P01.13=8s, P01.19=2s, then the deceleration time is 4s for 80–40 Hz and 1s for 40–0 Hz.

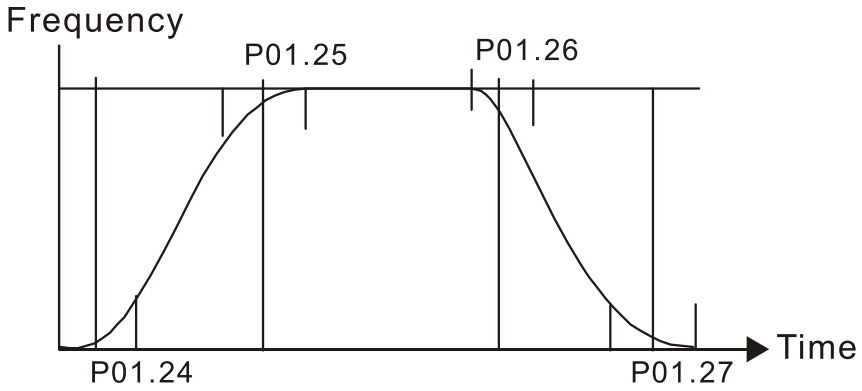


1st/4th Acceleration/Deceleration Frequency Switching

		Type	Hex Addr	Dec Addr
P01.24	**S-curve for Acceleration Begin Time 1**	♦R/W	0118	40281
P01.25	**S-curve for Acceleration Arrival Time 2**	♦R/W	0119	40282
P01.26	**S-curve for Deceleration Begin Time 1**	♦R/W	011A	40283
P01.27	**S-curve for Deceleration Arrival Time 2**	♦R/W	011B	40284
Range/Units (Format: 16-bit unsigned)		Default		
If P01.45 = 0: 0.00–25.00 sec.		0.20		
If P01.45 = 1: 0.0–250.0 sec.		0.2		

These parameters allow you to enable an S-curve. Using an S-curve gives the smoothest transition between speed changes. The acceleration and deceleration curve adjusts the acceleration and deceleration S-curve. When enabled, the drive produces a different acceleration and deceleration curve according to the acceleration and deceleration time.

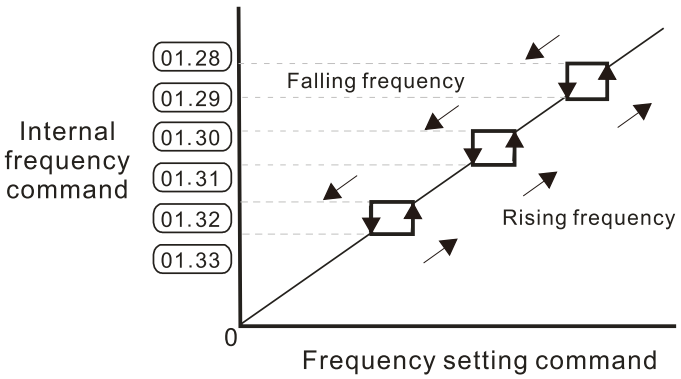
- *The S-curve function is invalid when you set the acceleration and deceleration time to 0.*
- *For P01.12, P01.14, P01.15, and P01.18:*
  When P01.1x ≥ P01.24 and P01.25, the actual acceleration time = P01.1x + (P01.24 + P01.25) / 2.
- *For P01.13, P01.15, P01.17, and P01.19:*
  When P01.1x ≥ P01.26 and P01.27, the actual deceleration time = P01.1x + (P01.26 + P01.27) / 2.



		Type	Hex Addr	Dec Addr
P01.28	***Skip Frequency 1 (Upper Limit)***	R/W	011C	40285
P01.29	***Skip Frequency 1 (Lower Limit)***	R/W	011D	40286
P01.30	***Skip Frequency 2 (Upper Limit)***	R/W	011E	40287
P01.31	***Skip Frequency 2 (Lower Limit)***	R/W	011F	40288
P01.32	***Skip Frequency 3 (Upper Limit)***	R/W	0120	40289
P01.33	***Skip Frequency 3 (Lower Limit)***	R/W	0121	40290
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	0.00		

These parameters set the AC motor drive's skip frequency. The drive's frequency setting skips these frequency ranges. However, the frequency output is continuous. There are no limits for these six parameters and you can combine them. P01.28 does not need to be greater than P01.29; P01.30 does not need to be greater than P01.31; P01.32 does not need to be greater than P01.33. You can set P01.28–01.33 as required. There is no size distinction among these six parameters.

- *These parameters set the skip frequency ranges for the AC motor drive. You can use this function to avoid frequencies that cause mechanical resonance. The skip frequencies are useful when a motor has resonance vibration at a specific frequency bandwidth. Skipping this frequency avoids the vibration. There are three frequency skip zones available.*
- *You can set the Frequency command (F) within the range of skip frequencies. Then the output frequency (H) is limited to the lower limit of skip frequency ranges.*
- *During acceleration and deceleration, the output frequency still passes through the skip frequency ranges.*

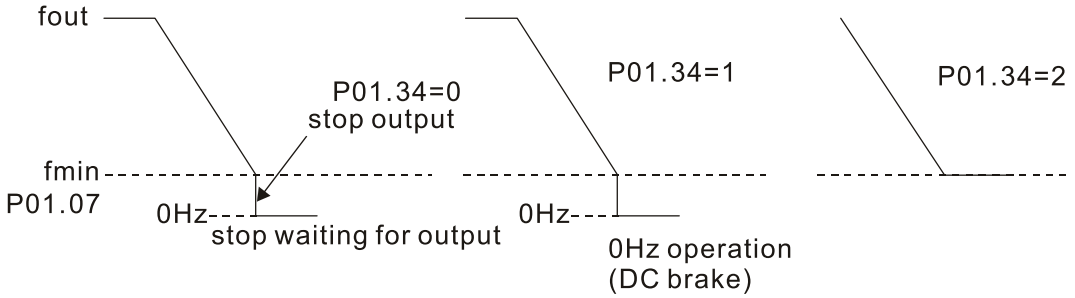


P01.34	Zero-speed Mode	Type	Hex Addr	Dec Addr
		R/W	0122	40291
Range/Units (Format: 16-bit binary)		Default		
0: Output waiting 1: Zero-speed operation 2: Fmin (refer to P01.07 and P01.41)		0		

When the drive's Frequency command is lower than Fmin (P01.07 and P01.41), the drive operates according to this parameter.

- *0: the AC motor drive is in waiting mode without voltage output from terminals U, V, W.*
- *1: the drive executes the DC brake by Vmin (P01.08 and P01.42) in V/F, FOC sensorless, and SVC modes. And it executes zero-speed operation in VFPG mode.*
- *2: the AC motor drive runs using Fmin (P01.07 and P01.41) and Vmin (P01.08 and P01.42) in V/F, VFPG, SVC, and FOC sensorless modes.*

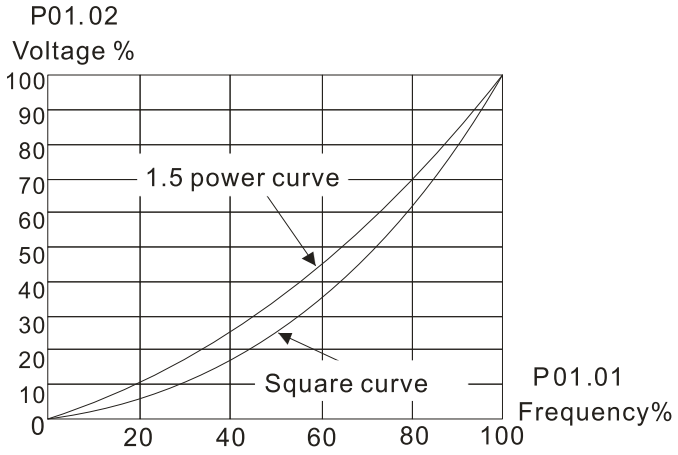
In V/F, VFPG, SVC and FOC sensorless modes:



P01.43	V/F Curve Selection	Type	Hex Addr	Dec Addr
		R/W	012B	40300
Range/Units (Format: 16-bit binary)		Default		
0: V/F curve determined by P.01.00–P01.08 1: V/F curve to the power of 1.5 2: V/F curve to the power of 2		0		

P01.43 is used to select the desired V/F curve for your application.

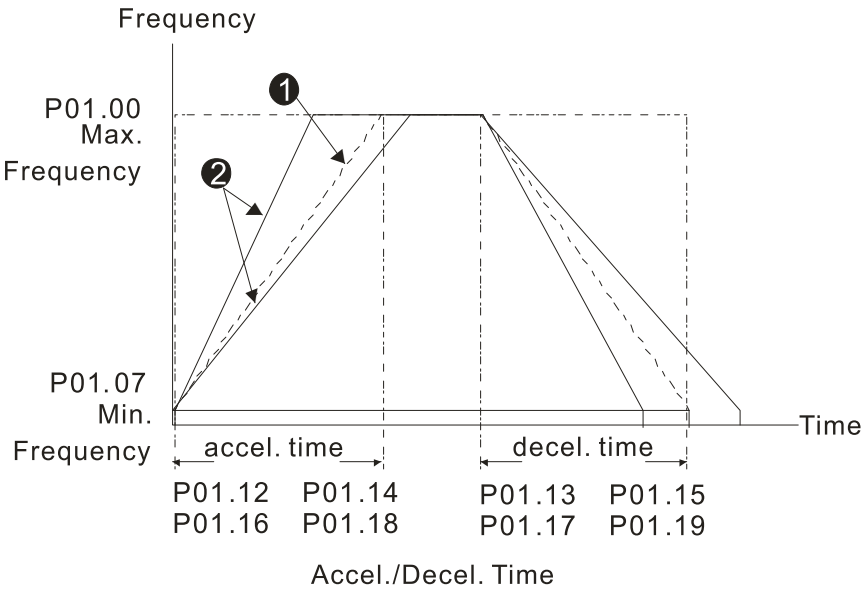
- *When setting to 0, refer to P01.01–01.08 for the motor 1 V/F curve. For motor 2, refer to P01.35–01.42. For motor 3, refer to P01.54–P01.61. For motor 4, refer to P01.35–P01.42.*
- *When setting to 1 or 2, the second and third voltage frequency settings (as shown in the V/F Curve diagram for P01.70) are invalid.*
- *If the load of the motor is a variable torque load (torque is in direct proportion to the rotating speed, such as the load of a fan or a pump), the load torque is low at low rotating speed. You can decrease the input voltage appropriately to make the magnetic field of the input current smaller and reduce flux loss and iron loss for the motor to increase efficiency.*
- *When you set the V/F curve to high power, it has lower torque at low frequency, and the drive is not suitable for rapid acceleration and deceleration. Do NOT use this parameter for rapid acceleration and deceleration.*



		Type	Hex Addr	Dec Addr
P01.44	**Auto-acceleration and Auto-deceleration Setting**	♦R/W	012C	40301
	Range/Units (Format: 16-bit binary)	Default		
	0: Linear acceleration and deceleration	0		
	1: Auto-acceleration and linear deceleration			
	2: Linear acceleration and auto-deceleration			
	3: Auto-acceleration and auto-deceleration			
	4: Stall prevention by auto-acceleration and auto-deceleration (limited by P01.12 –P01.21)			

P01.44 is used to configure auto-acceleration and auto-decleration settings.

- *0 (linear acceleration and deceleration): the drive accelerates and decelerates according to the setting for P01.12–P01.19.*
- *1 or 2 (auto/linear acceleration and auto/linear deceleration): the drive auto-tunes the acceleration and deceleration to effectively reduce the mechanical vibration during the load start-up and stop and make the auto-tuning process easier. It does not stall during acceleration and does not need a braking resistor during deceleration to stop. It can also improve operation efficiency and save energy.*
- *3 (auto-acceleration and auto-deceleration–decelerating by the actual load): the drive auto-detects the load torque and automatically accelerates from the fastest acceleration time and smoothest start-up current to the setting frequency. During deceleration, the drive automatically determines the loaded regenerative energy to steadily and smoothly stop the motor in the fastest deceleration time.*
- *4 (stall prevention by auto-acceleration and deceleration–references the acceleration and deceleration time settings (P01.12 through P01.19). If the settings for acceleration and deceleration are too short, the actual acceleration and decleration times will be greater than the acceleration and deceleration time settings.*



❶ When P01.44 is set to 0.

❷ When P01.44 is set to 3.

		Type	Hex Addr	Dec Addr
P01.45	**Time Unit for Acceleration and Deceleration and S-Curve**	R/W	012D	40302
Range/Units (Format: 16-bit binary)		Default		
0: Unit 0.01 sec. 1: Unit 0.1 sec.		0		

		Type	Hex Addr	Dec Addr
P01.49	**Regenerative Energy Restriction Control Method**	R/W	0131	40306
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Over voltage energy restriction 2: Traction energy control (TEC)		0		

P01.49 is used to select the regenerative energy restriction control method.

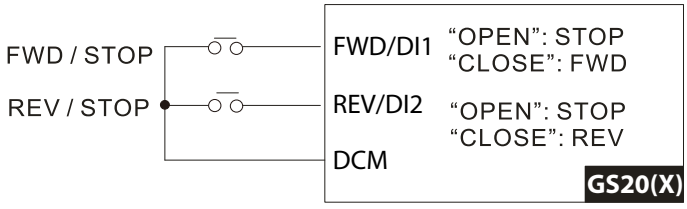
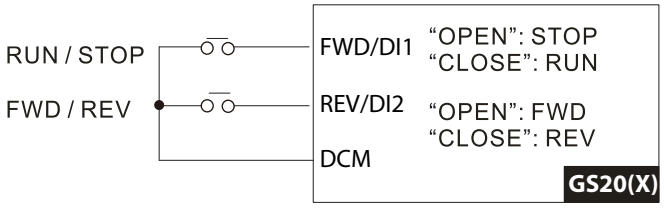
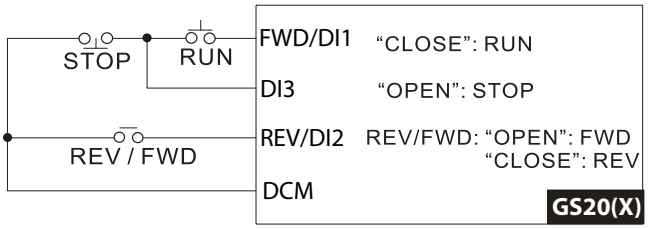
- *0: decelerate or stop in accordance with the original deceleration setting. The actual deceleration time of the motor is longer than the deceleration time setting because of the over-voltage stall prevention.*
- *1: during deceleration, the drive controls the motor according to the setting for P06.01 and the recovery voltage of the DC bus. The controller starts when the DC bus voltage reaches 95% of P06.01. When P06.01 is set to 0, the drive controls the motor according to the operating voltage and the recovery voltage of the DC bus. This method decelerates according to the setting for the deceleration time. The fastest actual deceleration time is not less than the deceleration time setting.*
- *2: during deceleration, the drive controls the motor according to the setting for P06.01 and the DC bus voltage. The controller starts when the DC bus voltage reaches 95% of P06.01, auto-tunes the output frequency and the output voltage to increase the consumption of the regenerative energy according to the drive's capability, and the deceleration time is the result of the drive's auto-tuning. Use this setting when over-voltage occurs due to unexpected deceleration time.*

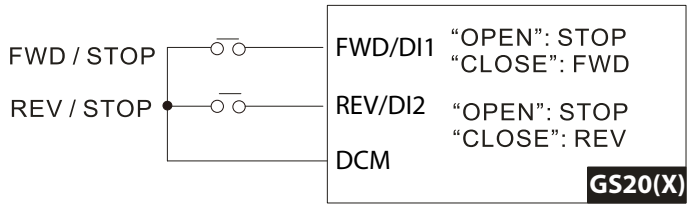
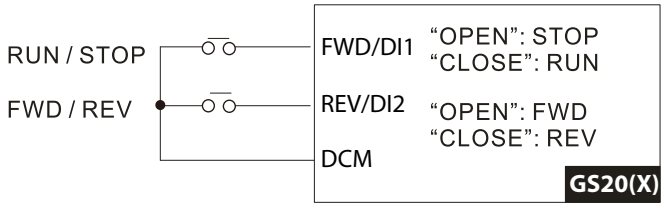
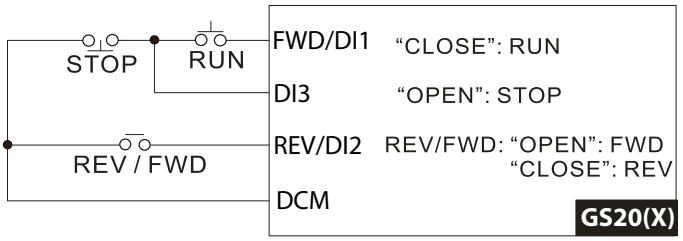
Group P02.xx Details – Digital Input/Output Parameters

		Type	Hex Addr	Dec Addr
P02.00	**Two-wire / Three-wire Operation Control**	R/W	0200	40513
	Range/Units (Format: 16-bit binary)	Default		
	0: No function	1		
	1: Two-wire mode 1, power on for operation control (DI1: FWD / STOP, DI2: REV / STOP)			
	2: Two-wire mode 2, power on for operation control (DI1: RUN / STOP, DI2: REV / FWD)			
	3: Three-wire, power on for operation control (DI1: RUN, DI2: REV / FWD, DI3: STOP)			
	4: Two-wire mode 1, Quick Start (DI1: FWD / STOP, DI2: REV / STOP)			
	5: Two-wire mode 2, Quick Start (DI1: RUN / STOP, DI2: REV / FWD)			
	6: Three-wire, Quick Start (DI1: RUN, DI2: REV / FWD, DI3: STOP)			

P02.00 is used to set the 2-wire or 3-wire operation control mode.

- *In the Quick Start function, the output remains ready for operation. The drive responds to the Start command immediately.*
- *When using Quick Start function, the output terminals UVW are with driving voltages in order to output and respond immediately if a Start command is given. Do NOT touch the terminals or modify the motor wiring to prevent electric shocks.*
- *This parameter sets the configuration of the external drive operation control and the Quick Start function. There are six different control modes listed in the following table.*

P02.00	External Terminal Control Circuits
Setting value: 1 Two-wire operation control FWD / STOP REV / STOP	
Setting value: 2 Two-wire operation control RUN / STOP FWD / REV	
Setting value: 3 Three-wire operation control	

P02.00	External Terminal Control Circuits
Setting value: 4 Two-wire operation control Quick Start	
Setting value: 5 Two-wire operation control Quick Start	
Setting value: 6 Three-wire operation control Quick Start	

		Type	Hex Addr	Dec Addr	Default
P02.01	**Multi-function input Command 1 (FWD/DI1)**	R/W	0201	40514	0
P02.02	**Multi-function input Command 2 (REV/DI2)**	R/W	0202	40515	0
P02.03	**Multi-function input Command 3 (DI3)**	R/W	0203	40516	1
P02.04	**Multi-function input Command 4 (DI4)**	R/W	0204	40517	2
P02.05	**Multi-function input Command 5 (DI5)**	R/W	0205	40518	3
P02.06	**Multi-function input Command 6 (DI6)**	R/W	0206	40519	4
P02.07	**Multi-function input Command 7 (DI7)**	R/W	0207	40520	0

Range/Units (Format: 16-bit binary)

0: No function
1: Multi-step speed command 1
2: Multi-step speed command 2
3: Multi-step speed command 3
4: Multi-step speed command 4
5: Reset
6: JOG [by external control or GS4-KPD (optional)]
7: Acceleration / deceleration speed inhibit
8: 1st and 2nd acceleration / deceleration time selection
9: 3rd and 4th acceleration / deceleration time selection
10: External Fault (EF) Input (P07.20)
11: Base Block (B.B.) input from external source
12: Output stop
13: Cancel the setting of auto-acceleration / auto-deceleration time
15: Frequency command from AI1
16: Frequency command from AI2
18: Force to stop (P07.20)
19: Digital up command
20: Digital down command
21: PID function disabled
22: Clear the counter
23: Input the counter value (DI6)
24: FWD JOG command
25: REV JOG command
26: TQC / FOC mode selection
27: ASR1 / ASR2 selection
28: Emergency stop (EF1)
29: Signal confirmation for Y-connection
30: Signal confirmation for Δ-connection
31: High torque bias (P11.30)
32: Middle torque bias (P11.31)
33: Low torque bias (P11.32)
38: Disable writing EEPROM function
39: Torque command direction
40: Force coasting to stop
41: HAND switch
42: AUTO switch
48: Mechanical gear ratio switch
49: Enable drive
50: Slave dEb action to execute
51: Selection for PLC mode bit 0
52: Selection for PLC mode bit 1
53: Reserved
56: Local / Remote selection
58: Enable fire mode (with RUN command)
59: Enable fire mode (without RUN command)
70: Force auxiliary frequency return to 0
71: Disable PID function, force PID output return to 0
72: Disable PID function, retain the output value before disabled
73: Force PID integral gain return to 0, disable integral
74: Reverse PID feedback
81: Simple positioning zero point position signal input
82: OOB loading balance detection
83: Multi-motor (IM) selection bit 0
84: Multi-motor (IM) selection bit 1

These parameters select the functions for each digital terminal.

- *When P02.00 = 0, you can set digital options with multi-function input terminals DI1, DI2.*
- *When P02.00 ≠ 0, the multi-function input terminals DI1, DI2 work in accordance with the setting values for P02.00.*

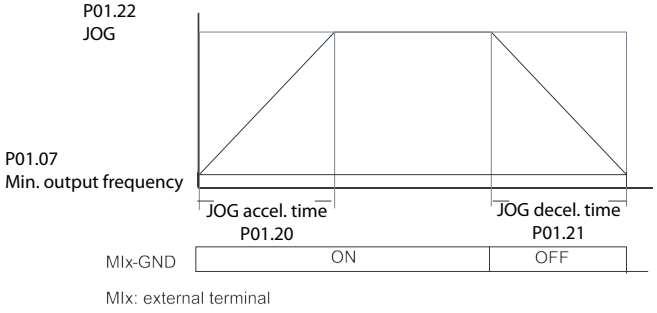
Example:

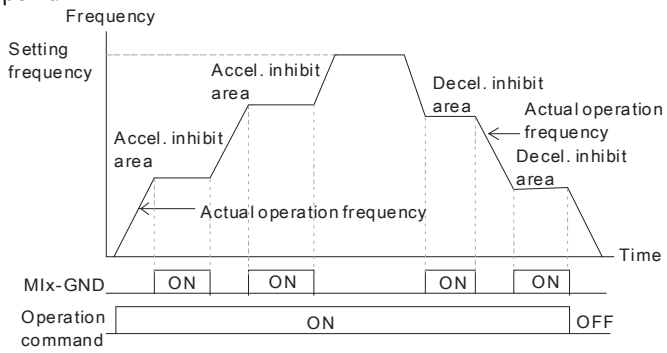
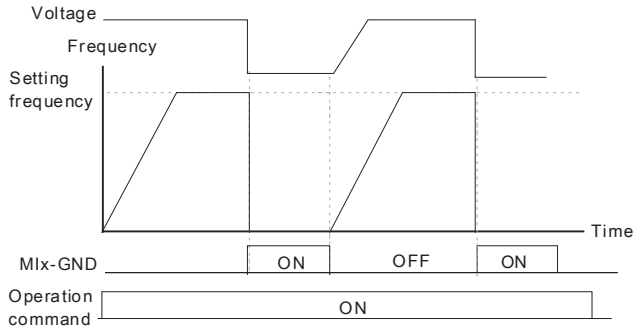
- *If P02.00 = 1: multi-function input terminal DI1 = FWD / STOP, DI2 = REV / STOP.*
- *If P02.00 = 2: multi-function input terminal DI1 = RUN / STOP, DI2 = FWD / REV.*
- *When multi-function input terminal DI7 = 0, DI7 is designated as a pulse input terminal.*
- *If P02.00 is set to three-wire operation control, terminal DI3 is for the STOP contact. The function set previously for this terminal is automatically invalid.*

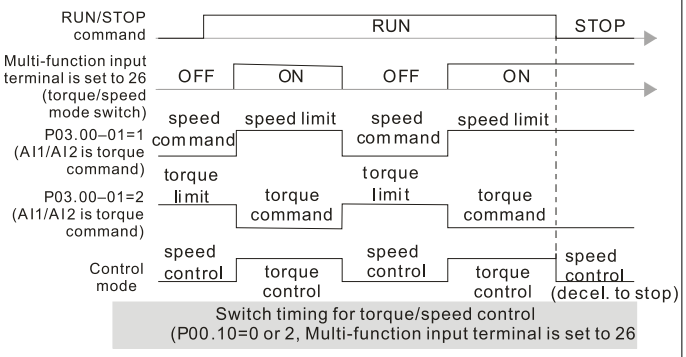
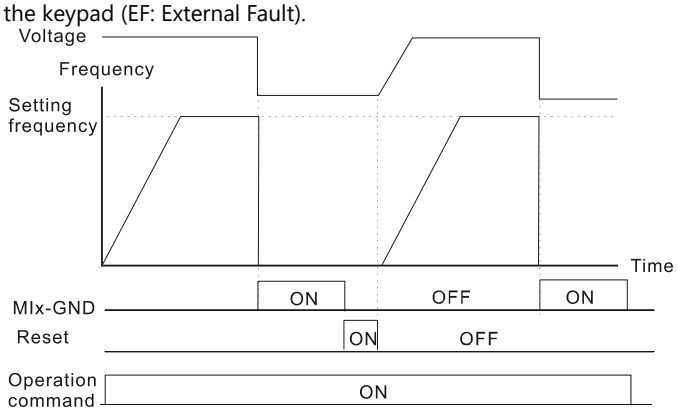
DI7 for Pulse Feedback:

DI7 is set to "0" for pulse feedback. See Group 10 Parameter details for more information.

Summary of Function Settings

Setting	*Function*	*Description*
0	No function	
1	Multi-step speed command 1	You can set 15 steps of speed or 15 positions with the digital status of these four terminals. You can use 16-steps of speed if you include the master speed when setting as 15 steps of speed (refer to Parameter Group 04 Multi-step Speed Parameters).
2	Multi-step speed command 2	
3	Multi-step speed command 3	
4	Multi-step speed command 4	
5	Reset	Use this terminal to reset the drive after clearing a drive fault.
6	JOG operation [by external control or GS4-KPD (optional)]	This function is valid when the source of the operation command is the external terminals. The JOG operation executes when the drive stops completely. While running, you can still change the operation direction, and the STOP key on the keypad* and the STOP command from communications are valid. Once the external terminal receives the OFF command, the motor stops in the JOG deceleration time. Refer to P01.20–P01.22 for details. *: This function is valid when P00.32 is set to 1. 

Setting	Function	Description
7	Acceleration / deceleration speed inhibit	When you enable this function, the drive stops acceleration or deceleration immediately. After you disable this function, the AC motor drive starts to accelerate or decelerate from the inhibit point. 
8	1st and 2nd acceleration / deceleration time selection	You can select the acceleration and deceleration time of the drive with this function, or from the digital status of the terminals; there are four acceleration and deceleration selections.
9	3rd and 4th acceleration / deceleration time selection	
10	External Fault (EF) input (P07.20)	For external fault input. The drive decelerates according to the P07.20 setting, and the keypad shows "EF" (it shows the fault record when an external fault occurs). The drive will begin running again when the fault is cleared (terminal status restored) and RESET is pressed.
11	Base Block (B.B.) input from external	ON: the output of the drive stops immediately. The motor is in free run and the keypad displays the B.B. signal. Refer to P07.08 for details.
12	Output stop	ON: the output of the drive stops immediately, and the motor is in free run status. The drive is in output waiting status until the switch is turned to OFF, and then the drive restarts and runs to the current setting frequency. 
13	Cancel the setting of auto-acceleration / auto-deceleration time	Set P01.44 to one of the 01–04 setting modes before using this function. When this function is enabled, OFF is for auto mode and ON is for linear acceleration / deceleration.
15	Rotating speed command from AI1	ON: force the source of the drive's frequency to be AI1. If the rotating speed commands are set to AI1 and AI2 at the same time, the priority is AI1 > AI2.
16	Rotating speed command from AI2	ON: force the source of the drive's frequency to be AI2. If the rotating speed commands are set to AI1 and AI2 at the same time, the priority is AI1 > AI2.
18	Force to stop (P07.20)	ON: the drive ramps to a stop according to the P07.20 setting.

Setting	Function	Description
19	Digital up command	ON: the frequency of the drive increases or decreases by one unit. If this function remains ON continuously, the frequency increases or decreases according to P02.09 / P02.10. The Frequency command returns to zero when the drive stops and the displayed frequency is 0.00 Hz. If you select P11.00, bit 7 = 1, the frequency is not saved.
20	Digital down command	
21	PID function disabled	ON: the PID function is disabled.
22	Clear the counter	ON: the current counter value is cleared and displays 0. The drive counts up when this function is disabled.
23	Input the counter value (DI6)	ON: the counter value increases by one. Use the function with P02.19.
24	FWD JOG command	This function is valid when the source of the operation command is the external terminal. ON: the drive executes forward JOG. When executing the JOG command in torque mode, the drive automatically switches to speed mode. The drive returns to torque mode after the JOG command is complete.
25	REV JOG command	This function is valid when the source of the operation command is the external terminal. ON: the drive executes reverse JOG. When executing the JOG command in torque mode, the drive automatically switches to speed mode. The drive returns to torque mode after the JOG command is complete.
26	TQC / FOC mode selection	ON: TQC mode, OFF: FOC mode. 
27	ASR1 / ASR2 selection	ON: the speed is adjusted by the ASR 2 setting. OFF: the speed is adjusted by the ASR 1 setting. Refer to Pr.11-02 for details.
28	Emergency stop (EF1)	ON: the output of the drive stops immediately, displays "EF1" on the keypad, and the motor is in free run status. The drive remains stopped until the external fault is cleared after you press RESET on the keypad (EF: External Fault). 
29	Signal confirmation for Y-connection	When the control mode is V/F, ON: the drive operates by the first V/F.
30	Signal confirmation for Δ-connection	When the control mode is V/F, ON: the drive operates by the second V/F.

<table>
<tr><th>Setting</th><th>Function</th><th>Description</th></tr>
<tr><td>31</td><td>High torque bias</td><td rowspan="3">Refer to P11.30–P11.32 for details.</td></tr>
<tr><td>32</td><td>Middle torque bias</td></tr>
<tr><td>33</td><td>Low torque bias</td></tr>
<tr><td>38</td><td>Disable writing EEPROM function (parameters memory disable)</td><td>ON: writing to EEPROM is disabled. Changed parameters are not saved after power off.</td></tr>
<tr><td>39</td><td>Torque command direction</td><td>For torque control (P00.10=2), when the torque command is AI1 or AI2, ON: negative torque.</td></tr>
<tr><td>40</td><td>Force coasting to stop</td><td>ON: during operation, the motor coasts to stop.</td></tr>
<tr><td>41</td><td>HAND switch</td><td rowspan="2">1) When the DI terminal switches to OFF, it executes a STOP command. Therefore, if the DI terminal switches to OFF during operation, the drive stops.
2) Use the optional keypad GS4-KPD to switch between HAND and AUTO. The drive stops first, and then switches to HAND or AUTO status.
3) The optional digital keypad GS4-KPD displays the current status of the drive (HAND / OFF / AUTO).
<table>
<tr><th></th><th>bit 1</th><th>bit 0</th></tr>
<tr><td>OFF</td><td>0</td><td>0</td></tr>
<tr><td>AUTO</td><td>0</td><td>1</td></tr>
<tr><td>HAND</td><td>1</td><td>0</td></tr>
<tr><td>OFF</td><td>1</td><td>1</td></tr>
</table></td></tr>
<tr><td>42</td><td>AUTO switch</td></tr>
<tr><td>48</td><td>Mechanical gear ratio switch</td><td>ON: the mechanical gear ratio switches to the second group. Refer to P10.04–P10.07 for details.</td></tr>
<tr><td>49</td><td>Enable drive</td><td>When the drive is enabled, the RUN command is valid.
When the drive is disabled, the RUN command is invalid.
When the drive is operating, the motor coasts to stop.
This function varies with a Multifunction Output DO1 or DO2 = 45.</td></tr>
<tr><td>50</td><td>Slave dEb action to execute</td><td>Enter the message setting in this parameter when the master triggers dEb. This ensures that the slave also triggers dEb, then the master and slave stop simultaneously.</td></tr>
<tr><td>51</td><td>Selection for PLC mode (bit 0)</td><td rowspan="2">
<table>
<tr><th>PLC Status</th><th>bit 1</th><th>bit 0</th></tr>
<tr><td>Disable PLC function (PLC 0)</td><td>0</td><td>0</td></tr>
<tr><td>Trigger PLC to operate (PLC 1)</td><td>0</td><td>1</td></tr>
<tr><td>Trigger PLC to stop (PLC 2)</td><td>1</td><td>0</td></tr>
<tr><td>No function</td><td>1</td><td>1</td></tr>
</table></td></tr>
<tr><td>52</td><td>Selection for PLC mode (bit 1)</td></tr>
<tr><td>56</td><td>Local / Remote selection</td><td>Use P00.29 to select LOCAL / REMOTE mode. When P00.29 is not set to 0, the optional digital keypad GS4-KPD displays LOC / REM status. (Refer to P00.29 for details).
<table>
<tr><th></th><th>bit 0</th></tr>
<tr><td>REM</td><td>0</td></tr>
<tr><td>LOC</td><td>1</td></tr>
</table></td></tr>
<tr><td>58</td><td>Enable fire mode (with RUN command)</td><td>When fire occurs, enable this terminal to make the drive enter the fire mode to force the drive to run. If the drive is in stop status, enable this terminal to make the drive enter the fire mode to force the drive to run according to P06.80 settings. (Refer to P06.80, P06.81, P06.88 for details).</td></tr>
</table>

Setting	Function	Description
59	Enable fire mode (without RUN command)	When fire occurs, enable this terminal to make the drive enter the fire mode. If the drive is in stop status, enable this terminal to make the drive enter the fire mode, but the drive does not run. If the drive is in running status, enable this terminal to run the drive according to P06.80 settings. (Refer to P06.80, P06.81, P06.88 for details)
70	Force auxiliary frequency return to 0	Forces the auxiliary frequency return to 0 when using this function. PID keeps operating if PID is the master frequency. When P00.35 ≠ 0, the master and auxiliary frequencies are enabled, and then selecting this function with the terminal effectively forces the auxiliary frequency return to 0.
71	Disable PID function, force PID output return to 0	When the master and auxiliary frequencies are enabled and when using the PID function, ON: PID does not operate, returns the integral value to 0, and forces the PID output return to 0.
72	Disable PID function, retain the output value before disabled	When the master and auxiliary frequencies are enabled, and the PID function is enabled, ON: PID does not operate, and its output value remains the same as the value before it was disabled.
73	Force PID integral gain return to 0, disable integral	ON: PID continues to operate, disables the integral control, and returns the integral value to 0.
74	Reverse PID feedback	ON: PID negative feedback becomes positive feedback, or PID positive feedback becomes negative feedback.
81	Simple positioning zero point position signal input	Use this function as the trigger terminal for simple positioning with P02.78–P02.80. This function is just a simple positioning, so you must verify the positioning accuracy. Refer to P02.80 for details.
82	OOB loading balance detection	You can use the OOB (Out Of Balance Detection) function with a PLC program in a washing machine system type application. ON: Parameter P07.48 is calculated according to P07.46 (OOB Sampling Time) and P07.47 (Number of OOB Sampling Times). The PLC or the host controller should be set up to read this parameter and determine the motor's speed according to this Δθ value (P07.48).
83	Multi-motor (IM) selection bit 0	ON: parameters can be changed. Example: DI1 = 83, DI2 = 84
84	Multi-motor (IM) selection bit 1	

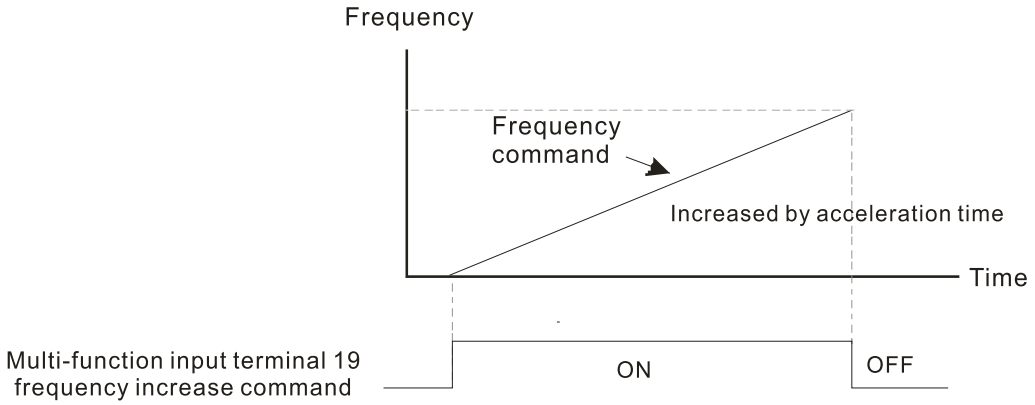
DI1	DI2	Motor Selection	Related Motor Parameter	
			Max Operation Frequency	V/F Curve Parameters
OFF	OFF	Motor 1	P01.00	P01.01–P01.08
ON	OFF	Motor 2	P01.52	P01.35–P01.42
OFF	ON	Motor 3	P01.53	P01.54–P01.61
ON	ON	Motor 4	P01.62	P01.63–P01.70

		Type	Hex Addr	Dec Addr
P02.09	**UP / DOWN Key Mode**	♦R/W	0209	40522
Range/Units (Format: 16-bit binary)		Default		
0: UP / DOWN by the acceleration / deceleration time 1: UP / DOWN constant speed (P02.10) 2: Pulse signal (P02.10) 3: External terminals UP / DOWN key mode		0		

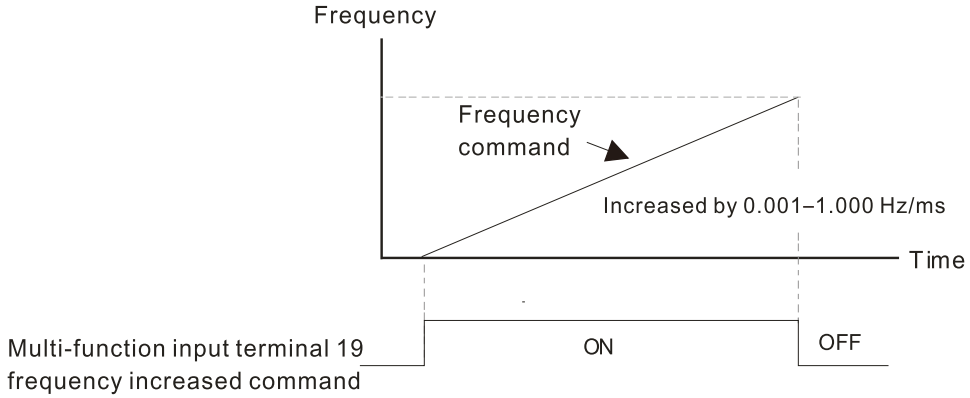
		Type	Hex Addr	Dec Addr
P02.10	**Constant Speed, Acceleration / Deceleration Speed of the UP / DOWN Key**	♦R/W	020A	40523
Range/Units (Format: 16-bit unsigned)		Default		
0.001–1.000 Hz / ms		0.001		

These parameters are used when the multi-function input terminals are set to 19, 20 (Digital UP / DOWN command). The frequency increases or decreases according to P02.09 and P02.10.

- *When P11.00 bit 7 = 1, the frequency is not saved. The Frequency command returns to zero when the drive stops, and the displayed frequency is 0.00 Hz. At this time, increasing or decreasing the Frequency command (F) by using the UP or DOWN key is valid only when the drive is running.*
- *When P02.09 is set to 0, the increasing or decreasing Frequency command (F) operates according to the setting for acceleration or deceleration time (refer to P01.12–P01.19).*



- *When P02.09 is set to 1, the increasing or decreasing Frequency command (F) operates according to the setting of P02.10 (0.001–1.000 Hz/ms).*



		Type	Hex Addr	Dec Addr
P02.11	**Multi-function Input Response Time**	♦R/W	020B	40524
Range/Units (Format: 16-bit unsigned)		Default		
0.000–30.000 sec.		0.005		

Use P02.11 to set the response time of the digital input terminals DI1–DI7.

This function is to delay and confirm the digital input terminal signal. The time for delay is also the time for confirmation. The confirmation prevents interference that could cause error in the input to the digital terminals. It delays the response time though confirmation to improve accuracy.

		Type	Hex Addr	Dec Addr
P02.12	**Multi-function Input Mode Selection**	♦R/W	020C	40525
Range/Units (Format: 16-bit unsigned)		Default		
0000h–FFFFh (0: N.O.; 1: N.C.)		0000		

The parameter value will be displayed/entered in decimal format on the drive keypad or in GSoft2. If using the GS4-KPD, the value will be displayed/entered in hexadecimal format. This parameter sets the status of the multi-function input signal (0: normally open, 1: normally closed) and it is not affected by the status of SINK / SOURCE.

- *bit 0–bit 6 correspond to DI1–DI7.*
- *The default for bit 0 (DI1) is FWD terminal, and the default for bit 1 (DI2) is REV terminal. You cannot use this parameter to change the input mode when P02.00 ≠ 0.*
- *You can change the terminal ON / OFF status through communications.*
- *For example: DI3 is set to 1 (multi-step speed command 1) and DI4 is set to 2 (multi-step speed command 2). Then the forward + second step speed command = 1001 (binary) = 9 (decimal). As long as P02.12 = 9 is set through communications, there is no need to wire any multi-function terminal to run forward with the second step speed.*

bit 6	***bit 5***	***bit 4***	***bit 3***	***bit 2***	***bit 1***	***bit 0***
DI7	DI6	DI5	DI4	DI3	DI2	DI1

- *Use P11.42 bit 1 to select whether FWD / REV terminal is controlled by P02.12 bit 0 and bit 1.*

		Type	Hex Addr	Dec Addr	Default
P02.13	**Multi-function Output 1 (R1)**	♦R/W	020D	40526	11
P02.16	**Multi-function Output 2 (DO1)**	♦R/W	0210	40529	0
P02.17	**Multi-function Output 3 (DO2)**	♦R/W	0211	40530	0

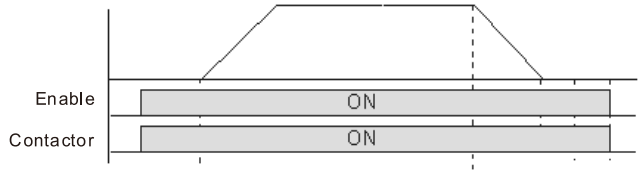
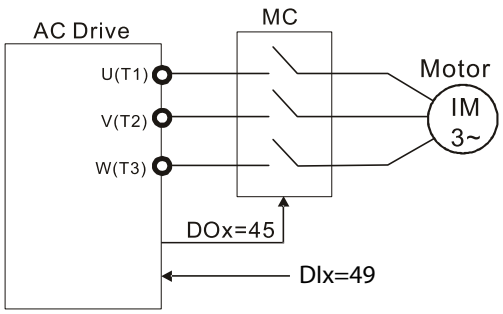
Range/Units (Format: 16-bit binary)

0: No function
1: Indication during RUN
2: Operation speed reached
3: Desired frequency reached 1 (P02.22)
4: Desired frequency reached 2 (P02.24)
5: Zero speed (Frequency command)
6: Zero speed including STOP (Frequency command)
7: Over-torque 1 (P06.06–06.08)
8: Over-torque 2 (P06.09–06.11)
9: Drive is ready
10: Low voltage warning (Lv) (P06.00)
11: Malfunction indication
13: Overheat warning (P06.15)
14: Software brake signal indicator (P07.00)
15: PID feedback error (P08.13, P08.14)
16: Slip error (oSL)
17: Count value reached, does not return to 0 (P02.20)
18: Count value reached, return to 0 (P02.19)
19: External interrupt B.B. input (Base Block)
20: Warning output
21: Over-voltage
22: Over-current stall prevention
23: Over-voltage stall prevention
24: Operation mode
25: Forward command
26: Reverse command
29: Output when frequency ≥ P02.34
30: Output when frequency < P02.34
31: Y-connection for the motor coil
32: Δ-connection for the motor coil
33: Zero speed (actual output frequency)
34: Zero speed including STOP (actual output frequency)
35: Error output selection 1 (P06.23)
36: Error output selection 2 (P06.24)
37: Error output selection 3 (P06.25)
38: Error output selection 4 (P06.26)
40: Speed reached (including STOP)
42: Crane function
43: Motor speed detection
44: Low current output (use with P06.71–06.73)
45: UVW output electromagnetic valve switch
46: Master dEb output
51: Digital output control for serial modbus
52: Digital output control for communication card
53: Fire mode indication
66: SO output logic A
67: Analog input level reached
68: SO output logic B
73: Over-torque 3
74: Over-torque 4
75: Forward RUN status
76: Reverse RUN status

Use these parameters to set the function of multi-function terminals.

Summary of Function Settings

Setting	Function	Description
0	No Function	Output terminal with no function
1	Indication during RUN	Activates when the drive is not in STOP.
2	Operation speed reached	Activates when output frequency of drive reaches to the setting frequency.
3	Desired frequency reached 1 (P02.22)	Activates when the desired frequency (P02.22) is reached.
4	Desired frequency reached 2 (P02.24)	Activates when the desired frequency (P02.24) is reached.
5	Zero speed (Frequency command)	Activates when Frequency command = 0. (the drive must be in RUN status)
6	Zero speed including STOP (Frequency command)	Activates when Frequency command = 0 or stopped.
7	Over-torque 1	Activates when the drive detects over-torque. P06.07 sets the over-torque detection level (motor 1), and P06.08 sets the over-torque detection time (motor 1). Refer to P06.06–P06.08.
8	Over-torque 2	Activates when the drive detects over-torque. P06.10 sets the over-torque detection level (motor 2), and P06.11 sets the over-torque detection time (motor 2). Refer to P06.09–P06.11.
9	Drive is ready	Activates when the drive is ON with no error detected.
10	Low voltage warning (Lv)	Activates when the DC bus voltage is too low. (refer to P06.00 Low Voltage Level)
11	Malfunction indication	Activates when fault occurs (except Lv stop).
13	Overheat warning	Activates when IGBT or heat sink overheats to prevent the drive from shutting down due to overheating. (refer to P06.15)
14	Software brake signal indication	Activates when the soft brake function is ON. (refer to P07.00).
15	PID feedback error (P08.13, P08.14)	Activates when the PID feedback signal error is detected.
16	Slip error (oSL)	Activates when the slip error is detected.
17	Count value reached, does not return to 0 (P02.20)	When the drive executes external counter, this contact activates if the count value is equal to the setting value for P02.20. This contact deactivates when the setting value for P02.20 > P02.19.
18	Count value reached, returns to 0 (P02.19)	When the drive executes the external counter, this contact activates if the count value is equal to the setting value for P02.19.
19	External interrupt B.B. input (Base Block)	Activates when external interrupt (B.B.) stop output occurs in the drive.
20	Warning output	Activates when a warning is detected.
21	Over-voltage	Activates when over-voltage is detected.
22	Over-current stall prevention	Activates when the over-current stall prevention is detected.
23	Over-voltage stall prevention	Activates when over-voltage stall prevention is detected.
24	Operation mode	Activates when the source of operation command is not controlled by the digital keypad (P00.21 ≠ 0).
25	Forward command	Activates when the operation direction is forward.
26	Reverse command	Activates when the operation direction is reverse.
29	Output when frequency ≥ P02.34	Activates when frequency is ≥ P02.34 (actual output H ≥ P02.34).
30	Output when frequency < P02.34	Activates when frequency is < P02.34 (actual output H < P02.34).
31	Y-connection for the motor coil	Activates when P05.24 = 1, the frequency output is lower than P05.23 minus 2 Hz and the time is longer than P05.25.
32	Δ-connection for the motor coil	Activates when P05.24 = 1, the frequency output is higher than P05.23 plus 2 Hz and the time is longer than P05.25.

Setting	Function	Description
33	Zero speed (actual output frequency)	Activates when the actual output frequency is 0 (the drive is in RUN mode).
34	Zero speed including stop (actual output frequency)	Activates when the actual output frequency is 0 or stopped.
35	Error output selection 1 (P06.23)	Activates when P06.23 is ON.
36	Error output selection 2 (P06.24)	Activates when P06.24 is ON.
37	Error output selection 3 (P06.25)	Activates when P06.25 is ON.
38	Error output selection 4 (P06.26)	Activates when P06.26 is ON.
40	Speed reached (including Stop)	Activates when the drive's output frequency reaches the setting frequency or stopped.
42	Crane function	Use this function with P02.34 and P02.58. Refer to P02.34 and P02.58 for details and application examples.
43	Actual motor speed detection	Activates when using the DI7 as pulse input signal and motor actual speed is less than P02.47.
44	Low current output	Use this function with P06.71–P06.73.
45	UVW output electromagnetic valve switch	Use this function with any multifunction input = 49 (drive enabled) and multifunction output = 45 (electromagnetic valve enabled), and then the electromagnetic valve is ON or OFF according to the status of the drive.  
46	Master dEb output	When dEb rises at the master, DO1 or DO2 sends a dEb signal to the slave. Output the message when the master triggers dEb. This ensures that the slave also triggers dEb. Then the slave follows the deceleration time of the master to stop simultaneously with the master.
51 52	Digital output control for serial modbus Digital output control for communication card	Control the digital outputs through communications(51= Serial Modbus, 52 = GS20A-CM-ENETIP). Use Register 2640 to set the Output value.

Physical terminal	Parameter Setting	Attribute	Corresponding index
R1	P02.13 = 51 or 52	RW	bit 0 of 2640
DO1	P02.16 = 51 or 52	RW	bit 3 of 2640
DO2	P02.17 = 51 or 52	RW	bit 4 of 2640

53	Fire mode indication	Activates when DI setting 58 or 59 is enabled.

<table>
<tr><th>Setting</th><th>Function</th><th>Description</th></tr>
<tr><td>66</td><td>SO output logic A</td><td rowspan="2"><table>
<tr><th rowspan="2">Status of the drive</th><th colspan="2">Status of the safety output</th></tr>
<tr><th>Status A (DOx = 66)</th><th>Status B (DOx = 68)</th></tr>
<tr><td>Normal</td><td>0</td><td>1</td></tr>
<tr><td>STO</td><td>1</td><td>0</td></tr>
<tr><td>STL1–STL3</td><td>1</td><td>0</td></tr>
</table></td></tr>
<tr><td>68</td><td>SO output logic B</td></tr>
<tr><td>67</td><td>Analog input level reached</td><td>The multi-function output terminals operate when the analog input level is between the high level and the low level.
P03.44: Select one of the analog input channels (AI1, AI2) to be compared.
P03.45: The high level for the analog input, default is 50%.
P03.46: The low level for the analog input, default is 10%.
If analog input > P03.45, the multi-function output terminal operates. If analog input < P03.46, the multi-function output terminal stops output.</td></tr>
<tr><td>73</td><td>Over-torque 3</td><td>Activates when over-torque is detected. P14.75 sets the over-torque detection level. P14.76 sets the over-torque detection time (refer to P14.74–P14.76).</td></tr>
<tr><td>74</td><td>Over-torque 4</td><td>Activates when over-torque is detected. P14.78 sets the over-torque detection level. P14.79 sets the over-torque detection time (refer to P14.77–P14.79).</td></tr>
<tr><td>75</td><td>Forward RUN status</td><td>When the drive runs FWD, the output terminal for forward running is closed; when the drive stops, the output terminal for forward running is open.</td></tr>
<tr><td>76</td><td>Reverse RUN status</td><td>When the drive runs REV, the output terminal for reverse running is closed; when the drive stops, the output terminal for reverse running is open.</td></tr>
</table>

P02.18	Multi-function Output Direction	Type	Hex Addr	Dec Addr
		♦R/W	0212	40531
Range/Units (Format: 16-bit unsigned)		Default		
0000h–FFFFh (0:N.O.; 1:N.C.)		0000h		

The parameter value will be displayed/entered in decimal format on the drive keypad or in GSoft2. If using the GS4-KPD, the value will be displayed/entered in hexadecimal format. This parameter is set by a bit. If the bit is 1, the corresponding multi-function output acts in an opposite way.

Example:

Assume P02.13 = 1. If the output is positive, and the bit is set to 0, then the Relay is ON when the drive runs and is OFF when the drive stops. Conversely, if the output is negative, and the bit is set to 1, then the Relay is OFF when the drive runs and is ON when the drive stops.

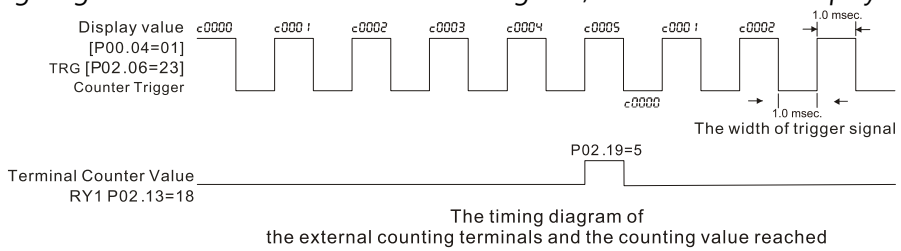
bit 4	bit 3	bit 2	bit 1	bit 0
DO2	DO1	Reserved	Reserved	R1

NOTE: Use this parameter to set digital outputs ON/OFF with remote communications.

P02.19	Terminal Counting Value Reached (returns to 0)	Type	Hex Addr	Dec Addr
		♦R/W	0213	40532
Range/Units (Format: 16-bit unsigned)		Default		
0–65500		0		

The counting function is enabled when P02.19≠0.

- *You can set the input point for the counter using the multifunction input terminal DI6 as a trigger terminal (set P02.06 to 23). When counting is completed, the specified multi-function output terminal is activated (P02.13, P02.16, or P02.17 is set to 18).*
- *The timing diagram below shows that when counting to 5, R1 activates and displays 0.*

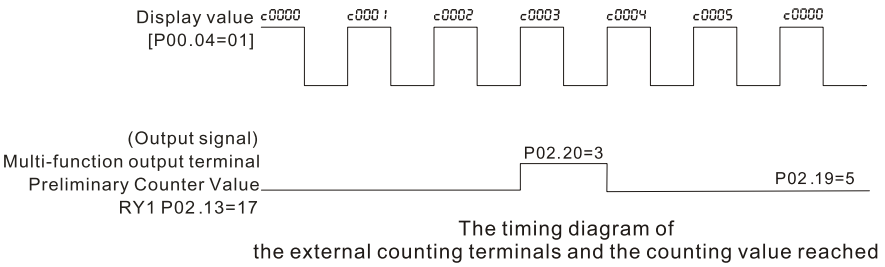


The timing diagram of
the external counting terminals and the counting value reached

P02.20	Preliminary Counting Value Reached (does not return to 0)	Type	Hex Addr	Dec Addr
		♦R/W	0214	40533
Range/Units (Format: 16-bit unsigned)		Default		
0–65500		0		

Use this parameter in conjuction with P02.19.

- *When the count value counts from 1 to reach this value, the corresponding multi-function output terminal is activated (P02.13, P02.16, or P02.17 is set to 17) and keeps counting to the last count value.*
- *Use this parameter as the end of counting to make the drive run from the low speed to stop.*
- *The timing diagram is R1 activates when the count value is three, and the display returns to zero when counts to five:*



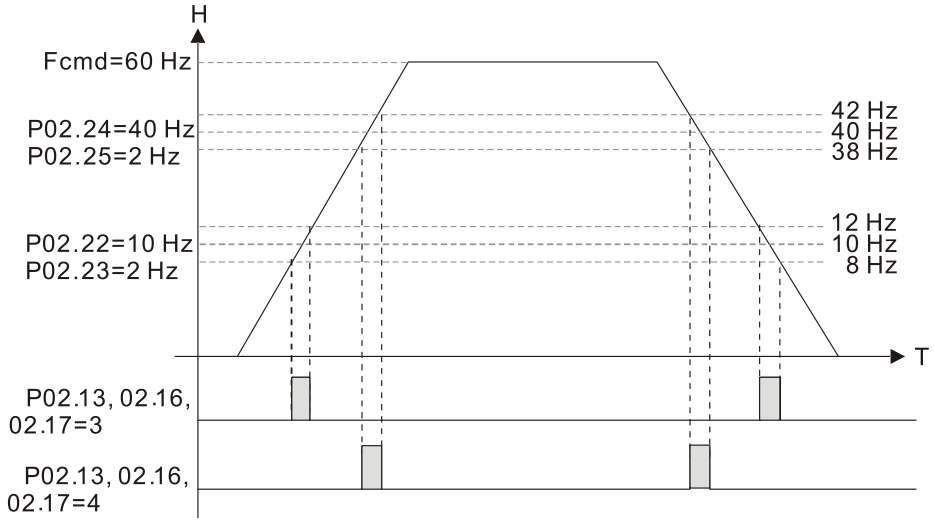
The timing diagram of
the external counting terminals and the counting value reached

		Type	Hex Addr	Dec Addr
P02.21	***Digital Output Gain (DO)***	♦R/W	0215	40534
Range/Units (Format: 16-bit unsigned)		*Default*		
1–55		1		

P02.21 sets the signal for the digital output terminals (DO-DCM) and the digital frequency output (pulse, work period=50 %). The output pulse per second = output frequency X P02.21.

		Type	Hex Addr	Dec Addr	Default
P02.22	***Desired Frequency Reached 1***	♦R/W	0216	40535	60.00/50.00
P02.23	***The Width of the Desired Frequency Reached 1***	♦R/W	0217	40536	2.00
P02.24	***Desired Frequency Reached 2***	♦R/W	0218	40537	60.00/50.00
P02.25	***The Width of the Desired Frequency Reached 2***	♦R/W	0219	40538	2.00
Range/Units (Format: 16-bit unsigned)					
0.00–599.00 Hz					

Use these parameters to close multi-function output terminals when the specified conditions are met. Once the output speed (frequency) reaches the desired speed (frequency), if the corresponding multi-function output terminal is set to 3 or 4 (P02.13, P02.16, and P02.17), this multi-function output terminal is “closed”.

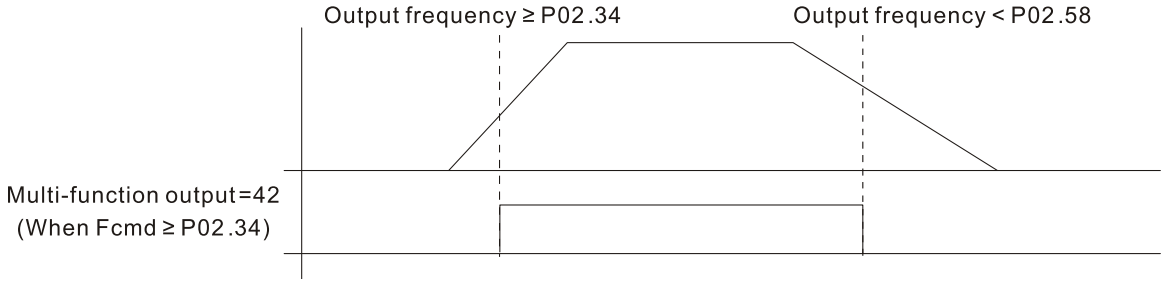


		Type	Hex Addr	Dec Addr
P02.34	***Output Frequency Setting for Multi-function Output Terminal***	♦R/W	0222	40547
P02.58	***Multi-function Output Terminal (Function 42): Brake Frequency Check Point***	♦R/W	023A	40571
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–599.00 Hz		0.00		

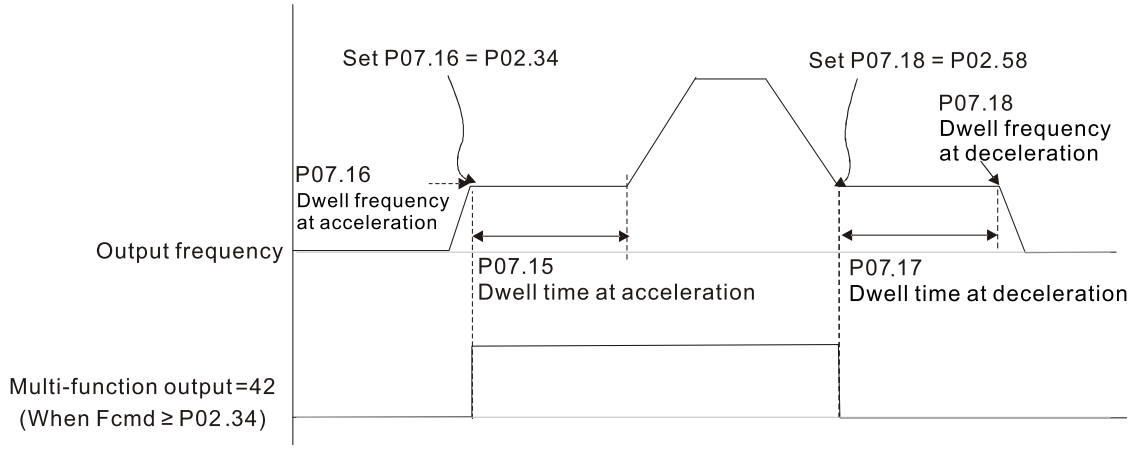
Use P02.34 with P02.58 for the crane function. Configure multifunction outputs P02.14, P02.16, and/or P02.17 with a terminal setting of 42: Crane function.

- *When the output frequency (H) is lower than the setting for P02.58, multi-function output terminal setting 42 stops after the command breaks off.*
- *P02.58 must be lower than P02.34 when using multifunction output terminal setting=42.*

Crane application example:



It is recommended that you use this with the Dwell acceleration/deceleration function as shown in the following diagram.



		Type	Hex Addr	Dec Addr
P02.35	**External Operation Control Selection after Reset and Reboot**	♦R/W	0223	40548
Range/Units (Format: 16-bit binary)		*Default*		
0: Disable 1: Drive runs if the RUN command remains after reset or reboot.		0		

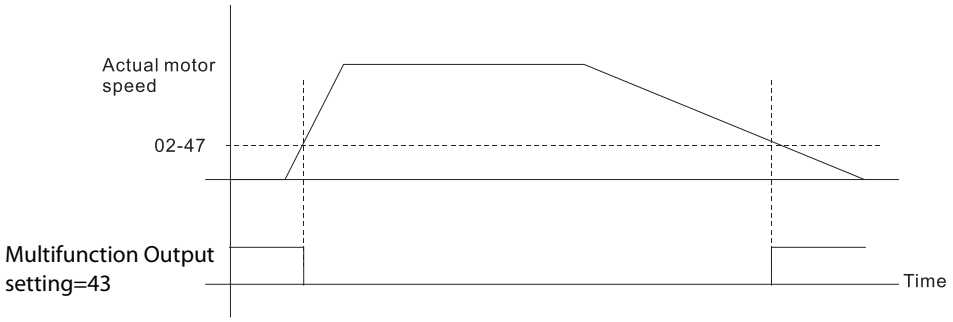
P02.35 allows the drive to resume running after a reset or reboot if an external control is still commanding it to RUN.

Setting value 1:

- *Situation 1: After the drive is powered up and the external terminal for RUN stays ON, the drive runs.*
- *Situation 2: After clearing a detected fault and while the external terminal for RUN stays ON, you can run the drive by pressing the RESET key.*

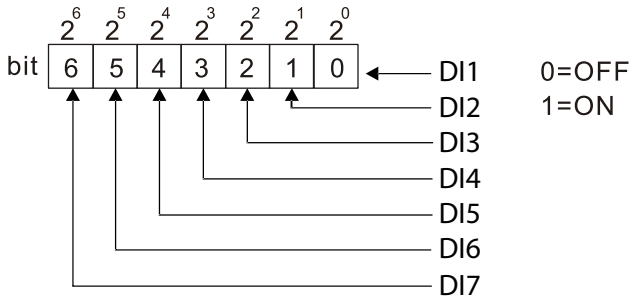
		Type	Hex Addr	Dec Addr
P02.47	**Motor Zero-speed Level**	♦R/W	022F	40560
Range/Units (Format: 16-bit unsigned)		*Default*		
0–65535 rpm		0		

Use this parameter with multifunction output=43 and set P10.00=5. Use this parameter to set the motor's speed level to zero-speed. When the actual speed is lower than this setting, the corresponding multi-function output terminal setting 43 is ON, as shown in the diagram below.



		Type	Hex Addr	Dec Addr
P02.50	**Display the Status of Multi-function Input Terminal**	Read	0232	40563
Range/Units (Format: 16-bit unsigned)		*Default*		
Monitor the status of the Multi-function Input Terminal		0		

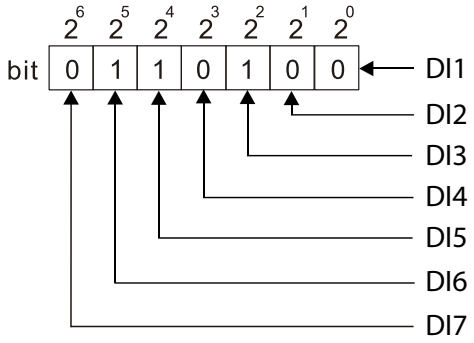
P02.50 displays the status of the multi-function input terminals. Use the diagram below to interpret the display. The value will display in decimal on the keypad and must be converted to binary.



NOTE
$2^6 = 64$ $2^5 = 32$ $2^4 = 16$
$2^3 = 8$ $2^2 = 4$ $2^1 = 2$ $2^0 = 1$

Example:

When P02.50 displays 0034h (hex) (52 (decimal) and 0110100 (binary)), it means that DI3, DI5 and DI6 are ON.



0=OFF
1=ON

Setting

$= \text{bit } 5 \times 2^5 + \text{bit } 4 \times 2^4 + \text{bit } 2 \times 2^2$

$= 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^2$

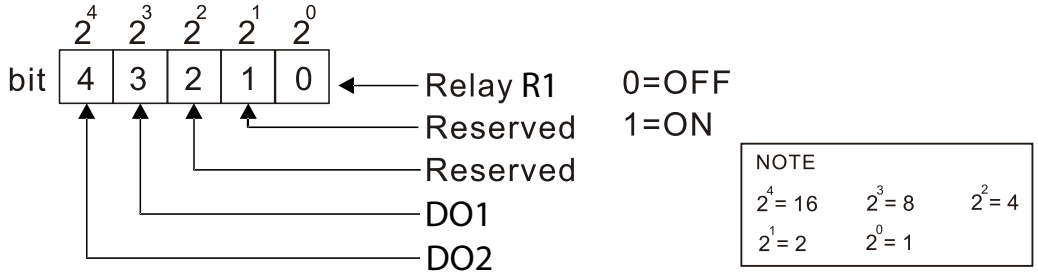
$= 32 + 16 + 4$

$= 52$

NOTE
$2^6 = 64$ $2^5 = 32$ $2^4 = 16$
$2^3 = 8$ $2^2 = 4$ $2^1 = 2$ $2^0 = 1$

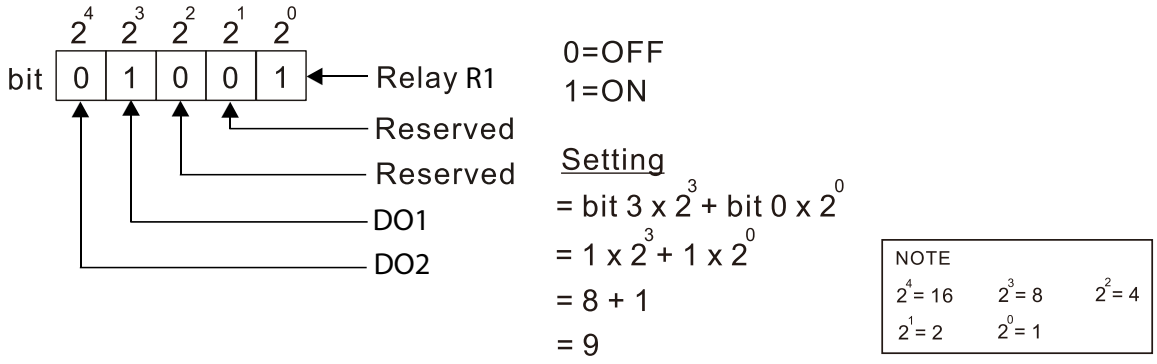
	Type	Hex Addr	Dec Addr
P02.51 **Display the Status of Multi-function Output Terminal**	Read	0233	40564
Range/Units (Format: 16-bit unsigned)	Default		
Monitor the status of the Multi-function Ouput Terminal	0		

P02.51 displays the status of the multi-function output terminals. Use the diagram below to interpret the display. The value will display in decimal on the keypad and must be converted to binary.



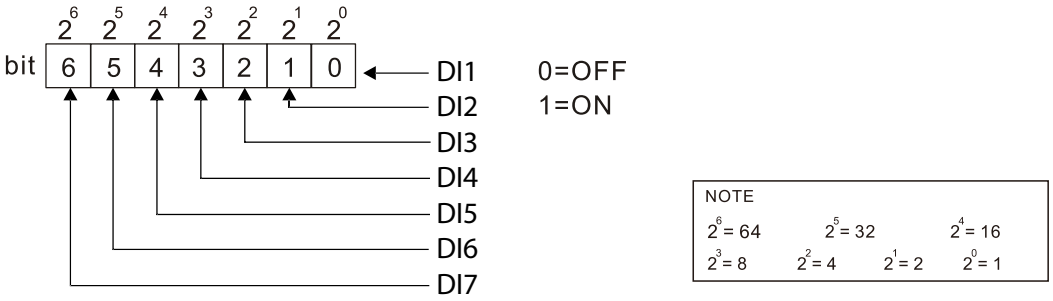
Example:

When P02.51 displays 0009h (hex) (9 (decimal) and 01001 (binary)), it means that Relay R1 and DO1 are ON.



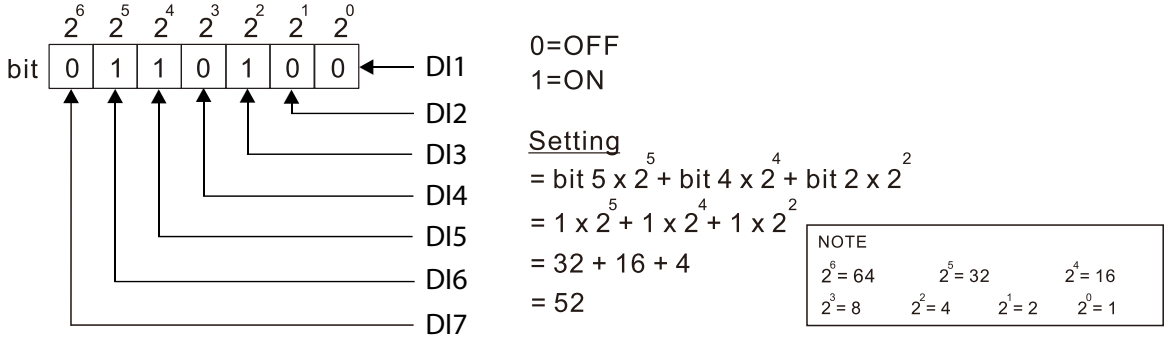
	Type	Hex Addr	Dec Addr
P02.52 **Display the External Multi-function Input Terminals Used by PLC**	Read	0234	40565
Range/Units (Format: 16-bit unsigned)	Default		
Monitor which inputs are controlled by the PLC	0		

P02.52 displays the mask status of the PLC input terminals. These values indicate if the input is controlled by the PLC or drive. Use the diagram below to interpret the display. The value will display in decimal on the keypad and must be converted to binary.



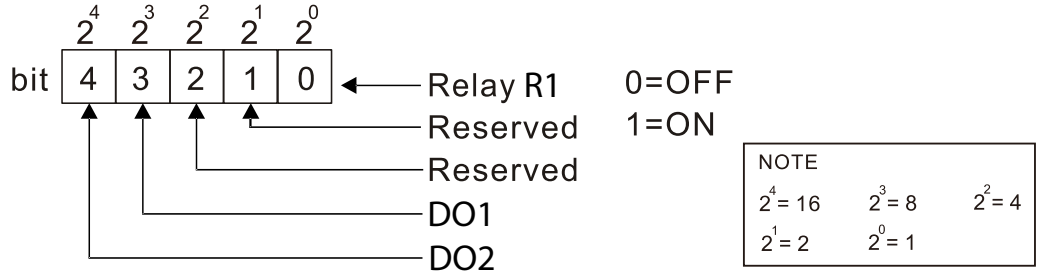
Example:

When P02.52 displays 0034h (hex) (52 (decimal) and 0110100 (binary)), it means that DI3, DI5 and DI6 are used by PLC.



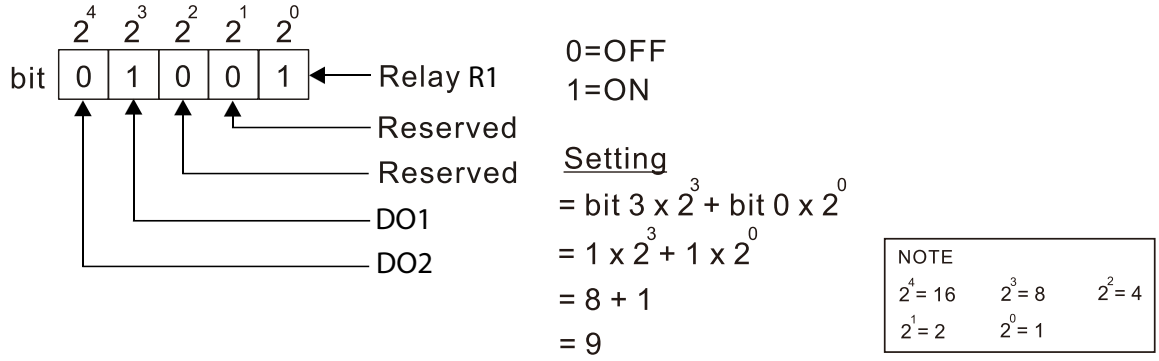
		Type	Hex Addr	Dec Addr
P02.53	***Display the External Multi-function Output Terminals Used by PLC***	Read	0235	40566
Range/Units (Format: 16-bit unsigned)		*Default*		
Monitor which outputs are controlled by the PLC		0		

P02.53 displays the mask status of the PLC output terminals. These values indicate if the output is controlled by the PLC or Drive. Use the diagram below to interpret the display. The value will display in decimal on the keypad and must be converted to binary.



Example:

When P02.53 displays 0009h (hex) (9 (decimal) and 01001 (binary)), it means that Relay R1 and DO1 are used by PLC.



	Type	Hex Addr	Dec Addr
P02.54 **Display the Frequency Command Executed by External Terminal**	Read	0236	40567
Range/Units (Format: 16-bit unsigned)	Default		
0.00–599.00 Hz (Read only)	0		

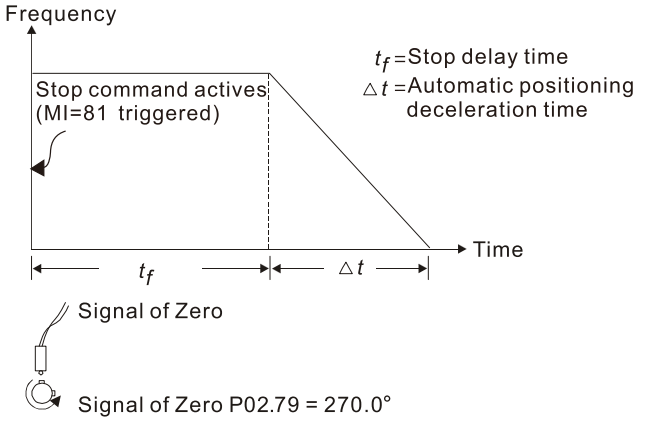
When you set the source of the Frequency command as the external terminal, if LV or Fault occurs, the external terminal Frequency command is saved in this parameter.

	Type	Hex Addr	Dec Addr
P02.78 **Motor Deceleration Ratio**	R/W	024E	40591
Range/Units (Format: 16-bit unsigned)	Default		
4.0–1000.0	200.0		

	Type	Hex Addr	Dec Addr
P02.79 **Automatic Positioning Angle Setting**	R/W	024F	40592
Range/Units (Format: 16-bit unsigned)	Default		
0.0–6480.0	180.0		

	Type	Hex Addr	Dec Addr
P02.80 **Automatic Positioning Deceleration Time**	♦R/W	0250	40593
Range/Units (Format: 16-bit unsigned)	Default		
0.00: Disable the function 0.01–100.00 sec.	0.00		

- *Automatic positioning function is disabled when P02.80=0.00.*
- *Use this parameter with the multi-function input terminal setting 81 (Simple positioning zero point position signal input) to complete the positioning setting for application.*
- *tf automatically generates according to the positioning angle. Δt=P02.80. The gross area* (tf + Δt) is the required distance of the positioning.



	Type	Hex Addr	Dec Addr
P02.81 **EF Activates when the Terminal Count Value Reached**	♦R/W	0251	40594
Range/Units (Format: 16-bit binary)	Default		
0: Terminal count value reached, no EF displays (continues to operate) 1: Terminal count value reached, EF activates	0		

	Type	Hex Addr	Dec Addr
P02.82 **Initial Frequency Command (F) Mode after Stop**	♦R/W	0252	40595
Range/Units (Format: 16-bit binary)	Default		
0: Use current Frequency command 1: Use zero Frequency command 2: Refer to P02.83 to set up	0		

		Type	Hex Addr	Dec Addr
P02.83	**Initial Frequency Command (F) Setting after Stop**	♦R/W	0253	40596
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		60.00		

Group P03.xx Details – Analog Input/Output Parameters

		Type	Hex Addr	Dec Addr	Default
P03.00	**Analog Input Selection (AI1))**	♦R/W	0300	40769	1
P03.01	**Analog Input Selection (AI2)**	♦R/W	0301	40770	0

Range/Units (Format: 16-bit binary)

0: No function
1: Frequency command
2: Torque command (torque limit under speed mode)
3: Torque compensation command
4: PID target value
5: PID feedback signal
6: Thermistor (PTC) input value
7: Positive torque limit
8: Negative torque limit
9: Regenerative torque limit
10: Positive / negative torque limit
11: PT100 RTD input value
12: Auxiliary frequency input
13: PID compensation value

When using the analog analog input as the PID reference target, you must set P00.20 to 2 (external analog input).

- *Setting method 1: P03.00–P03.01 set 1 as PID reference target input.*
- *Setting method 2: P03.00–P03.01 set 4 as PID reference target input.*

If both setting value 1 and 4 are input, the AI1 input has highest priority to become the PID reference target input value.

- *When you use analog input as the PID compensation value, you must set P08.16 to 1 (source of PID compensation value is analog input). You can see the compensation value with P08.17.*
- *When using the Frequency command, the corresponding value for 0–10 V / 4–20 mA is 0–maximum operation frequency (P01.00).*
- *When using the torque command, the corresponding value for 0–10 V / 4–20 mA is 0–maximum output torque (P11.27).*
- *When using torque compensation, the corresponding value for 0–10 V / 4–20 mA is 0–the motor's rated torque.*
- *If the settings for P03.00–P03.01 are the same, the AI1 input has priority over the AI2 input.*
- *For use of Selection 2 as Torque limit , a multifunction input must be set to value 26 (TQC/FOC mode selection) to toggle between Torque command and Torque limit mode.*

		Type	Hex Addr	Dec Addr
P03.03	**Analog Input Bias (AI1)**	♦R/W	0302	40771
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0 %		0		

P03.03 sets the corresponding AI1 voltage for the external analog input. P03.50 must be set to zero for this parameter to be active. See analog input examples at the end of this section for further explanation of bias/gain settings.

		Type	Hex Addr	Dec Addr
P03.04	**Analog Input Bias (AI2)**	♦R/W	0303	40772
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0 %		0		

P03.04 sets the corresponding AI2 voltage for the external analog input. P03.50 must be set to zero for this parameter to be active. See analog input examples at the end of this section for further explanation of bias/gain settings.

		Type	Hex Addr	Dec Addr
P03.07	**Positive / Negative Bias Mode (AI1)**	♦R/W	0304	40773
P03.08	**Positive / Negative Bias Mode (AI2)**	♦R/W	0308	40777
Range/Units (Format: 16-bit binary)		Default		
0: No bias 1: Lower than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center		0		

Using negative bias to set the frequency greatly reduces noise interference. In a noisy environment, do NOT use signals less than 1V to set the drive's operation frequency. P03.50 must be set to zero for these parameters to be active. See analog input examples at the end of this section for further explanation of bias/gain settings.

		Type	Hex Addr	Dec Addr
P03.10	**Reverse Setting when Analog Signal Input is Negative Frequency**	♦R/W	030A	40779
Range/Units (Format: 16-bit binary)		Default		
0: Negative frequency input is not allowed. The digital keypad or external terminal controls the forward and reverse direction. 1: Negative frequency input is allowed. Positive frequency = run in a forward direction; negative frequency = run in a reverse direction. The digital keypad or external terminal control cannot change the running direction.		0		

Use this parameter only for AI1 or AI2 analog input.

Requirements for negative frequency (reverse running):

1) P03.10 = 1
2) P03.07/P03.08 Bias mode = 4: Bias serves as the center
3) P03.11/P03.12 analog input gain < 0 (negative); this makes the input frequency negative. When using the analog input addition function (P03.18=1), if the analog signal is negative after the addition, you can set this parameter to allow or not allow the reverse running. The result after adding depends on the "Requirements for negative frequency (reverse running)".

P03.50 must be set to zero for this parameter to be active.

See analog input examples at the end of this section for further explanation of bias/gain settings.

		Type	Hex Addr	Dec Addr
P03.11	**Analog Input Gain (AI1)**	♦R/W	030B	40780
P03.12	**Analog Input Gain (AI2)**	♦R/W	030C	40781
Range/Units (Format: 16-bit signed)		Default		
-500.0–500.0 %		100.0		

P03.03–P03.12 are used when the Frequency command source is the analog voltage or current signal. P03.50 must be set to zero for these parameters to be active.

See analog input examples at the end of this section for further explanation of bias/gain settings.

		Type	Hex Addr	Dec Addr
P03.15	**Analog Input Filter Time (AI1)**	♦R/W	030F	40784
P03.16	**Analog Input Filter Time (AI2)**	♦R/W	0310	40785
Range/Units (Format: 16-bit signed)		Default		
0.00–20.00 sec.		0.01		

Analog signals, such as those entering AI2 and AI2, are commonly affected by interference that affects the stability of the analog control. Use the Input Noise Filter to create a more stable system.

- *When the time constant setting is too large, the control is stable but the control response is slow.*
- *When the time constant setting is too small, the control response is faster but the control may be unstable.*
- *For optimal setting, adjust the setting based on the control stability or the control response.*

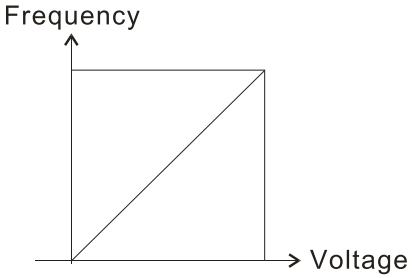
		Type	Hex Addr	Dec Addr
P03.18	**Analog Input Addition Function**	♦R/W	0312	40787
Range/Units (Format: 16-bit binary)		Default		
0: Disable (AI1, AI2)		0		
1: Enable				

Enables the analog input addition function when P03.18=1:

Example:

P03.00 = P03.01 = 1, Frequency command = AI1 + AI2

When P03.18=0 and the analog input selection settings (P03.00 and P03.01) are the same, AI1 has priority over AI2. For example, when P03.00 and P03.01 are both set to 1 (Frequency command), the drive ignores the setting value from AI2 but executes the Frequency command according to the setting value from AI1.



$$\text{F command}=[(\text{ay}\pm\text{bias})*\text{gain}]*\frac{\text{Fmax (P01.00)}}{\text{10V or 16mA or 20mA}}$$

F command: the corresponding frequency for 10V or 20mA
ay: 0–10 V, 4–20 mA, 0–20 mA
bias: P03.03, P03.04
gain: P03.11, P03.12

		Type	Hex Addr	Dec Addr
P03.19	**Signal Loss Selection for the Analog Input 4–20 mA**	R/W	0313	40788
Range/Units (Format: 16-bit binary)		Default		
0: Disable		0		
1: Continue operation at the last frequency				
2: Decelerate to 0Hz				
3: Stop immediately and display "ACE"				

Determines the treatment when the 4–20 mA signal is lost (AI2 (P03.29 = 0)).

- *When P03.29 ≠ 0, the voltage input to AI2 terminal is 0–10 V or 0–20 mA, and P03.19 is invalid.*
- *When the setting is 1 or 2, the keypad displays the warning code "ANL". It keeps blinking until the AI2 signal is recovered.*
- *When the drive stops, the condition that causes the warning does not exist , so the warning automatically disappears.*

	Type	Hex Addr	Dec Addr
P03.20 Multi-function Output (A01)	♦R/W	0314	40789
Range/Units (Format: 16-bit binary)	*Default*		
0–23	0		

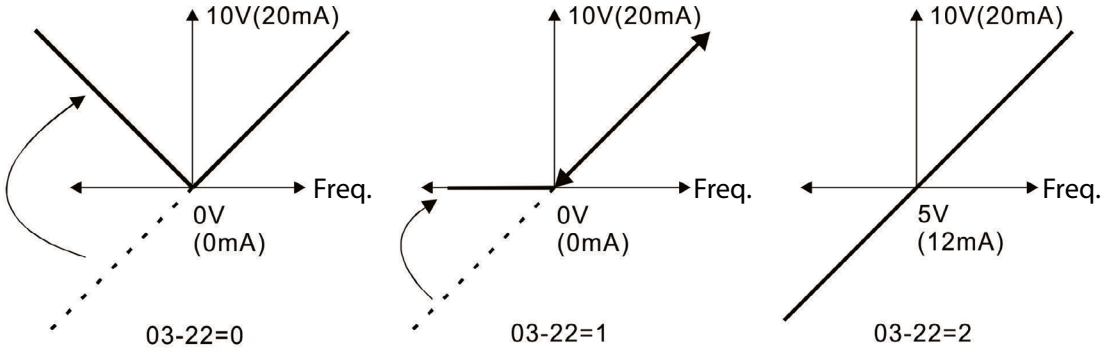
Summary of Function Settings

Setting	Function	Description
0	Output frequency (Hz)	Maximum frequency P01.00 is processed as 100 %.
1	Frequency command (Hz)	Maximum frequency P01.00 is processed as 100 %.
2	Motor speed (Hz)	Maximum frequency P01.00 is processed as 100 %.
3	Output current (rms)	(2.5 X drive rated current) is processed as 100 %.
4	Output voltage	(2 X motor rated voltage) is processed as 100 %.
5	DC bus voltage	120V/230V series: 450V = 100 % 460V series: 900V = 100 % 575V series: 1125V = 100 %
6	Power factor	-1.000–1.000 = 100 %
7	Power	(2 X drive rated power) is processed as 100 %.
8	Output torque	Full-load torque = 100 %
9	AI1	0–10 V = 0–100 %
10	AI2	4–20 mA = 0–100 %
12	Iq current command	(2.5 X drive rated current) is processed as 100 %.
13	Iq feedback value	(2.5 X drive rated current) is processed as 100 %.
14	Id current command	(2.5 X drive rated current) is processed as 100 %.
15	Id feedback value	(2.5 X rated current) is processed as 100 %.
16	Vq-axis voltage command	120V/230V series: 250V = 100 % 460V series: 500V = 100 % 575V series: 625V = 100 %
17	Vd-axis voltage command	120V/230V series: 250V = 100 % 460V series: 500V = 100 % 575V series: 625V = 100 %
18	Torque command	Motor rated torque = 100%
19	PG2 (DI7) frequency command	Maximum operation frequency (Pr.01-00) is processed as 100 %.
21	RS-485 analog output	For RS-485 (Modbus) control analog output Terminal: A01 — Address: 26A0H
22	Communication card analog output	For communication analog output (GS20A-CM-ENETIP)) Terminal: A01 — Address: 26A0H
23	Constant voltage output	P03.32 controls the voltage output level. 0–100 % of P03.32 corresponds to 0–10 V for A01.

	Type	Hex Addr	Dec Addr
P03.21 Analog Output Gain (A01)	♦R/W	0315	40790
Range/Units (Format: 16-bit unsigned)	*Default*		
0.0–500.0 %	100.0		

P03.21 adjusts the voltage level output to the analog meter from the analog signal (P03.20) output terminal A01 of the drive. See P03.27 for equation.

P03.22	Analog Output in REV Direction (A01)	Type	Hex Addr	Dec Addr
		♦R/W	0316	40791
Range/Units (Format: 16-bit binary)		Default		
0: Absolute value in output voltage 1: Reverse output 0 V; forward output 0–10 V 2: Reverse output 5-0 V; forward output 5–10 V		0		



P03.27	A01 Output Bias	Type	Hex Addr	Dec Addr
		♦R/W	031B	40796
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00 %		0.00		

This parameter sets the corresponding voltage of the analog output.

Example 1:

A01 0–10 V is set to the output frequency, the output equation is:

$$10\ V \times \left(\frac{\text{Output Frequency}}{\text{Pr.01-00}}\right) \times \text{Pr.03-21} + 10\ V \times \text{Pr.03-27}$$

Example 2:

A01 0–20 mA is set to the output frequency, the output equation is:

$$20\ mA \times \left(\frac{\text{Output Frequency}}{\text{Pr.01-00}}\right) \times \text{Pr.03-21} + 20\ mA \times \text{Pr.03-27}$$

Example 3:

A01 4–20 mA is set to the output frequency, the output equation is:

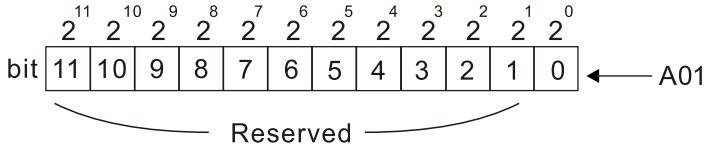
$$4\ mA + 16\ mA \times \left(\frac{\text{Output Frequency}}{\text{Pr.01-00}}\right) \times \text{Pr.03-21} + 16\ mA \times \text{Pr.03-27}$$

		Type	Hex Addr	Dec Addr
P03.28	**AI1 Terminal Input Selection**	♦R/W	031C	40797
Range/Units (Format: 16-bit binary)		Default		
0: 0–10 V (P03.63–P03.68 is valid) 3: -10–10 V (P03.69–P03.74 are valid)		0		

		Type	Hex Addr	Dec Addr
P03.29	**AI2 Terminal Input Selection**	♦R/W	031D	40798
Range/Units (Format: 16-bit binary)		Default		
0: 4–20 mA 1: 0–10 V 2: 0–20 mA		0		

When you change the input mode, verify that the external terminal switch (AI2) position is correct.

		Type	Hex Addr	Dec Addr
P03.30	**PLC Analog Output Terminal Status**	Read	031E	40799
Range/Units (Format: 16-bit unsigned)		Default		
Monitor the status of the PLC analog output terminals bit 0: A01		0		

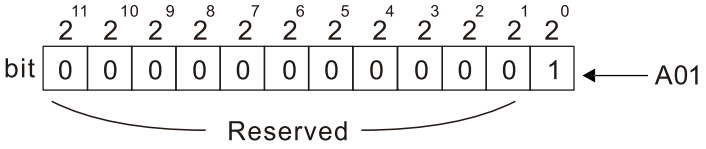


0=OFF
1=ON

NOTE
2^{11} = 2048 2^{10} = 1024 2^{9} = 512 2^{8} = 256
2^{7} = 128 2^{6} = 64 2^{5} = 32 2^{4} = 16
2^{3} = 8 2^{2} = 4 2^{1} = 2 2^{0} = 1

Example:

When P03.30 displays 0001 (hex) (1 (decimal) and 1 (binary)), it means that A01 is used by PLC..



Setting
= bit 0 x 2^{0}
= 1 x 1
= 1

0=OFF
1=ON

NOTE
2^{11} = 2048 2^{10} = 1024 2^{9} = 512 2^{8} = 256
2^{7} = 128 2^{6} = 64 2^{5} = 32 2^{4} = 16
2^{3} = 8 2^{2} = 4 2^{1} = 2 2^{0} = 1

		Type	Hex Addr	Dec Addr
P03.31	**A01 Output Selection**	♦R/W	031F	40800
Range/Units (Format: 16-bit binary)		*Default*		
0: 0–10 V output 1: 0–20 mA output 2: 4–20 mA output		0		

		Type	Hex Addr	Dec Addr
P03.32	**A01 DC Output Setting Level**	♦R/W	0320	40801
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–100.00 %		0.0		

		Type	Hex Addr	Dec Addr
P03.35	**A01 Output Filter Time**	♦R/W	0323	40804
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–20.00 sec.		0		

		Type	Hex Addr	Dec Addr
P03.39	**VR Input Selection (GS20 only)**	♦R/W	0327	40808
Range/Units (Format: 16-bit binary)		*Default*		
0: Disable 1: Frequency command		1		

VR is the abbreviation for Variable Resistor; it is the potentiometer of the integrated GS20 drive digital keypad. The VR can be selected for use in P00.20, P00.30, and P00.35 with setting 7: Digital Keypad VR/Potentiometer Dial (GS20 only). Applicable to GS20 models only - there is no VR on GS20X models.

		Type	Hex Addr	Dec Addr
P03.40	**VR Input Bias (GS20 only)**	♦R/W	0328	40809
Range/Units (Format: 16-bit signed)		*Default*		
-100–100 %		0.0		

		Type	Hex Addr	Dec Addr
P03.41	**VR Positive / Negative Bias (GS20 only)**	♦R/W	0329	40810
Range/Units (Format: 16-bit binary)		*Default*		
0: No bias 1: Lower than or equal to bias 2: Greater than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center		0		

		Type	Hex Addr	Dec Addr
P03.42	**VR Gain (GS20 only)**	♦R/W	032A	40811
Range/Units (Format: 16-bit signed)		*Default*		
-500.0–500.0 %		100.0		

		Type	Hex Addr	Dec Addr
P03.43	**VR Filter Time (GS20 only)**	R/W	032B	40812
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–2.00 sec.		0.01		

VR parameters are applicable to GS20 models only - there is no VR on GS20X models.

		Type	Hex Addr	Dec Addr
P03.44	**Multi-function Output (DOx) by AI Level Source**	♦R/W	032C	40813
Range/Units (Format: 16-bit binary)		Default		
0: AI1 1: AI2		0		

		Type	Hex Addr	Dec Addr
P03.45	**DOx - AI Upper Level**	♦R/W	032D	40814
Range/Units (Format: 16-bit signed)		Default		
-100–100 %		50		

		Type	Hex Addr	Dec Addr
P03.46	**DOx - AI Lower Level**	♦R/W	032E	40815
Range/Units (Format: 16-bit signed)		Default		
-100–100 %		10		

Use parameters P03.44–P03.46 with multi-function output setting 67: (analog input level reached) on P02.13, P02.16, and P02.17. The digital output is active when the AI input level is higher than P03.45. The digital output is disabled when the AI input is lower than P03.46.

When setting levels, P03.45 DOx-AI upper level must be higher than P03.46 DOx-AI lower level.

		Type	Hex Addr	Dec Addr
P03.47	**AI1%**	Read	032F	40816
Range/Units (Format: 16-bit signed)		Default		
-100–100 %		0		

		Type	Hex Addr	Dec Addr
P03.48	**AI2%**	Read	0330	40817
Range/Units (Format: 16-bit signed)		Default		
-100–100 %		0		

Parameters P03.47 – P03.48 allow the user to monitor the actual input signal to the analog inputs. The configured voltage or current signal will display as -100 to 100%. These registers are read only.

		Type	Hex Addr	Dec Addr
P03.50	**Analog Input Curve Selection**	♦R/W	0332	40819
Range/Units (Format: 16-bit binary)		Default		
0: Normal curve 1: Three-point curve of AI1 2: Three-point curve of AI2 3: Three-point curve of AI1 & AI2		0		

This parameter determines use of the gain/bias settings or the three point curve settings to adjust the frequency output command.

- *P03.50=0: Normal Curve- This enables parameters P03.03, P03.04, P03.07, P03.10, P03.11, and P03.12 for AI1 and AI2. Proportional parameters are not used.*
- *P03.50=1:*
  Utilizes Parameters P03.63–P03.68. (if P03.28= 0) for AI1. Keeps Gain/Bias for AI2.
  Utilizes Parameters P03.63–P03.74 (if P03.28=3) Keeps Gain/Bias for AI2.
- *P03.50=2:*
  Utilizes parameters P03.57–P03.62 for AI2, Uses Gain/Bias for AI1.
- *P03.50=3:*
  Utilizes parameters P03.57–P03.74 for AI1 and AI2. Gain/Bias is not used.

When 3-point curve mode is selected, P03.10 is not used. Forward/Reverse action is determined by the frequency polarity in the proportional parameters.

For a -10V to 10V signal in AI1, parameters P03.62 - P03.68 are used for the 0-10V signal and Parameters P03.69 to P03.74 are used for the -10-0V signal. This is effectively a 6 point curve.

NOTE: For -10V to 10V signal, parameters P03.62 - P03.68 are used to set the 0 to +10V portion of the signal.

		Type	Hex Addr	Dec Addr
P03.57	**AI2 Lowest Point**	♦R/W	0339	40826
Range/Units (Format: 16-bit unsigned)		Default		
P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA		4.00		

When the input current falls below this parameter, the action defined in P03.19 will initiate.

		Type	Hex Addr	Dec Addr
P03.58	**AI2 Proportional Lowest Point**	♦R/W	033A	40827
Range/Units (Format: 16-bit unsigned)		Default		
-100.00–100.00 %		0.00		

		Type	Hex Addr	Dec Addr
P03.59	**AI2 Mid-point**	♦R/W	033B	40828
Range/Units (Format: 16-bit unsigned)		Default		
P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA		12.00		

		Type	Hex Addr	Dec Addr
P03.60	**AI2 Proportional Mid-point**	♦R/W	033C	40829
Range/Units (Format: 16-bit unsigned)		Default		
-100.00–100.00 %		50.00		

		Type	Hex Addr	Dec Addr
P03.61	**AI2 Highest Point**	♦R/W	033D	40830
Range/Units (Format: 16-bit unsigned)		Default		
P03.29 = 1, 0.00–10.00 V P03.29 ≠ 1, 0.00–20.00 mA		20.00		

		Type	Hex Addr	Dec Addr
P03.62	**AI2 Proportional Highest Point**	♦R/W	033E	40831
Range/Units (Format: 16-bit unsigned)		Default		
-100.00–100.00 %		100.00		

When P03.29 = 1, the AI2 setting is 0–10 V and the unit is voltage (V).

When P03.29 ≠ 1, the AI2 setting is 0–20 mA or 4–20 mA and the unit is current (mA).

- *When you set the analog input AI2 to the Frequency command, 100% corresponds to Fmax (P01.00 Maximum Operation Frequency).*
- *The requirement for the low, mid, and high point parameters (P03.57, P03.59 and P03.61) is P03.57 < P03.59 < P03.61. The values for three proportional points (P03.58, P03.60 and P03.62) have no limits. There is a linear calculation between two points.*
- *The output percentage becomes 0% when the AI2 input value is lower than the lowest point setting.*

Example:

If P03.57 = 2mA; P03.58 = 10%, then the output becomes 0% when the AI2 input is ≤ 2mA.

Once the AI2 input goes above 2mA, the drive's output frequency starts at 10%.

		Type	Hex Addr	Dec Addr
P03.63	**AI1 Voltage Lowest Point**	♦R/W	033F	40832
Range/Units (Format: 16-bit unsigned)		Default		
0.00–10.00 V		0.00		

		Type	Hex Addr	Dec Addr
P03.64	**AI1 Proportional Lowest Point**	♦R/W	0340	40833
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00 %		0.00		

		Type	Hex Addr	Dec Addr
P03.65	**AI1 Voltage Mid-point**	♦R/W	0341	40834
Range/Units (Format: 16-bit unsigned)		Default		
0.00–10.00 V		5.00		

		Type	Hex Addr	Dec Addr
P03.66	**AI1 Proportional Mid-point**	♦R/W	0342	40835
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00 %		50.00		

		Type	Hex Addr	Dec Addr
P03.67	**AI1 Highest Point**	♦R/W	0343	40836
Range/Units (Format: 16-bit unsigned)		Default		
0.00–10.00 V		10.00		

		Type	Hex Addr	Dec Addr
P03.68	**AI1 Proportional Highest Point**	♦R/W	0344	40837
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00 %		100.00		

When you set the positive voltage AI1 to the Frequency command, 100% corresponds to Fmax (P01.00 Maximum Operation Frequency) and the motor runs in the forward direction.

- *The requirement for the low, mid, and high point parameters (P03.63, P03.65, and P03.67) is P03.63 < P03.65 < P03.67. The values for three proportional points (P03.64, P03.66 and P03.68) have no limits. There is a linear calculation between two points.*
- *The output percentage becomes 0 % when the positive voltage AI1 input value is lower than the lowest point setting.*

Example:

If P03.63 = 1V; P03.64 = 10%, then the output becomes 0% when the AI1 input is ≤ 1V.

Once the AI1 input increases above 1V, the drive output frequency will start at 10%.

		Type	Hex Addr	Dec Addr
P03.69	**Negative AI1 Voltage Highest Point**	♦R/W	0345	40838
Range/Units (Format: 16-bit signed)		Default		
-10.00–0.00 V (valid when P03.28 set as -10–10 V)		0.00		

		Type	Hex Addr	Dec Addr
P03.70	**Negative AI1 Proportional Highest Point**	♦R/W	0346	40839
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00 % (valid when P03.28 set as -10–10 V)		0.00		

		Type	Hex Addr	Dec Addr
P03.71	**Negative AI1 Voltage Mid-point**	♦R/W	0347	40840
Range/Units (Format: 16-bit signed)		Default		
-10.00–0.00 V (valid when P03.28 set as -10–10 V)		-5.00		

		Type	Hex Addr	Dec Addr
P03.72	**Negative AI1 Proportional Mid-point**	♦R/W	0348	40841
Range/Units (Format: 16-bit signed)		*Default*		
-100.00–100.00 % (valid when P03.28 set as -10–10 V)		-50.00		

		Type	Hex Addr	Dec Addr
P03.73	**Negative AI1 Lowest Point**	♦R/W	0349	40842
Range/Units (Format: 16-bit signed)		*Default*		
-10.00–0.00 V (valid when P03.28 set as -10–10 V)		-10.00		

		Type	Hex Addr	Dec Addr
P03.74	**Negative AI1 Proportional Lowest Point**	♦R/W	034A	40843
Range/Units (Format: 16-bit signed)		*Default*		
-100.00–100.00 % (valid when P03.28 set as -10–10 V)		-100.00		

When you set the negative voltage AI1 to the Frequency command, -100% corresponds to Fmax (P01.00 Maximum Operation Frequency) and the motor runs in the reverse direction.

- *The requirement for the low, mid, and high point parameters (P03.69, P03.71, and P03.73) is P03.69 < P03.71 < P03.73, the values for three proportional points (P03.70, P03.72, and P03.74) have no limits. There is a linear calculation between two points.*
- *The output percentage becomes 0% when the negative voltage AI1 input value is lower than the lowest point setting.*

Example:

If P03.69 = -1V; P03.70 = 10%, then the output becomes 0% when the AI1 input is ≥ -1V.

If the AI1 input swings between -1V and -1.1 V, drive's output frequency oscillates between 0% and 10%.

NOTE: For -10V to 10V signal, parameters P03.69 - P03.74 are used to set the 0 to -10V signal.

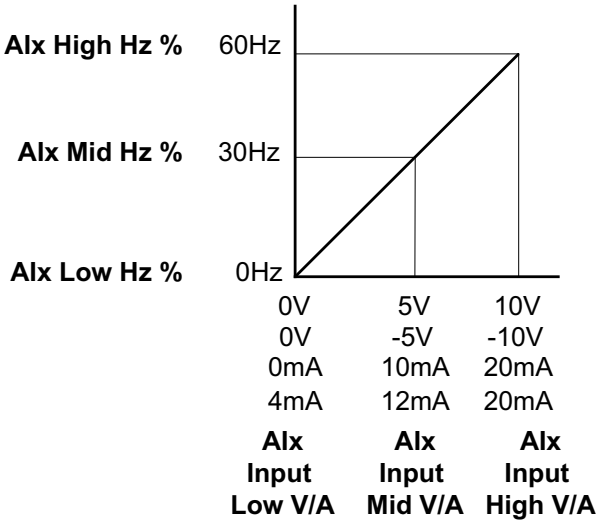
Analog Input Parameter Examples

Refer to the following equations and examples for changing the ratio of the analog input signal relative to the output frequency of the drive.

There are 2 methods of changing the ratio: Three point curve or Bias/Gain. Either method can be used and is largely a matter of user preference.

Three Point Curve (P03.50 ≠ 0):

The Three Point Curve parameters are used to set the low, mid, and high input signals corresponding to a low, mid, and high proportional output value. This method eliminates the need for using any mathematic equations by the user. A curve slope will be calculated automatically between the low and mid point values, and the mid and high point values. See "Analog Input Parameter Example 11: Forward and Reverse Operation with -10V to +10V Input" on page 4–138 for Three point curve using a -10 to 10V input signal.



Analog Input	AI1	AI2
Polarity	0–10 V	Positive (+)
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3
Low V/A	P03.63	P03.57
Low Hz Percent	P03.64	P03.58
Mid V/A	P03.65	P03.59
Mid Hz Percent	P03.66	P03.60
High V/A	P03.67	P03.61
High Hz Percent	P03.68	P03.62

Bias/Gain (P03.50 = 0: Normal Curve, default):

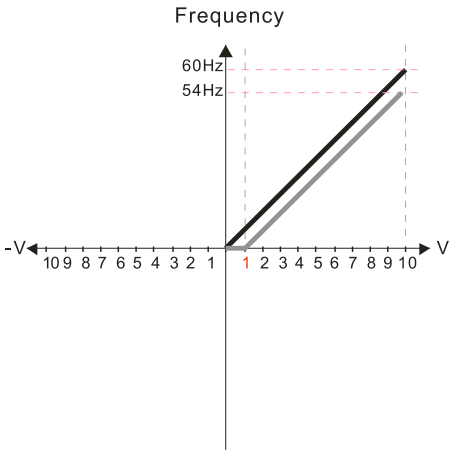
The Normal Curve setting utilizes 4 different parameters to modify the output frequency of the drive. The bias/gain parameters work in accordance with the Pos/Neg bias mode and reverse setting parameter. Use diagrams 1 - 32 to understand the frequency outputs that will result from these parameter settings.

Analog Input	AI1	AI2
Bias Parameter	P03.03	P03.04
Pos/Neg Bias Parameter	P03.07	P03.08
Gain Parameter	P03.11	P03.12
Reverse Setting Parameter	P03.10	
Curve Parameter	P03.50	
Drive Max Output Freq	P01.00	

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 1:



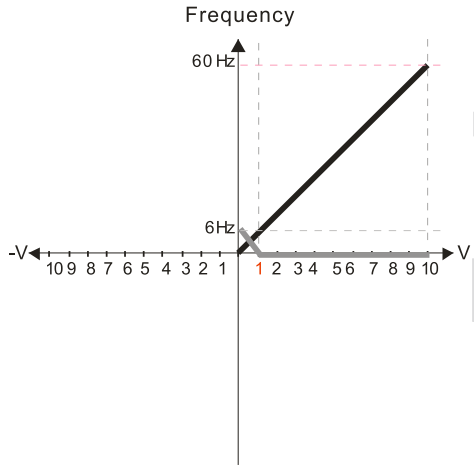
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 2:



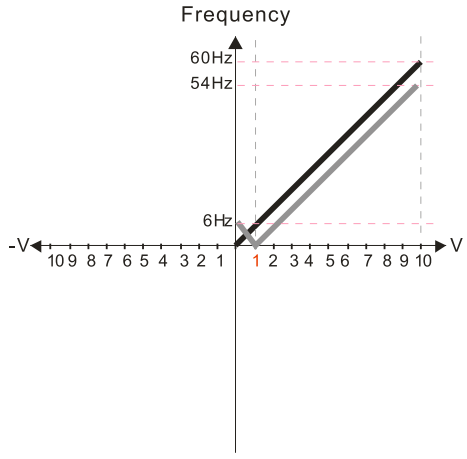
P03.03=10%
P03.07– P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 3:



P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

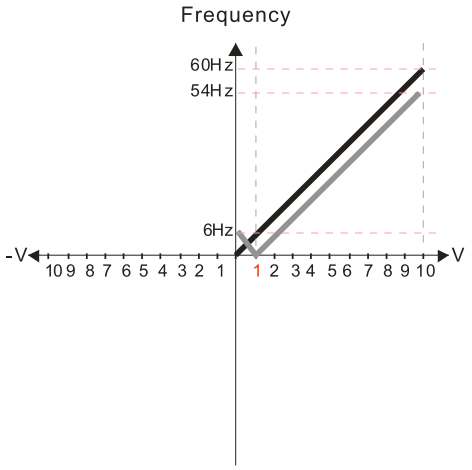
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 4:



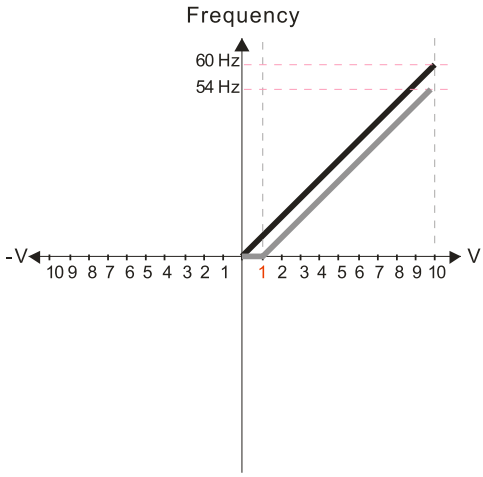
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run; negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 5:



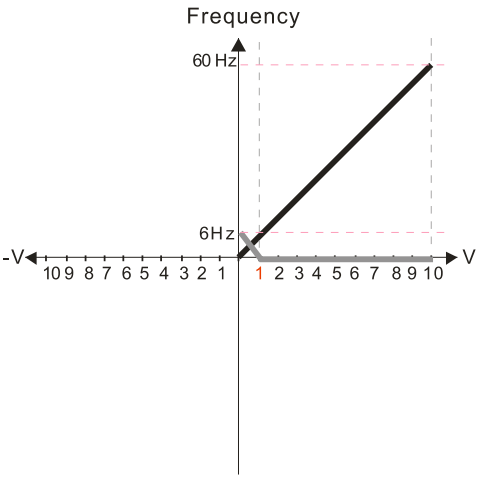
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run; negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 6:



P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

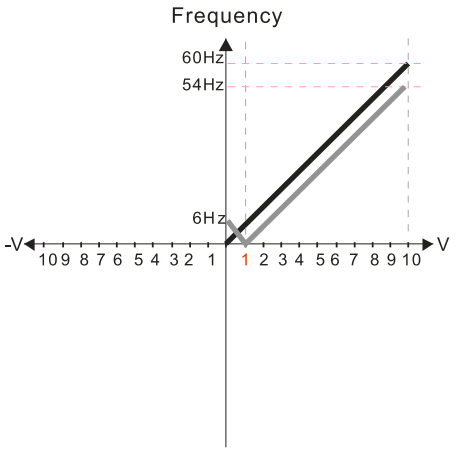
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run; negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 7:



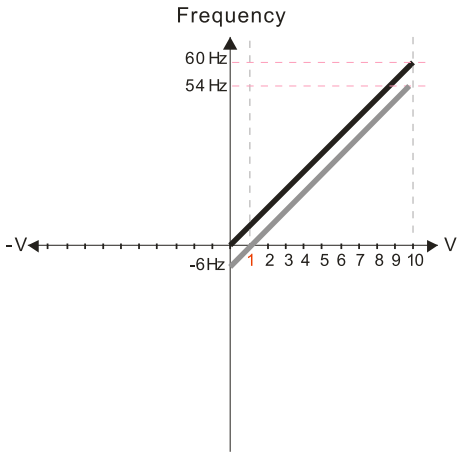
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 8:



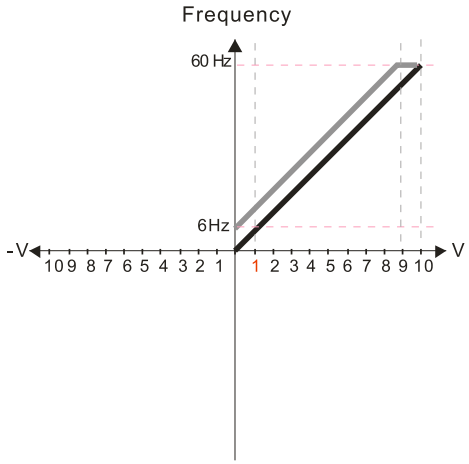
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 9:



P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

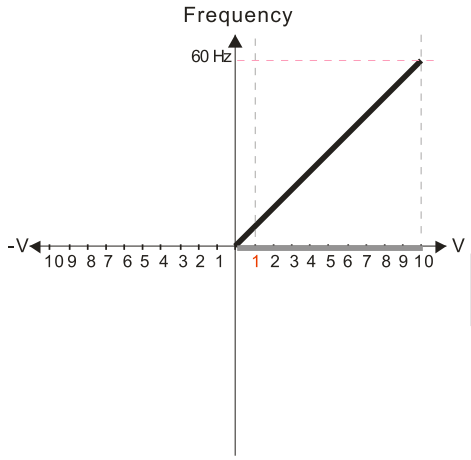
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 10:



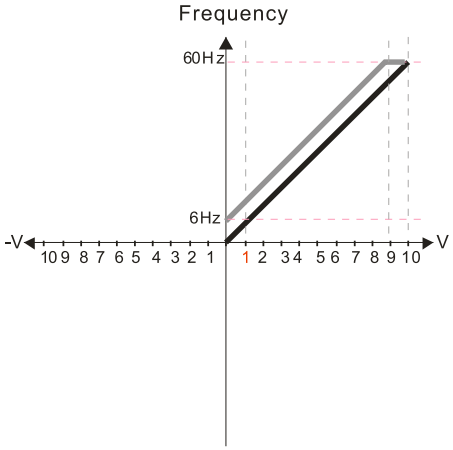
P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 11:



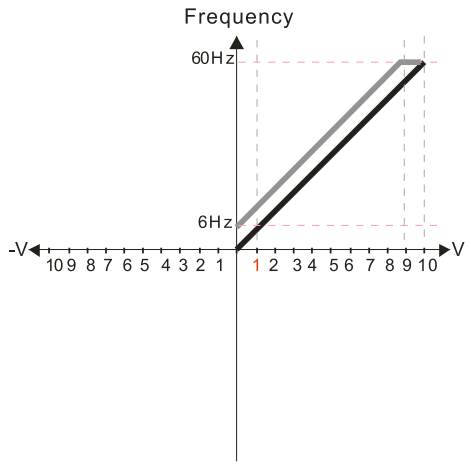
P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 12:



P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

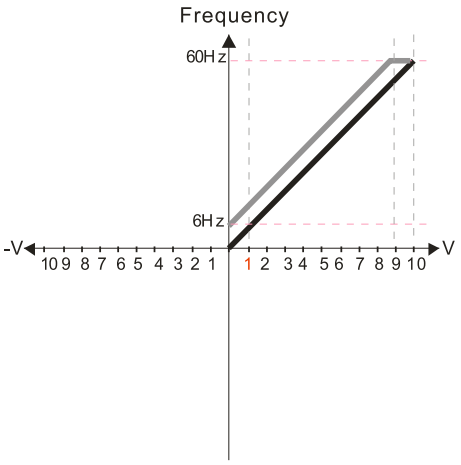
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 13:



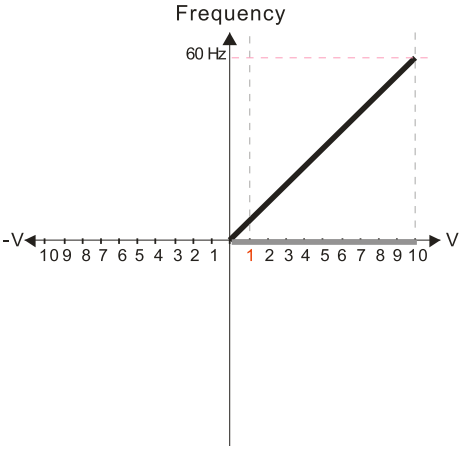
P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 14:



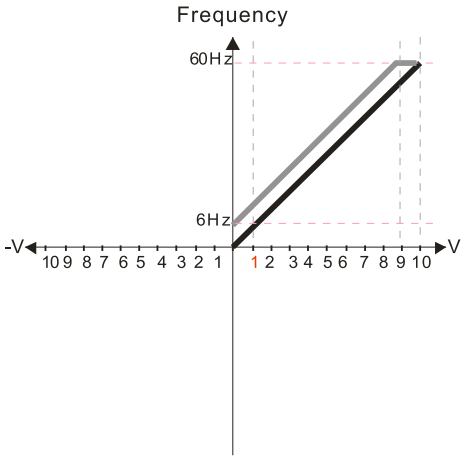
P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 15:



P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

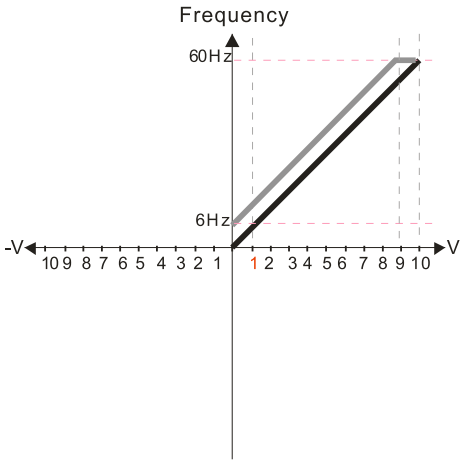
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 16:



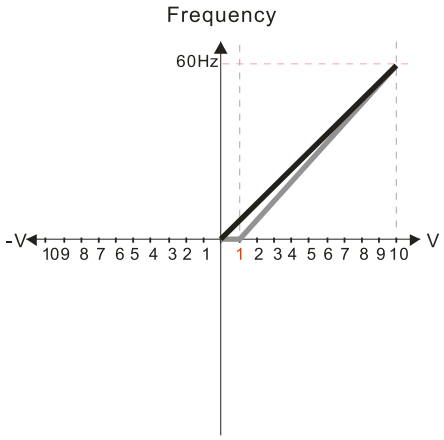
P03.03=-10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 100%

Bias and Gain Example 17:



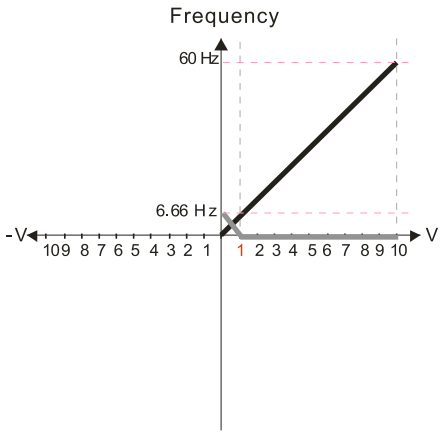
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Bias and Gain Example 18:



P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

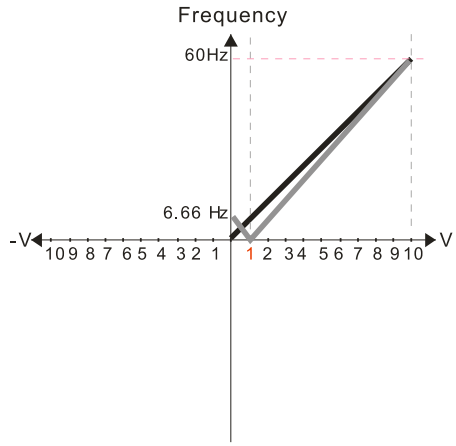
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 19:



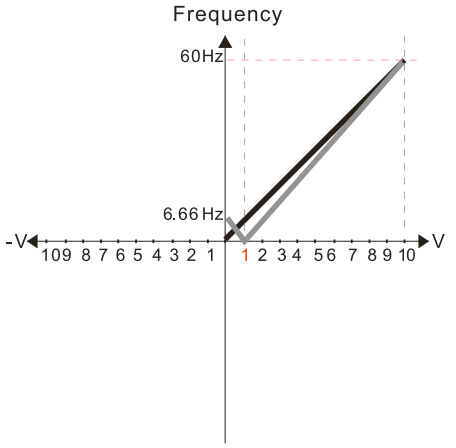
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Bias and Gain Example 20:



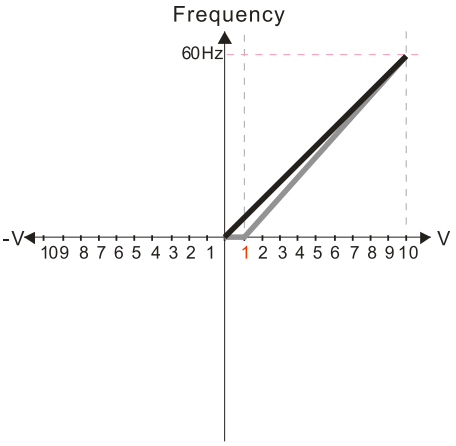
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Bias and Gain Example 21:



P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

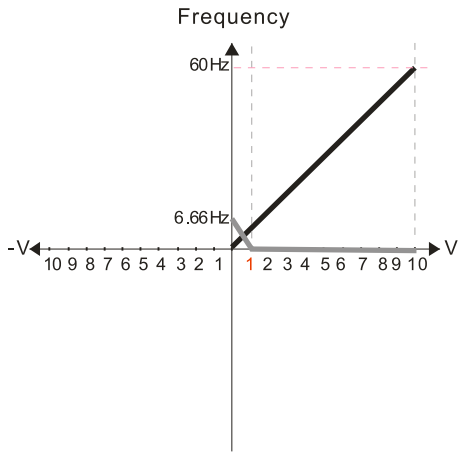
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 22:



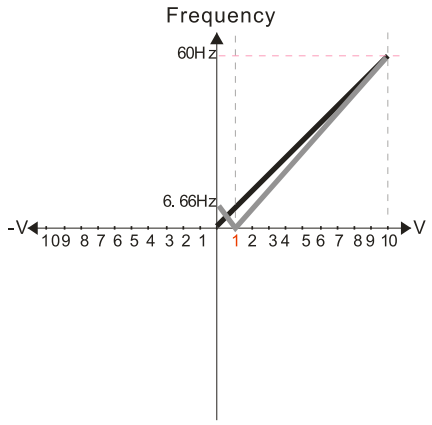
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage
while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled
by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad
or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Bias and Gain Example 23:



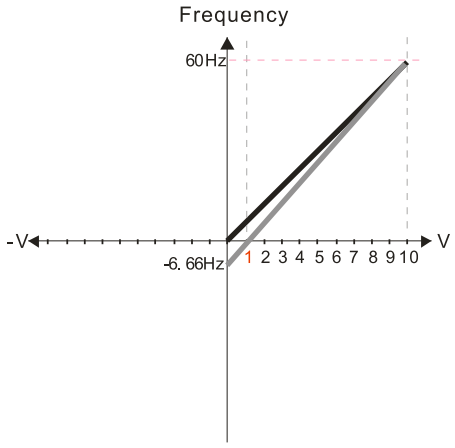
P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage
while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled
by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad
or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Bias and Gain Example 24:



P03.03=10%
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage
while serving as the center
4: Bias serves as the center

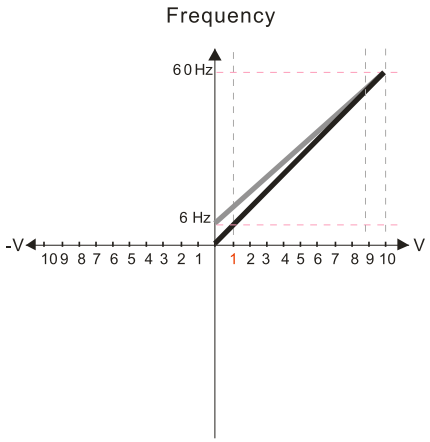
P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled
by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad
or external terminal control.

P03.11 Analog input Gain (AI1) = 111.1%
10/9 = 111.1%

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 25:



P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)

0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

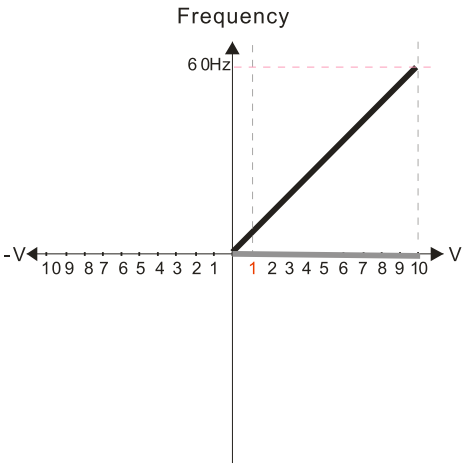
$\frac{60-6Hz}{10V} = \frac{6-0Hz}{(0-X)V}$ $XV = \frac{100}{-9} = -1.11V$ $\therefore 03\text{-}03 = \frac{-1.11}{10} \times 100\%$

$= -11.1\%$

Calculate the gain:

$P03.11 = \frac{10V}{11.1V} \times 100\% = 90.0\%$

Bias and Gain Example 26:



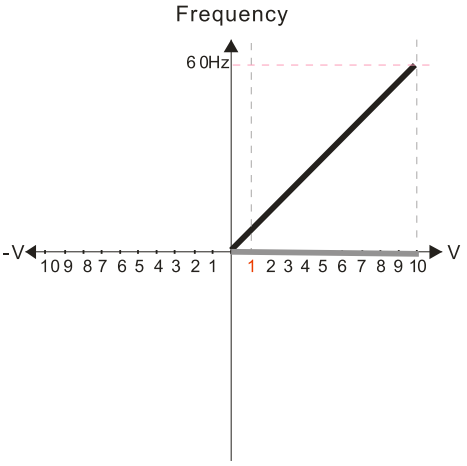
P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)

0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Bias and Gain Example 27:



P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

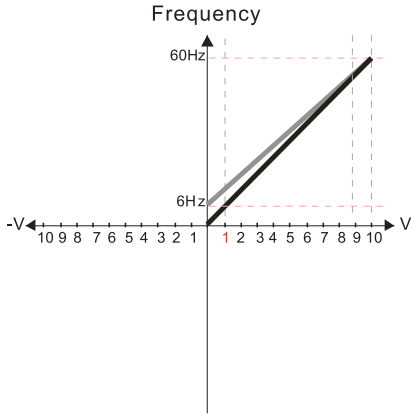
P03.10 (Analog Frequency Command for Reverse Run)

0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 28:



P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)

0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

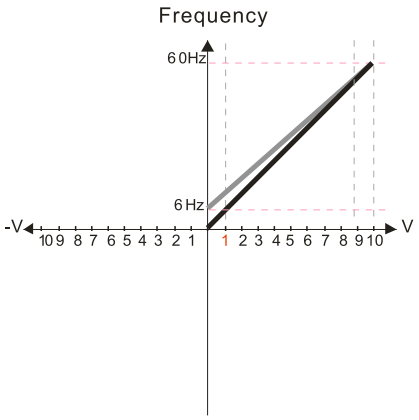
$$\frac{60-6\,Hz}{10V}=\frac{6-0\,Hz}{(0-XV)}\quad XV=\frac{100}{-9}=-1.11V\quad \therefore 03\text{-}03=\frac{-1.11}{10}\times 100\%$$

$$=-11.1\,\%$$

Calculate the gain:

$$P03.11=\frac{10V}{11.1V}\times 100\%=90.0\,\%$$

Bias and Gain Example 29:



P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)

0: Negative frequency is not valid. Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid. Positive frequency = forward run; negative frequency = reverse run. Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

$$\frac{60-6\,Hz}{10V}=\frac{6-0\,Hz}{(0-XV)}\quad XV=\frac{100}{-9}=-1.11V\quad \therefore 03\text{-}03=\frac{-1.11}{10}\times 100\%$$

$$=-11.1\,\%$$

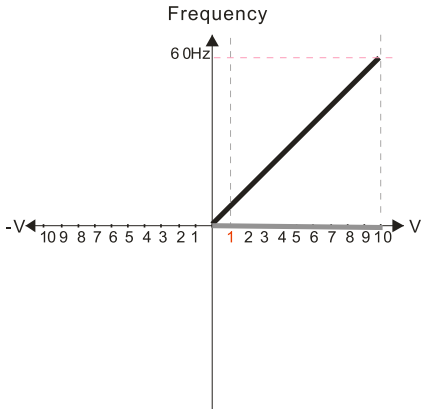
Calculate the gain:

$$P03.11=\frac{10V}{11.1V}\times 100\%=90.0\,\%$$

Frequency output at default bias/gain settings

Manipulated frequency output based on listed parameter values

Bias and Gain Example 30:

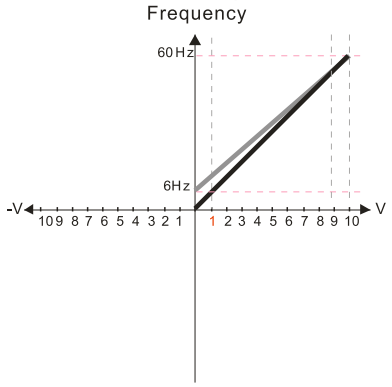


P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Bias and Gain Example 31:



P03.07–P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

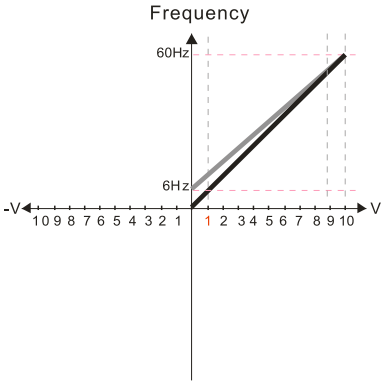
Calculate the bias:

$$\frac{60-6Hz}{10V} = \frac{6-0Hz}{(0-XV)} \quad XV = \frac{100}{-9} = -1.11V \quad \therefore 03.03 = \frac{-1.11}{10} \times 100\% = -11.1\%$$

Calculate the gain:

$$P03.11 = \frac{10V}{11.1V} \times 100\% = 90.0\%$$

Bias and Gain Example 32:



P03.07– P03.08 (Positive/Negative Bias Mode)

0: No bias
1: Lower than or equal bias
2: Greater than or equal to bias
3: The absolute value of the bias voltage while serving as the center
4: Bias serves as the center

P03.10 (Analog Frequency Command for Reverse Run)
0: Negative frequency is not valid.
Forward and reverse run is controlled by digital keyboard or external terminals.
1: Negative frequency is valid.
Positive frequency = forward run;
negative frequency = reverse run.
Direction can not be switched by digital keypad or external terminal control.

Calculate the bias:

$$\frac{60-6Hz}{10V} = \frac{6-0Hz}{(0-XV)} \quad XV = \frac{100}{-9} = -1.11V \quad \therefore 03.03 = \frac{-1.11}{10} \times 100\% = -11.1\%$$

Calculate the gain:

$$P03.11 = \frac{10V}{11.1V} \times 100\% = 90.0\%$$

Analog Input Parameter Example 1: Standard Operation

This example illustrates the default operation of the drive. The example is given to further illustrate the use of the analog calculations. The full range of the analog input signal corresponds to the full forward frequency range of the AC drive.

- *Minimum Frequency Reference = 0Hz*
- *Maximum Frequency Reference = 60Hz*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to zero (Normal Curve) to enable bias and gain calculations.***

Calculations

A) **Drive Maximum Output Frequency** = P01.00 = (1750 rpm / 1750 rpm) x 60Hz = 60Hz

B) **Analog Bias %** = 0%

Analog Input (AIx)	*AI1*	*AI2*
Bias Parameter	P03.03	P03.04

C) **Analog Gain %** = [(60Hz - 0Hz) / 60Hz] x 100 = 100%

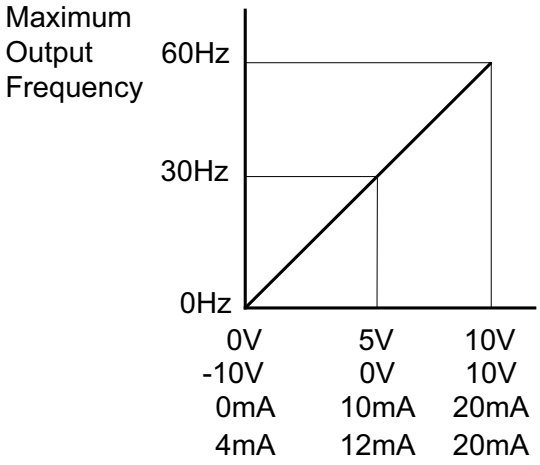
Analog Input	*AI1*	*AI2*
Gain Parameter	P03.11	P03.12

D) **Mid-point Frequency** = [(60Hz - 0Hz) / 2] + 0Hz = 30Hz

Parameter Settings

Analog Input	*AI1 or*	*AI2*	*Parameter Settings*
Bias Parameter	P03.03	P03.04	0.0%
Pos/Neg Bias Parameter	P03.07	P03.08	0: No Bias
Gain Parameter	P03.11	P03.12	100.0%
Reverse Setting Parameter	P03.10		0: No Neg Freq
Curve Parameter	P03.50		0
Drive Max Output Freq	P01.00		60Hz

Results



Analog Input Parameter Example 2: Standard Operation with Increased Maximum Output Frequency

This example illustrates how to run the motor faster than its base speed. For this purpose, the only required parameter change is P01.00, Drive Maximum Output Frequency. (Motors produce reduced output torque when running above their base speed.)

Warning: The Drive Maximum Output Frequency parameter (P01.00) should never exceed the maximum speed rating for the motor you are using. If this information is not readily available, consult your motor manufacturer.

The analog input adjustment parameters can remain defaulted, as determined by the analog input calculations shown below. The increased Drive Maximum Output Frequency can be obtained regardless of whether the Source of Frequency Command (P03.00 or P03.01) is an analog input or one of the other sources, such as the keypad, RS-485 communication interface, jog, or multi-speed settings.

- *Minimum Frequency Reference = 0Hz*
- *Maximum Frequency Reference = 70Hz*
- *Motor Maximum Output Speed = 2042 rpm*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to zero (Normal Curve) to enable bias and gain calculations.***

Calculations

A) **Drive Maximum Output Frequency** = P01.00 = (2042 rpm / 1750 rpm) x 60Hz = 70Hz

B) **Analog Bias %** = 0%

Analog Input (AIx)	AI1	AI2
Bias Parameter	P03.03	P03.04

C) **Analog Gain %** = [(70Hz – 0Hz) / 70Hz] x 100 = 100% = AIx Input Gain

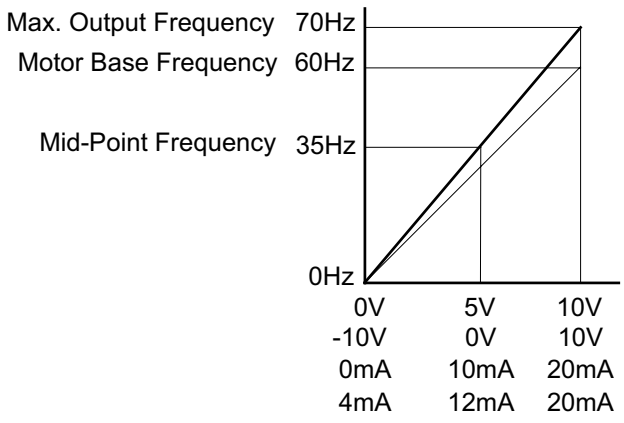
Analog Input	AI1	AI2
Gain Parameter	P03.11	P03.12

D) **Mid-point Frequency** = [(70Hz – 0Hz) / 2] + 0Hz = 35Hz

Parameter Settings

Analog Input	AI1 or	AI2	Parameter Settings
Bias Parameter	P03.03	P03.04	0.0%
Pos/Neg Bias Parameter	P03.07	P03.08	0: No Bias
Gain Parameter	P03.11	P03.12	100.0%
Reverse Setting Parameter	P03.10		0: No Neg Freq
Curve Parameter	P03.50		0
Drive Max Output Freq	P01.00		70Hz

Results



Analog Input Parameter Example 3: Positive Offset

In this example, the Analog Input will have a positive offset while still using the full scale of the potentiometer or other analog signal device. When the analog signal is at its lowest value (-10V, 0V, 0mA, or 4mA), the set-point frequency will be at 10Hz. When analog signal is at its maximum value (10V or 20mA), the set-point frequency will be 60Hz. This example will use the three point curve method.

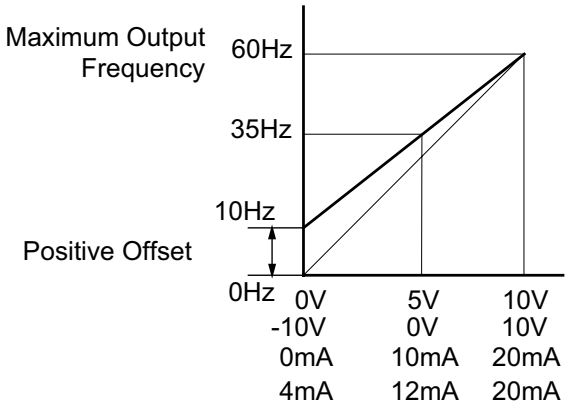
- *Minimum Frequency Reference @0V = 10Hz (10/60=16%)*
- *Mid-point Frequency Reference @5V = 35Hz (35/60=58%)*
- *Maximum Frequency Reference @10V = 60Hz (60/60=100%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve calculations.***

Parameter Settings

Analog Input	***AI1***	***AI2***	***Parameter Settings***
Polarity	0–10 V	Positive (+)	
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3	1, 2, or 3
Term Input Selection	P03.28=0	P03.29=0,1,2	0, 1, or 2
Low V/A	P03.63	P03.57	0V
Low Hz Percent	P03.64	P03.58	16%
Mid V/A	P03.65	P03.59	5V
Mid Hz Percent	P03.66	P03.60	58%
High V/A	P03.67	P03.61	10V
High Hz Percent	P03.68	P03.62	100%

Results



Analog Input Parameter Example 4: Forward and Reverse Operation

In this example, the potentiometer (or other analog signal device) is programmed to run a motor full-speed in both forward and reverse directions. The frequency reference will be 0Hz when the potentiometer is positioned at mid-point of its scale. This example will be shown using the three point curve parameters.

Utilize negative frequency percentage values in the proportional settings for reverse motion. Use positive percentage values for forward motion.

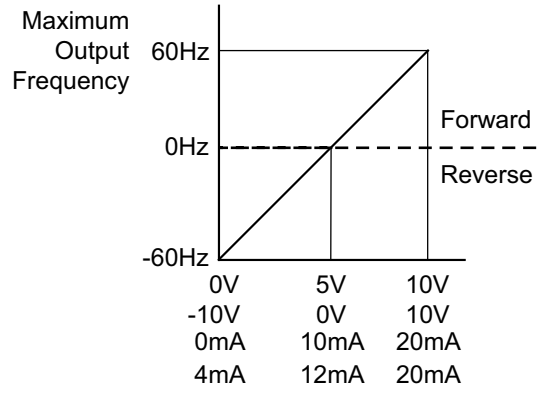
- *Minimum Frequency Reference @0V = -60Hz (-100%)(reverse)*
- *Mid-point Frequency Reference @5V = 0Hz (0%)*
- *Maximum Frequency Reference @10V = 60Hz (100%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve parameters.***

Parameter Settings

Analog Input	***AI1***	***AI2***	***Parameter Settings***
Polarity	0–10 V	Positive (+)	
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3	1, 2, or 3
Term Input Selection	P03.28=0	P03.29=0,1,2	0, 1, or 2
Low V/A	P03.63	P03.57	0V
Low Hz Percent	P03.64	P03.58	-100%
Mid V/A	P03.65	P03.59	5V
Mid Hz Percent	P03.66	P03.60	0%
High V/A	P03.67	P03.61	10V
High Hz Percent	P03.68	P03.62	100%

Results



Analog Input Parameter Example 5: Forward Run/Reverse Jog

This example shows an application in which the drive runs full-speed forward and jogs in reverse. The full scale of the potentiometer (or other analog signal device) will be used.

Use negative frequency percentage values in the proportional settings for reverse motion. Use positive percentage values for forward motion.

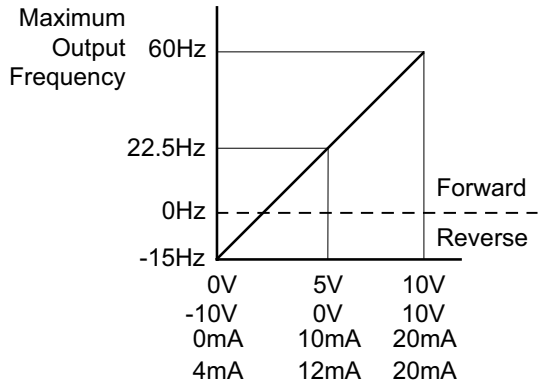
- *Minimum Frequency Reference @0V = -15Hz (-15/60 = -25%)(reverse)*
- *Mid-Point Frequency Reference @5V = 22.5 Hz (22.5/60 = 37.5%)*
- *Maximum Frequency Reference @10V = 60Hz (60/60 = 100%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve parameters.***

Parameter Settings

Analog Input	**AI1**	**AI2**	**Parameter Settings**
Polarity	0–10 V	Positive (+)	
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3	1, 2, or 3
Term Input Selection	P03.28=0	P03.29=0,1,2	0, 1, or 2
Low V/A	P03.63	P03.57	0V
Low Hz Percent	P03.64	P03.58	-25%
Mid V/A	P03.65	P03.59	5V
Mid Hz Percent	P03.66	P03.60	37.5%
High V/A	P03.67	P03.61	10V
High Hz Percent	P03.68	P03.62	100%

Results



Analog Input Parameter Example 6: Reduced Analog Gain

This example shows how to limit the Maximum Frequency Reference by reducing the Analog Input Gain. When the Analog Input is at its maximum value (10V or 20mA), the set-point frequency will be 50Hz. However, this reduced maximum frequency applies only to an Analog Input Source of Frequncy Command. The Maximum Output Frequency can still can still go to 60Hz if controlled from the Keypad, RS-485 interface, Jog Command, or Multi-Speed settings. For this example, the only required parameter change is P03.11 or P03.12, Gain parameter.

- *Minimum Frequency Reference = 0Hz*
- *Maximum Frequency Reference = 50Hz*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to zero (Normal Curve) to enable bias and gain calculations.***

Calculations

A) **Drive Maximum Output Frequency** = P01.00 = (1750 rpm / 1750 rpm) x 60Hz = 60Hz

B) **Analog Bias %** = 0%

Analog Input (AIx)	*AI1*	*AI2*
Bias Parameter	P03.03	P03.04

C) **Analog Gain %** = [(50Hz – 0Hz) / 60Hz] x 100 = 83.3% = AIx Input Gain

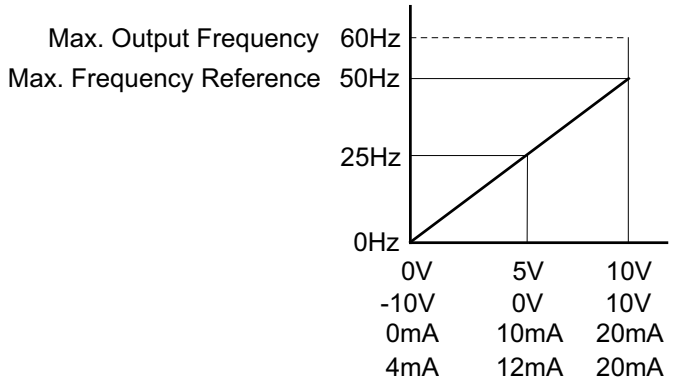
Analog Input	*AI1*	*AI2*
Gain Parameter	P03.11	P03.12

D) **Mid-point Frequency** = [(50Hz – 0Hz) / 2] + 0Hz = 25Hz

Parameter Settings

Analog Input	*AI1 or*	*AI2*	*Parameter Settings*
Polarity	Positive (+)	Positive (+)	
Bias Parameter	P03.03	P03.04	0.0%
Pos/Neg Bias Parameter	P03.07	P03.08	0: No Bias
Gain Parameter	P03.11	P03.12	83.3%
Reverse Setting Parameter	P03.10		0: No Neg Freq
Curve Parameter	P03.50		0

Results



Analog Input Parameter Example 7: Positive Offset with Reduced Analog Gain

This example illustrates how to provide a positive offset of the Analog Input, while using the full scale of the potentiometer or other analog device. At the same time, the Maximum Frequency Reference is limited by reducing the Analog Input Gain.

When the analog signal is at its lowest value, the set-point frequency will be at 11.5Hz. When the analog signal is at its maximum value, the set-point frequency will be 39.6Hz.

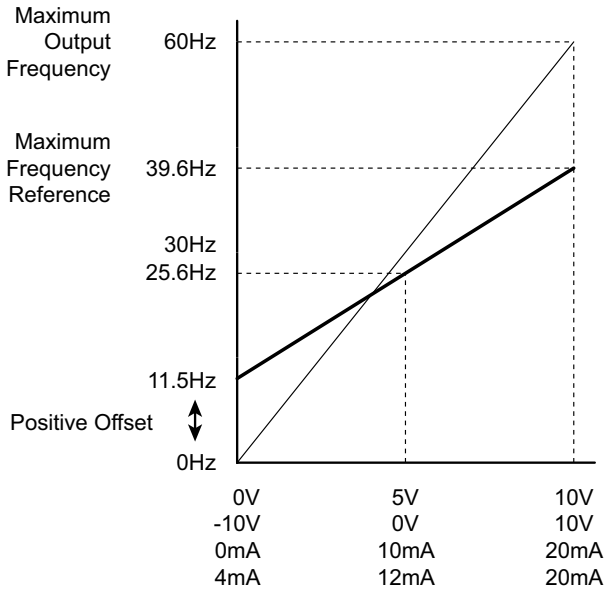
- *Minimum Frequency Reference @0V = 11.5 Hz (11.5/60 = 19%)*
- *Mid-point Frequency Reference @5V = 22.5 Hz (22.5/60 = 37.5%)*
- *Maximum Frequency Reference @10V = 39.6 Hz (39.6/60 = 66%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve parameters.***

Parameter Settings

Analog Input	***AI1***	***AI2***	***Parameter Settings***
Polarity	0–10 V	Positive (+)	
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3	1, 2, or 3
Term Input Selection	P03.28=0	P03.29=0,1,2	0, 1, or 2
Low V/A	P03.63	P03.57	0V
Low Hz Percent	P03.64	P03.58	19%
Mid V/A	P03.65	P03.59	5V
Mid Hz Percent	P03.66	P03.60	37.5%
High V/A	P03.67	P03.61	10V
High Hz Percent	P03.68	P03.62	66%

Results



Analog Input Parameter Example 8: Trim

This example illustrates trimming the output frequency of the drive.

- *Minimum Frequency Reference = 0Hz*
- *Maximum Frequency Reference = 45Hz*
- *Actual Drive Output Frequency (when P4.08 = 4) = Frequency Command - Trim Reference Frequency*
- *Trim Frequency Reference P4.07 = 15Hz*
  (use comms or keypad to adjust this value based on the application needs)

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to zero (Normal Curve) to enable bias and gain calculations.***

Calculations

A) **Drive Maximum Output Frequency** = P01.00 = (1750 rpm / 1750 rpm) x 60Hz = 60Hz

B) **Analog Bias %** = 25%

Analog Input (AIx)	***AI1***	***AI2***
Bias Parameter	P03.03	P03.04

C) **Analog Gain %** = [(60Hz - 0Hz) / 60Hz] x 100 = 100%

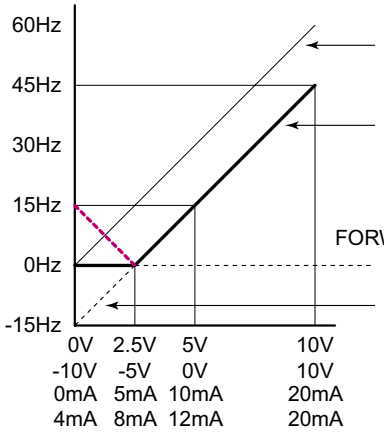
Analog Input	***AI1***	***AI2***
Polarity	Positive (+)	Positive (+)
Gain Parameter	P03.11	P03.12

D) **Mid-point Frequency** = [(45Hz – 0Hz) / 2] + 0Hz = 22.5 Hz

Parameter Settings

Analog Input	***AI1 or***	***AI2***	***Parameter Settings***
Polarity	Positive (+)	Positive (+)	
Bias Parameter	P03.03	P03.04	25%
Pos/Neg Bias Parameter	P03.07	P03.08	3: ABS of Bias
Gain Parameter	P03.11	P03.12	100.0%
Reverse Setting Parameter	P03.10		1: Neg Freq Allowed
Curve Parameter	P03.50		0

Results



The drive will not reverse direction unless the Frequency Command is from an analog input, and reverse motion is enabled in P03.10. If negative motion is disabled (P03.10=0), the analog signal will be treated as an absolute value. Instead of 0Hz output below 2.5V analog input, the Hz output will be treated as an absolute value and will follow the red line below 2.5V. To establish 0Hz below a specific analog threshold, please see Analog Input Parameter Example 9.

Analog Input Parameter Example 9: Zero Volts Out at Low V_{IN}

This example gives 0Hz output through the first 0V~2.5V of Analog Input. The rest of the 2.5V~10V corresponds to 0~45 Hz. This example will use the three point curve method.

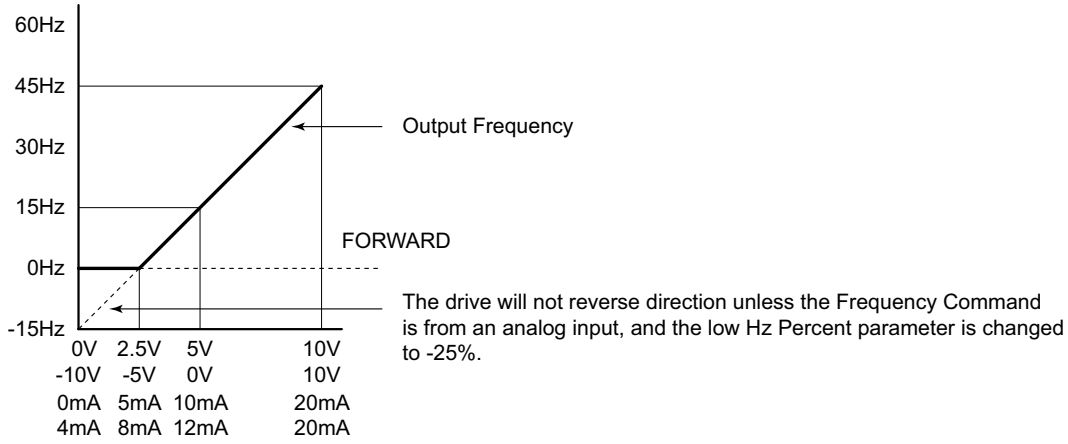
- *Minimum Frequency Reference @0V = 0Hz (0/60 = 0%)*
- *Mid-point Frequency Reference @5V = 0Hz (0/60 = 0%)*
- *Maximum Frequency Reference @10V = 45Hz (45/60 = 75%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve parameters.***

Parameter Settings

Analog Input	AI1	AI2	Parameter Settings
Polarity	0–10 V	Positive (+)	
Curve Selection	P03.50 = 1 or 3	P03.50 = 2 or 3	1, 2, or 3
Term Input Selection	P03.28=0	P03.29=0,1,2	0, 1, or 2
Low V/A Input	P03.63	P03.57	0V
Low Hz Percent	P03.64	P03.58	0%
Mid V/A Input	P03.65	P03.59	2.5V
Mid Hz Percent	P03.66	P03.60	0%
High V/A Input	P03.67	P03.61	10V
High Hz Percent	P03.68	P03.62	75%

Results



Analog Input Parameter Example 10: Inverse Analog Speed Reference

This example illustrates the use of an inverse analog speed reference to the drive. The minimum analog reference value corresponds to the full forward output frequency of the drive. In this example, only the Pos/Neg Bias Parameter must be changed from default.

- *Minimum Frequency Reference = 60Hz*
  (drive output frequency at the minimum analog input reference, 0V)
- *Maximum Frequency Reference = 0Hz*
  (drive output frequency at the maximum analog input reference, 10V)

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to zero (Normal Curve) to enable bias and gain calculations.***

Calculations (see page 4–116 for formulas)

A) **Drive Maximum Output Frequency** = P01.00 = (1750 rpm / 1750 rpm) x 60Hz = 60Hz

B) **Analog Bias %** = 100%

Analog Input (AIx)	*AI1*	*AI2*
Bias Parameter	P03.03	P03.04

C) **Analog Gain %** = [(0Hz - 60Hz) / 60Hz] x 100 = -100%

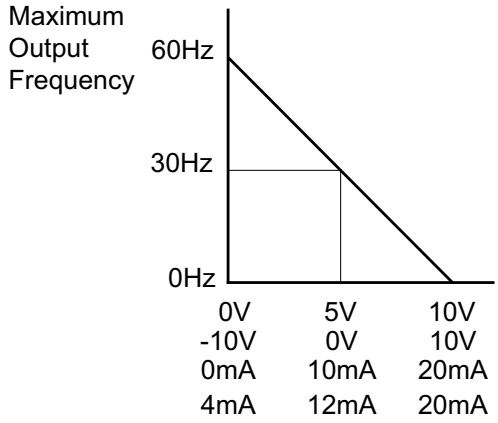
Analog Input	*AI1*	*AI2*
Gain Parameter	P03.11	P03.12

D) **Mid-point Frequency** = [(60Hz - 0Hz) / 2] + 0Hz = 30Hz

Parameter Settings

Analog Input	*AI1 or*	*AI2 or*	*Parameter Settings*
Polarity	Positive (+)	Positive (+)	
Bias Parameter	P03.03	P03.04	100.0%
Pos/Neg Bias Parameter	P03.07	P03.08	2: Greater than or equal to
Gain Parameter	P03.11	P03.12	100.0%
Reverse Setting Parameter	P03.10		0: No Neg Freq
Curve Parameter	P03.50		0
Drive Max Output Freq	P01.00		60Hz

Results



Analog Input Parameter Example 11: Forward and Reverse Operation with -10V to +10V Input

In this example, the potentiometer (or other analog signal device) is programmed to run a motor full-speed in both forward and reverse directions using a -10V to +10V analog input. The frequency reference will be 0Hz when the potentiometer is positioned at mid-point of its scale (0V). When using -10V to +10V the three point curve method is used. This requires using parameters P03.62 – P03.68 for 0 to +10V scaling and P03.69 – P03.74 for 0 to -10V scaling. This is effectively a six point curve.

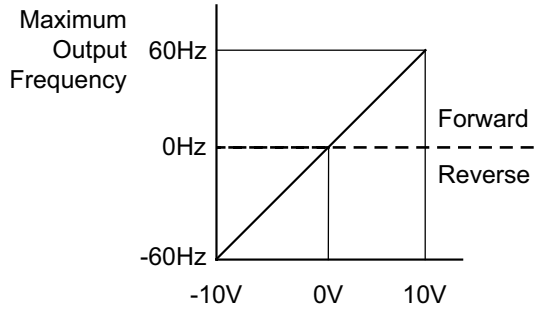
- *Minimum Frequency Reference @-10V = -60Hz (-60/60 = -100%)(reverse)*
- *Mid-point Frequency Reference @-5V = -30Hz (-30/60 = -50%)(reverse)*
- *Maximum Frequency Reference @0V = 0Hz (0/60 = 0%)*
- *Minimum Frequency Reference @0V = 0Hz (0/60 = 0%)*
- *Mid-point Frequency Reference @5V = 30Hz (30/60 = 50%)*
- *Maximum Frequency Reference @10V = 60Hz (60/60 = 100%)*

For AI1 and AI2: ***P03.50 (Analog Input Curve) must be set to 1, 2, or 3 to enable three point curve parameters.***

Parameter Settings

Analog Input	***AI1***	***Parameter Settings***
Polarity	-10V to +10V	
Curve Selection	P3.50	1 or 3
Term Input Select	P3.28	3
Low Point Input Value	03.63	0
Low Proportional % Out	03.64	0
Middle Point Input Value	03.65	5
Middle Proportional % Out	03.66	-50%
High Point Input Value	03.67	10
High Proportional % Out	03.68	100%
High Point Input Value	03.69	0
High Proportional % Out	03.70	0
Middle Point Input Value	03.71	-5
Middle Proportional % Out	03.72	-50%
Low Point Input Value	03.73	-10
Low Proportional % Out	03.74	-100%

Results



Group P04.xx Details – Multi-Step Speed Parameters

		Type	Hex Addr	Dec Addr
P04.00	**1st Step Speed Frequency**	♦R/W	0400	41025
P04.01	**2nd Step Speed Frequency**	♦R/W	0401	41026
P04.02	**3rd Step Speed Frequency**	♦R/W	0402	41027
P04.03	**4th Step Speed Frequency**	♦R/W	0403	41028
P04.04	**5th Step Speed Frequency**	♦R/W	0404	41029
P04.05	**6th Step Speed Frequency**	♦R/W	0405	41030
P04.06	**7th Step Speed Frequency**	♦R/W	0406	41031
P04.07	**8th Step Speed Frequency**	♦R/W	0407	41032
P04.08	**9th Step Speed Frequency**	♦R/W	0408	41033
P04.09	**10th Step Speed Frequency**	♦R/W	0409	41034
P04.10	**11th Step Speed Frequency**	♦R/W	040A	41035
P04.11	**12th Step Speed Frequency**	♦R/W	040B	41036
P04.12	**13th Step Speed Frequency**	♦R/W	040C	41037
P04.13	**14th Step Speed Frequency**	♦R/W	040D	41038
P04.14	**15th Step Speed Frequency**	♦R/W	040E	41039

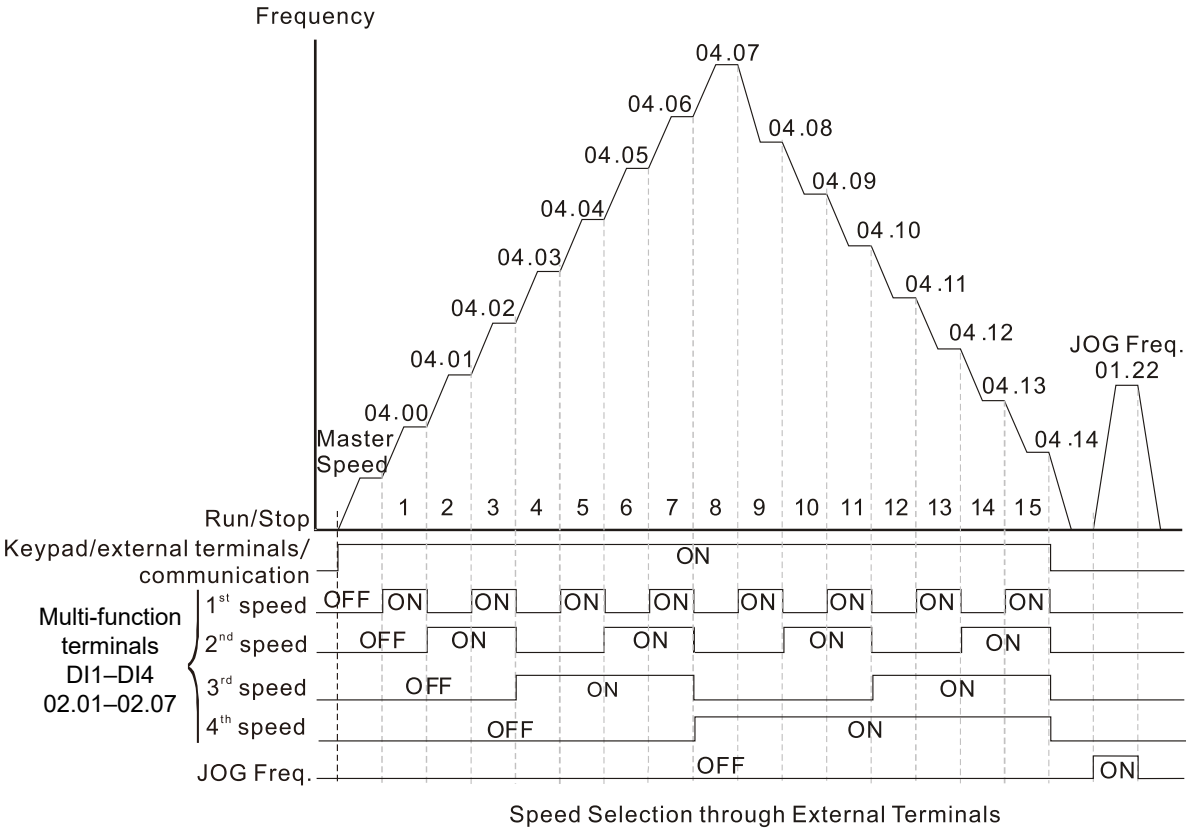
Range/Units (Format: 16-bit unsigned)	Default
0.00–599.00 Hz	0.00

Use the multi-function input terminals (refer to settings 1–4 of P02.01–P02.07 Multi-function Input Command) to select the multi-step speed command (the maximum is 15th step speed). P04.00 to P04.14 sets the multi-step speed (frequency) as shown in the following diagram.

- *The external terminal/digital keypad/communication controls the RUN and STOP commands with P00.21.*
- *You can set each multi-step speed between 0.00–599.00 Hz during operation.*
- *Explanation for the timing diagram of the multi-step speed and external terminals.*
  The related parameter settings are:
  a) P04.00–P04.14: sets the 1st–15th multi-step speed (to set the frequency of each step speed).
  b) P02.01–P02.07: sets the multi-function input terminals (multi-step speed command 1–4).

Related parameters:

- *P01.22 JOG frequency setting*
- *P02.01 multi-function input command 1 (DI1)*
- *P02.02 multi-function input command 2 (DI2)*
- *P02.03 multi-function input command 3 (DI3)*
- *P02.04 multi-function input command 4 (DI4)*



Speed Selection through External Terminals

		Type	Hex Addr	Dec Addr
P04.50	***PLC Buffer 0***	♦R/W	0432	41075
P04.51	***PLC Buffer 1***	♦R/W	0433	41076
P04.52	***PLC Buffer 2***	♦R/W	0434	41077
P04.53	***PLC Buffer 3***	♦R/W	0435	41078
P04.54	***PLC Buffer 4***	♦R/W	0436	41079
P04.55	***PLC Buffer 5***	♦R/W	0437	41080
P04.56	***PLC Buffer 6***	♦R/W	0438	41081
P04.57	***PLC Buffer 7***	♦R/W	0439	41082
P04.58	***PLC Buffer 8***	♦R/W	043A	41083
P04.59	***PLC Buffer 9***	♦R/W	043B	41084
P04.60	***PLC Buffer 10***	♦R/W	043C	41085
P04.61	***PLC Buffer 11***	♦R/W	043D	41086
P04.62	***PLC Buffer 12***	♦R/W	043E	41087
P04.63	***PLC Buffer 13***	♦R/W	043F	41088
P04.64	***PLC Buffer 14***	♦R/W	0440	41089
P04.65	***PLC Buffer 15***	♦R/W	0441	41090
P04.66	***PLC Buffer 16***	♦R/W	0442	41091
P04.67	***PLC Buffer 17***	♦R/W	0443	41092
P04.68	***PLC Buffer 18***	♦R/W	0444	41093
P04.69	***PLC Buffer 19***	♦R/W	0445	41094
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–65535	0		

You can combine the PLC buffer with the built-in PLC function for a variety of applications.

Group P05.xx Details – Motor Parameters

In this parameter group, the following are abbreviations for different types of motors:

- *IM: Induction motor*
- *PM: Permanent magnet synchronous AC motor*
- *IPM: Interior permanent magnet synchronous AC motor*
- *SPM: Surface permanent magnet synchronous AC motor*

		Type	Hex Addr	Dec Addr
P05.00	**Motor Parameter Auto-tuning**	R/W	0000	41281
Range/Units (Format: 16-bit binary)		*Default*		
0: No function 1: Adv. rolling auto-tuning for IM motor flux curve (FOC/TQC) 2: Static test for induction motor (IM) 5: Rolling auto-tuning for PM (IPM / SPM) 6: Simple rolling auto-tuning for induction motor (IM) 12: FOC/TQC sensorless inertia estimation (IM) 13: Static Auto-tuning for PM (IPM/SPM)		0		

Setting 1 can be used for P00.10=2 Torque mode and P00.11=5 FOC sensorless mode only.

Setting 6 can be used for induction motor auto tune in these speed modes: P00.11=0, 1 or 2.

Drive motion will occur during these tests.

When auto tuning is in process, "TUN" will display on the drive keypad.

For PM motors, tune motor with no load connected. P05.00=5 provides more accurate calculation of the Ke parameter (P05.43) based on actual motor rotation. When P05.00=13, the Ke parameter is calculated based on the motor power, current and rotor speed.

See Adjustment and Applications section for detailed tuning procedures.

		Type	Hex Addr	Dec Addr
P05.01	**Full-load Current for Induction Motor 1 (A)**	Read	0501	41282
Range/Units (Format: 16-bit unsigned)		*Default*		
10–120 % of the drive's rated current		Model dependent		

Sets this value according to the rated current of the motor as indicated on the motor nameplate. The default is 90% of the drive's rated current.

Example:

The rated current for a 7.5 hp (5.5 kW) motor is 25A. The default is 22.5 A.

The setting range is 2.5–30 A (25 × 10% = 2.5 A and 25 × 120% = 30A).

		Type	Hex Addr	Dec Addr
P05.02	**Rated Power for Induction Motor 1 (kW)**	♦R/W	0502	41283
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–655.35 kW		Model dependent		

P05.02 sets the rated power for motor 1. The default is the drive's power value.

		Type	Hex Addr	Dec Addr
P05.03	**Rated Speed for Induction Motor 1 (rpm)**	♦R/W	0503	41284
Range/Units (Format: 16-bit unsigned)		Default		
0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz 4 poles); 1410 (50Hz 4 poles)		Dependent on the motor's number of poles		

P05.03 sets the rated speed for the motor as indicated on the motor nameplate.

This parameter works in conjunction with the Number of Poles and Hertz. Set up P01.01 and P05.04 before setting up P05.03 to ensure that the motor operates normally.

		Type	Hex Addr	Dec Addr
P05.04	**Number of Poles for Induction Motor 1**	R/W	0504	41285
Range/Units (Format: 16-bit unsigned)		Default		
2–20		4		

P05.04 sets the number of poles for the motor (must be an even number).

		Type	Hex Addr	Dec Addr
P05.05	**No-load Current for Induction Motor 1 (A)**	R/W	0505	41286
Range/Units (Format: 16-bit unsigned)		Default		
0.00–P05.01 default		Model dependent		

The default is 40% of the motor's rated current.

		Type	Hex Addr	Dec Addr
P05.06	**Stator Resistance (Rs) for Induction Motor 1**	R/W	0506	41287
Range/Units (Format: 16-bit unsigned)		Default		
0.000–65.535 Ω		Model dependent		

		Type	Hex Addr	Dec Addr
P05.07	**Rotor Resistance (Rr) for Induction Motor 1**	R/W	0507	41288
Range/Units (Format: 16-bit unsigned)		Default		
0.000–65.535 Ω		0.000		

		Type	Hex Addr	Dec Addr
P05.08	**Magnetizing Inductance (Lm) for Induction Motor 1**	R/W	0508	41289
P05.09	**Stator Inductance (Lx) for Induction Motor 1**	R/W	0509	41290
Range/Units (Format: 16-bit unsigned)		Default		
0.0–6553.5 mH		0.0		

		Type	Hex Addr	Dec Addr
P05.13	**Full-load Current for Induction Motor 2 (A)**	R/W	050D	41294
Range/Units (Format: 16-bit unsigned)		Default		
10–120 % of the drive's rated current		Model dependent		

Set P05.13 according to the rated current of the motor as indicated on the motor nameplate. The default is 90% of the drive's rated current.

Example:

The rated current for a 7.5 hp (5.5 kW) motor is 25A. The default is 22.5 A.

The setting range is 2.5–30 A (25 × 10 % = 2.5 A and 25 × 120 % = 30A).

		Type	Hex Addr	Dec Addr
P05.14	**Rated Power for Induction Motor 2 (kW)**	♦R/W	050E	41295
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–655.35 kW		Model dependent		

P05.14 sets the rated power for motor 2. The default is the drive's power value.

		Type	Hex Addr	Dec Addr
P05.15	**Rated Speed for Induction Motor 2 (rpm)**	♦R/W	050F	41296
Range/Units (Format: 16-bit unsigned)		*Default*		
0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz 4 poles); 1410 (50Hz 4 poles)		Dependent on the motor's number of poles		

P05.15 sets the rated speed for the motor as indicated on the motor nameplate.

This parameter works in conjunction with the Number of Poles and Hertz. Set up P01.35 and P05.16 before setting up P05.15 to ensure that the motor operates normally.

		Type	Hex Addr	Dec Addr
P05.16	**Number of Poles for Induction Motor 2**	R/W	0510	41297
Range/Units (Format: 16-bit unsigned)		*Default*		
2–20		4		

P05.16 sets the number of poles for the motor (must be an even number).

Check P05.15 for accuracy after changing this value.

		Type	Hex Addr	Dec Addr
P05.17	**No-load Current for Induction Motor 2 (A)**	R/W	0511	41298
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–P05.13 default		Model dependent		

The default is 40% of the motor's rated current.

		Type	Hex Addr	Dec Addr
P05.18	**Stator Resistance (Rs) for Induction Motor 2**	R/W	0512	41299
Range/Units (Format: 16-bit unsigned)		*Default*		
0.000–65.535 Ω		Model dependent		

		Type	Hex Addr	Dec Addr
P05.19	**Rotor Resistance (Rr) for Induction Motor 2**	R/W	0513	41300
Range/Units (Format: 16-bit unsigned)		*Default*		
0.000–65.535 Ω		0.000		

		Type	Hex Addr	Dec Addr
P05.20	**Magnetizing Inductance (Lm) for Induction Motor 2**	R/W	0514	41301
P05.21	**Stator Inductance (Lx) for Induction Motor 2**	R/W	0515	41302
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–6553.5 mH		0.0		

		Type	Hex Addr	Dec Addr
P05.22	**Multi-motor (Induction) Selection**	R/W	0516	41303
Range/Units (Format: 16-bit binary)		Default		
1: Motor 1 2: Motor 2 3: Motor 3 (VF or SVC control mode only) 4: Motor 4 (VF or SVC control mode only)		1		

P05.22 sets the motor operated by the AC motor drive. Multi-motor selection only supports single control mode. For example, when you set motor 1 as SVC control mode, the control mode of motors 2–4 are also set as SVC

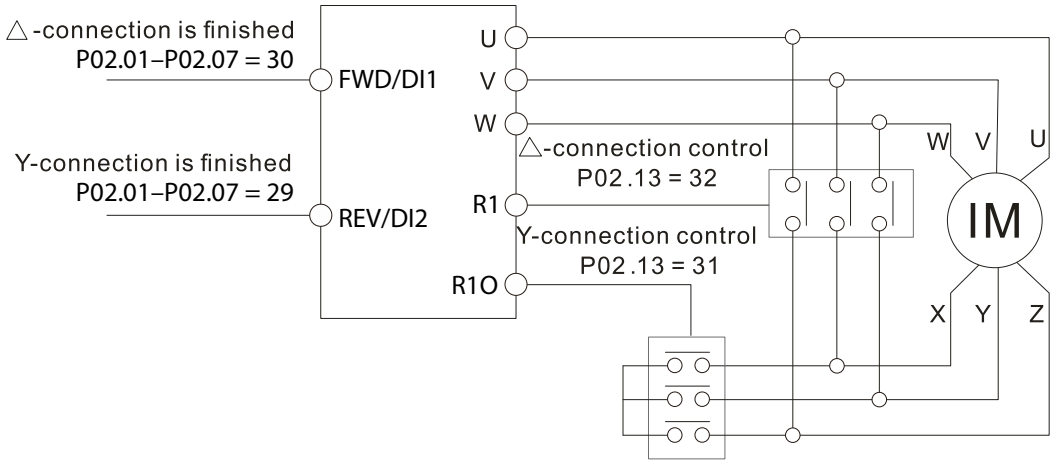
		Type	Hex Addr	Dec Addr
P05.23	**Frequency for Y-connection /Δ-connection Switch for an Induction Motor**	♦R/W	0517	41304
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		60.00		

		Type	Hex Addr	Dec Addr
P05.24	**Y-connection /Δ-connection Switch for an Induction Motor**	R/W	0518	41305
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Enable		0		

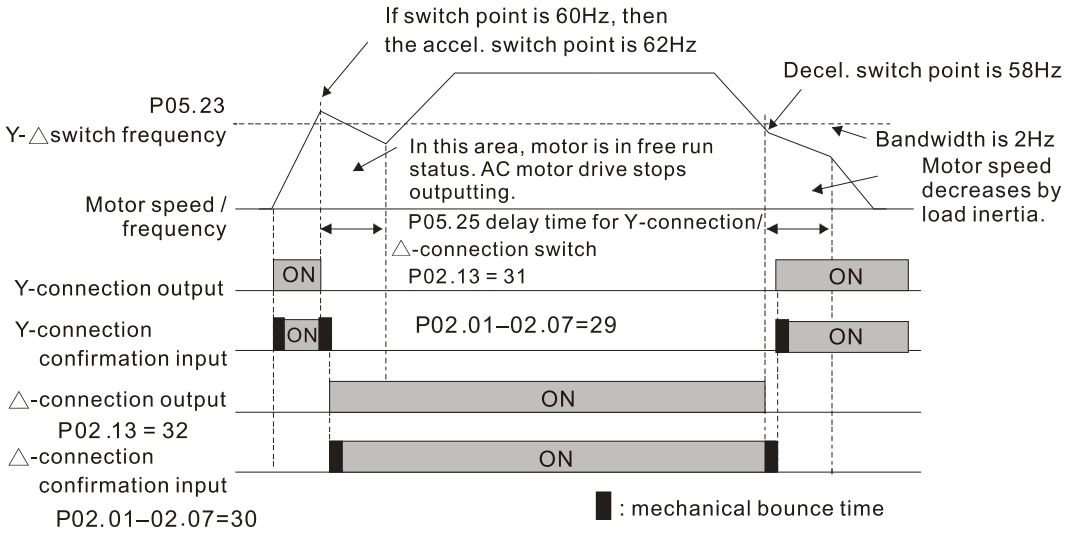
		Type	Hex Addr	Dec Addr
P05.25	**Delay Time for Y-connection/Δ-connection Switch for an Induction Motor**	♦R/W	0519	41306
Range/Units (Format: 16-bit unsigned)		Default		
0.000–60.000 sec.		0.200		

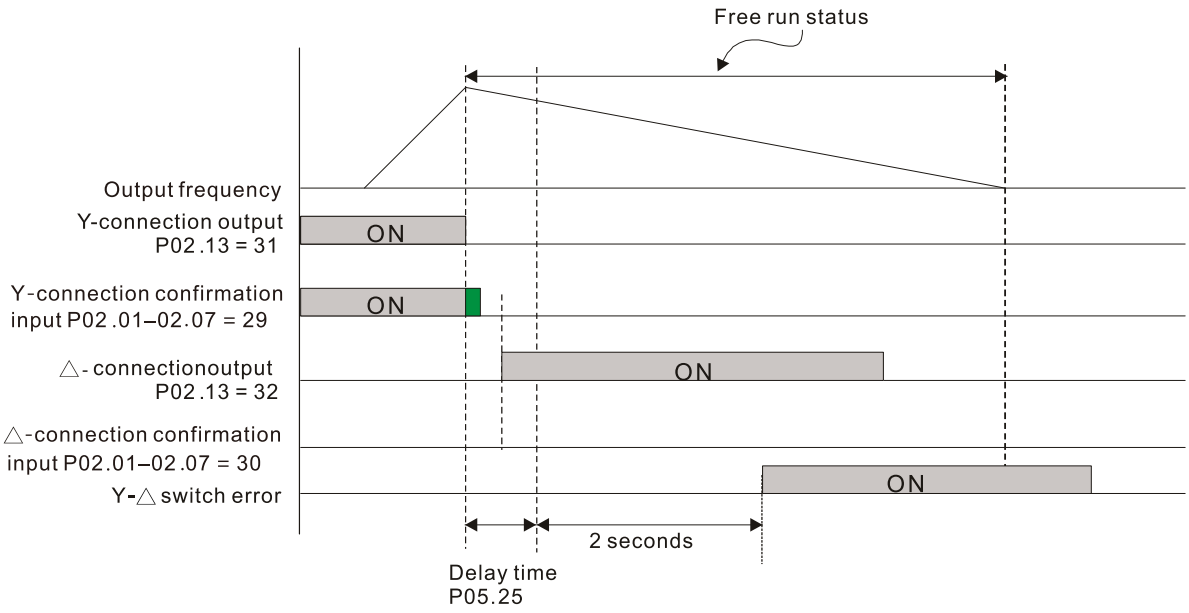
You can apply P05.23–P05.25 in wide range motors, and the motor coil executes the Y-connection/Δ-connection switch as required. The wide range motors are related to the motor design. In general, the motor has higher torque with low speed Y-connection and has higher speed with high speed Δ-connection.

- *P05.24 enables and disables the switch of Y-connection/Δ-connection.*
- *When you set P05.24 to 1, the drive uses the P05.23 setting and current motor frequency, and switches the current motor to Y-connection or Δ-connection. You can switch the relevant motor parameter settings simultaneously.*
- *P05.25 sets the switch delay time of Y-connection/Δ-connection.*
- *When the output frequency reaches the Y-connection/Δ-connection switch frequency, the drive delays according to P05.25 before activating the multi-function output terminals.*



Y- △connection switch: can be used for wide range motor
Y -connection for low speed: higher torque can be used for rigid tapping
△-connection for high speed: higher speed can be used for high-speed drilling





		Type	Hex Addr	Dec Addr
P05.26	***Accumulated Watt-second for a Motor (W-msec.)***	Read	051A	41307
P05.27	***Accumulated Watt-second for a Motor (W-sec. or joule)***	Read	051B	41308
P05.28	***Accumulated Watt-hour for a Motor (W-hour)***	Read	051C	41309
P05.29	***Accumulated Watt-hour for a Motor (kW-hour)***	Read	051D	41310
P05.30	***Accumulated Watt-hour for a Motor (MW-hour)***	Read	051E	41311
	Range/Units (Format: 16-bit unsigned)	*Default*		
	Read only	0		

Parameters P05.26–P05.30 record the amount of power the motors consume. The accumulation begins when the drive is activated and the record is saved when the drive stops or turns OFF. The amount of consumed watts continues to accumulate when the drive is activated again. To clear the accumulation, set P00.02 to 5 to return the accumulation record to 0.

- *The accumulated total watts of the motor per second = P05.27 x 65536 + P05.26.*
  Example: When P05.26 = 2548.1 and P05.27 = 15.2, the accumulated total watts of the motor per second = 15.2 x 65536 + 2548.1 = 996147.2 + 2548.1 = 998695.3
- *The accumulated total kilowatts of the motor per hour = P05.30 x 65536 + P05.29.*
  Example: When P05.29 = 3361.4 and P05.30 = 11.2, the accumulated total kilowatts of the motor per hour = 11.2 x 65536 + 3361.4 = 734003.2 + 3361.4 = 737364.6

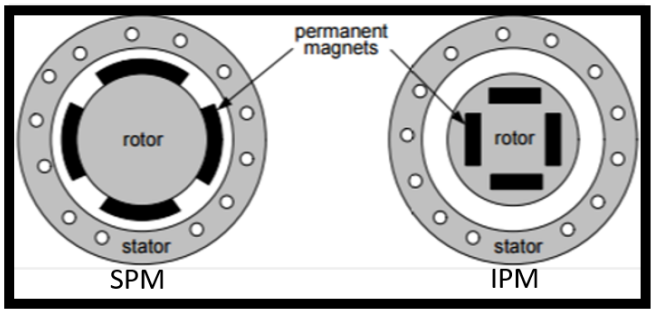
		Type	Hex Addr	Dec Addr
P05.31	***Accumulated Motor Operation Time (minutes)***	R/W	051F	41312
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–1439	0		

		Type	Hex Addr	Dec Addr
P05.32	***Accumulated Motor Operation Time (days)***	R/W	0520	41313
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–65535	0		

Use P05.31 and P05.32 to record the motor operation time. To clear the operation time, set P05.31 and P05.32 to 0. An operation time shorter than 60 seconds is not recorded.

P05.33	Induction Motor (IM) or Permanent Magnet Synchronous AC Motor Selection	Type: R/W	Hex Addr: 0521	Dec Addr: 41314
Range/Units (Format: 16-bit binary)		Default		
0: IM (Induction motor) 1: SPM (Surface permanent magnet synchronous AC motor) 2: IPM (Interior permanent magnet synchronous AC motor)		0		

On SPM motors, magnets are mounted on the exterior of the rotor shaft. On IPM motors, magnets are mounted inside of the rotor shaft.



P05.34	Full-load Current for a Permanent Magnet Synchronous AC Motor	Type: R/W	Hex Addr: 0522	Dec Addr: 41315
Range/Units (Format: 16-bit unsigned)		Default		
0–120% of the drive's rated current		Model dependent		

P05.35	Rated Power for a Permanent Magnet Synchronous AC Motor	Type: R/W	Hex Addr: 0523	Dec Addr: 41316
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 kW		Model dependent		

Sets the rated power for the permanent magnet synchronous AC motor. The default is the drive's power value.

P05.36	Rated Speed for a Permanent Magnet Synchronous AC Motor	Type: R/W	Hex Addr: 0524	Dec Addr: 41317
Range/Units (Format: 16-bit unsigned)		Default		
0–65535 rpm		2000		

P05.37	Number of Poles for a Permanent Magnet Synchronous AC Motor	Type: R/W	Hex Addr: 0525	Dec Addr: 41318
Range/Units (Format: 16-bit unsigned)		Default		
0–65535		10		

P05.39	Stator Resistance for a Permanent Magnet Synchronous AC Motor	Type: R/W	Hex Addr: 0527	Dec Addr: 41320
Range/Units (Format: 16-bit unsigned)		Default		
0.000–65.535 Ω		0.000		

P05.40	Permanent Magnet Synchronous AC Motor Ld	Type: R/W	Hex Addr: 0528	Dec Addr: 41321
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 mH		0.00		

		Type	Hex Addr	Dec Addr
P05.41	**Permanent Magnet Synchronous AC Motor Lq**	R/W	0529	41322
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 mH		0.00		

		Type	Hex Addr	Dec Addr
P05.43	**Ke parameter of a Permanent Magnet Synchronous AC Motor**	R/W	052B	41324
Range/Units (Format: 16-bit unsigned)		Default		
0–65535 V / krpm		0		

		Type	Hex Addr	Dec Addr
P05.64	**Full-load Current for Induction Motor 3 (A)**	R/W	0540	41345
Range/Units (Format: 16-bit unsigned)		Default		
10–120% of the drive's rated current		Model dependent		

Set this value according to the rated current of the motor as indicated on the motor nameplate. The default is 90% of the drive's rated current.

Example:

The rated current for a 7.5 hp (5.5 kW) motor is 25A. The default is 22.5 A.

The setting range is 2.5–30 A (25 × 10 % = 2.5 A and 25 × 120 % = 30A).

		Type	Hex Addr	Dec Addr
P05.65	**Rated Power for Induction Motor 3 (kW)**	♦R/W	0541	41346
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 kW		Model dependent		

P05.65 sets the rated power for motor 3. The default is the drive's power value.

		Type	Hex Addr	Dec Addr
P05.66	**Rated Speed for Induction Motor 3 (rpm)**	♦R/W	0542	41347
Range/Units (Format: 16-bit unsigned)		Default		
0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz 4 poles); 1410 (50Hz 4 poles)		Dependent on the motor's number of poles		

P05.66 sets the rated speed for the motor as indicated on the motor nameplate.

		Type	Hex Addr	Dec Addr
P05.67	**Number of Poles for Induction Motor 3**	R/W	0543	41348
Range/Units (Format: 16-bit unsigned)		Default		
2–20		4		

P05.67 sets the number of poles for the motor (must be an even number).

Set up P01.54 and P05.66 before setting up P05.67 to ensure that the motor operates normally.

		Type	Hex Addr	Dec Addr
P05.68	**No-load Current for Induction Motor 3 (A)**	R/W	0544	41349
Range/Units (Format: 16-bit unsigned)		Default		
0.00–P05.64 default		Model dependent		

The default is 40% of the motor's rated current.

	Type	Hex Addr	Dec Addr
P05.69 **Stator Resistance (Rs) for Induction Motor 3**	R/W	0545	41350
Range/Units (Format: 16-bit unsigned)	Default		
0.000–65.535 Ω	Model dependent		

	Type	Hex Addr	Dec Addr
P05.70 **Full-load Current for Induction Motor 4 (A)**	R/W	0546	41351
Range/Units (Format: 16-bit unsigned)	Default		
10–120% of the drive's rated current	Model dependent		

Set this value according to the rated current of the motor as indicated on the motor nameplate. The default is 90% of the drive's rated current.

Example:

The rated current for a 7.5 hp (5.5 kW) motor is 25A. The default is 22.5 A.

The setting range is 2.5–30 A (25 × 10% = 2.5 A and 25 × 120% = 30A).

	Type	Hex Addr	Dec Addr
P05.71 **Rated Power for Induction Motor 4 (kW)**	♦R/W	0547	41352
Range/Units (Format: 16-bit unsigned)	Default		
0.00–655.35 kW	Model dependent		

P05.71 sets the rated power for motor 4. The default is the drive's power value.

	Type	Hex Addr	Dec Addr
P05.72 **Rated Speed for Induction Motor 4 (rpm)**	♦R/W	0548	41353
Range/Units (Format: 16-bit unsigned)	Default		
0–xxxxx rpm (Depending on the motor's number of poles) 1710 (60Hz 4 poles); 1410 (50Hz 4 poles)	Dependent on the motor's number of poles		

P05.72 sets the rated speed for the motor as indicated on the motor nameplate.

	Type	Hex Addr	Dec Addr
P05.73 **Number of Poles for Induction Motor 4**	R/W	0549	41354
Range/Units (Format: 16-bit unsigned)	Default		
2–20	4		

P05.73 sets the number of poles for the motor (must be an even number).

Set up P01.63 and P05.72 before setting up P05.73 to make sure the motor operates normally.

	Type	Hex Addr	Dec Addr
P05.74 **No-load Current for Induction Motor 4 (A)**	R/W	054A	41355
Range/Units (Format: 16-bit unsigned)	Default		
0.00–P05.70 default	Model dependent		

The default is 40% of the motor's rated current.

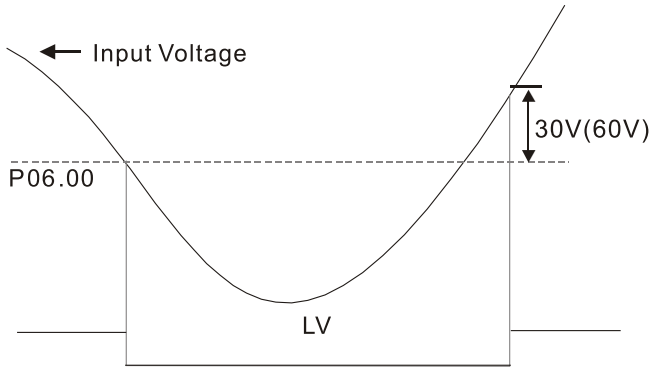
	Type	Hex Addr	Dec Addr
P05.75 **Stator Resistance (Rs) for Induction Motor 4**	R/W	054B	41356
Range/Units (Format: 16-bit unsigned)	Default		
0.000–65.535 Ω	Model dependent		

Group P06.xx Details – Protection Parameters

		Type	Hex Addr	Dec Addr
P06.00	**Low Voltage Level**	♦R/W	0600	41537
Range/Units (Format: 16-bit unsigned)		Default		
120V / 230V series: 150.0–220.0 VDC		180.0		
460V series: 300.0–440.0 VDC		360.0		
575V series: 375.0–550.0 VDC		450.0		

P06.00 sets the Low Voltage (LV) level. When the DC bus voltage is lower than P06.00 an LV fault is triggered.

- *If the LV fault is triggered during operation, the drive stops output and the motor coasts to a stop. There are three LV faults, LvA (LV during acceleration), Lvd (LV during deceleration), and Lvn (LV in constant speed) that are triggered according to the status of acceleration or deceleration. You must press RESET to clear the LV fault. The drive automatically restarts if set to restart after momentary power loss (refer to P07.06 Restart after Momentary Power Loss and P07.07 Allowed Power Loss Duration for details).*
- *If the LV fault is triggered when the drive is in STOP status, the drive displays LvS (LV during stop), which is not recorded, and the drive restarts automatically when the input voltage is higher than the LV level +30V (120V/230V series), +60V (460V series) or +75V (575 series).*



		Type	Hex Addr	Dec Addr
P06.01	**Over-voltage Stall Prevention**	♦R/W	0601	41538
Range/Units (Format: 16-bit unsigned)		Default		
0: Disabled				
120V / 230V: 0.0–390.0 VDC		380.0		
460V: 0.0–900.0 VDC		760.0		
575V: 0.0–1000.0 VDC		975.0		

Set P06.01 to 0.0 to disable the over-voltage stall prevention function (connected with braking unit or braking resistor). Use this setting when braking units or braking resistors are connected to the drive.

Set P06.01 to a value > 0.0 to enable the over-voltage stall prevention. This setting refers to the power supply system and loading. If the setting is too low, then over-voltage stall prevention is easily activated, which may increase deceleration time.

Related parameters:

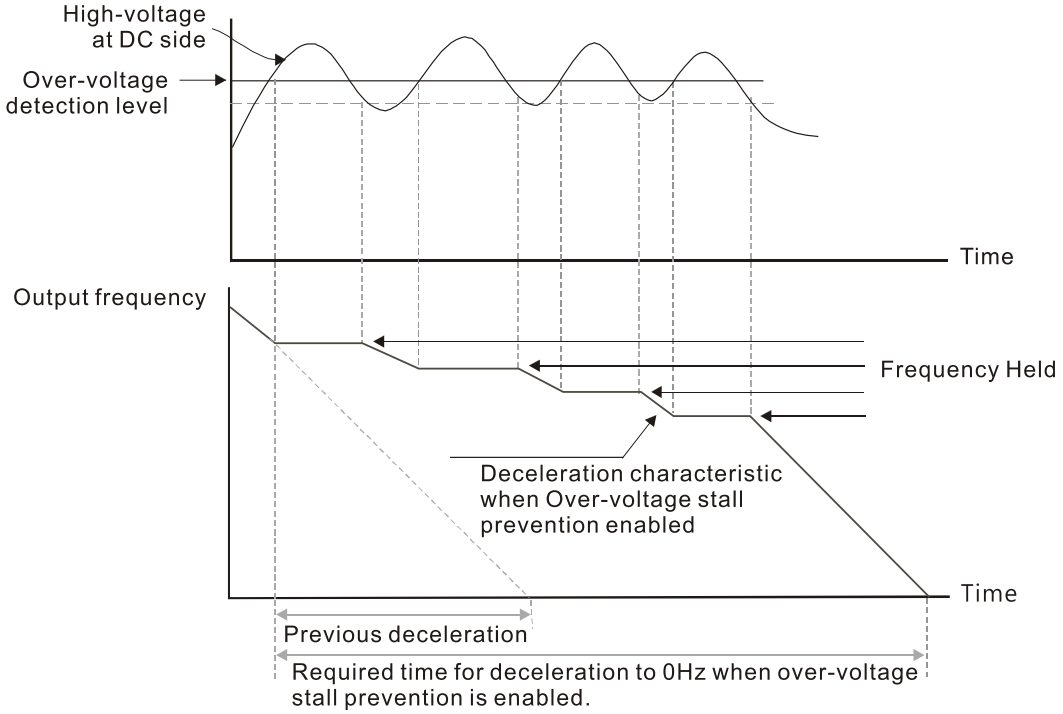
P01.13, P01.15, P01.17, P01.19 Deceleration Time 1–4, P02.13 Multi-function Output 1 (R1), P02.16–P02.17 Multi-function Output (DO1, DO2), and P06.02 Selection for Over-voltage Stall Prevention.

		Type	Hex Addr	Dec Addr
P06.02	**Selection for Over-voltage Stall Prevention**	♦R/W	0602	41539
Range/Units (Format: 16-bit binary)		*Default*		
0: Traditional over-voltage stall prevention		0		
1: Smart over-voltage stall prevention				

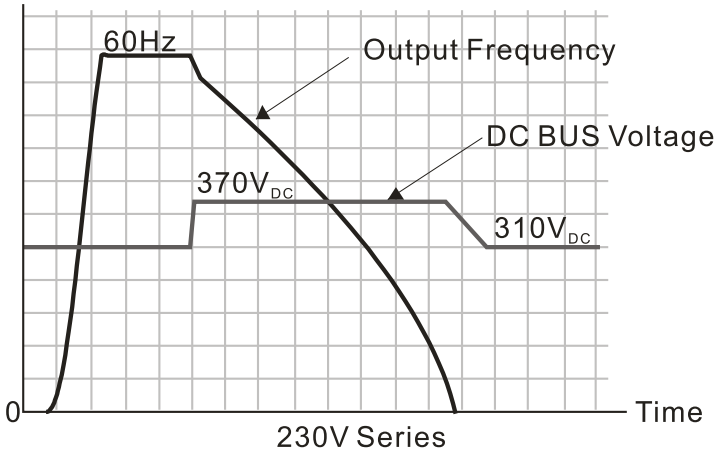
Use this function when you are unsure about the load inertia. When stopping under normal load, the over-voltage does not occur during deceleration and meet the deceleration time setting.

If an over-voltage occurs during deceleration to STOP due to a regenerative inertial load increase, then the AC motor drive extends the deceleration time automatically until the drive stops.

When P06.02 is set to 0, and during deceleration the motor exceeds the synchronous speed due to high load inertia (the motor becomes an electrical generator), then the DC bus voltage may exceed its maximum allowable value due to motor regeneration, or drive deceleration time being set too short. When traditional over-voltage stall prevention is enabled, if the DC bus voltage detected is too high, then the drive stops deceleration until the DC bus voltage drops below the setting value.



When P06.02 is set to 1 (smart over-voltage stall prevention), during deceleration the drive maintains the DC bus voltage preventing drive OV.



When you enable the over-voltage stall prevention, the drive's deceleration time is longer than the setting. If you encounter any problem with the deceleration time, refer to the following guides for troubleshooting.

1) Increase the deceleration time to a proper value.
2) Install a braking resistor (refer to Accessories appendix for details) to dissipate the electrical energy that is generated from the motor.

Related parameters:

P01.13, P01.15, P01.17, P01.19 Deceleration Time 1–4, P02.13 Multi-function Output 1 (Relay 1), P02.16–P02.17 Multi-function Output (DO1, DO2), and P06.01 Over-voltage Stall Prevention.

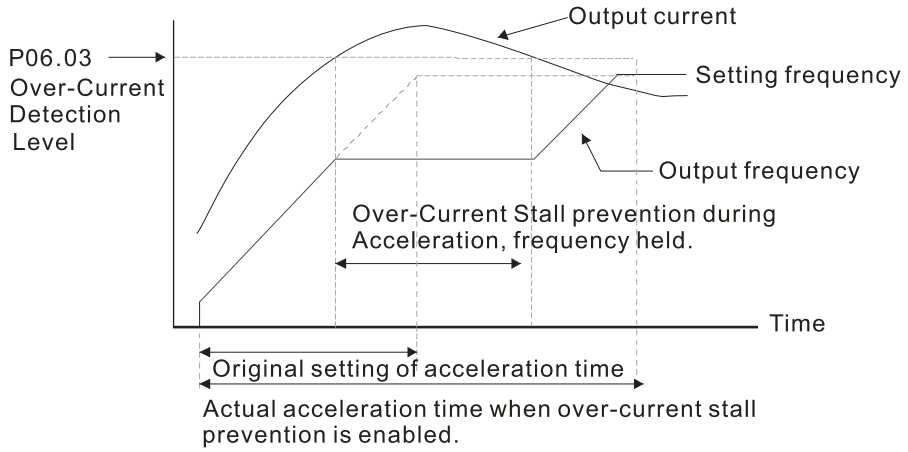
		Type	Hex Addr	Dec Addr
P06.03	***Over-current Stall Prevention during Acceleration***	♦R/W	0603	41540
Range/Units (Format: 16-bit unsigned)		*Default*		
Variable Torque (VT): 0–150% (100% corresponds to the rated current of the drive)		120		
Constant Torque (CT): 0–200% (100% corresponds to the rated current of the drive)		180		

In constant torque mode (P00.16=1), if the DC voltage is higher than the 875VDC (575V series), 700VDC (460V series) or 350VDC (120/230 series), the maximum value for P06.03 is 185%.

- *If the motor load is too large or the drive's acceleration time is too short, the output current of the drive may be too high during acceleration, and it may cause motor damage or trigger the drive's protection functions (OL or OC). Use this parameter to prevent these situations.*
- *During acceleration, the output current of the drive may increase abruptly and exceed the setting value of P06.03. In this case, the drive stops accelerating and keeps the output frequency constant, and then continues to accelerate until the output current decreases.*
- *When you enable the over-current stall prevention, the drive's acceleration time is longer than the setting.*
- *When the over-current stall prevention occurs because the motor capacity is too small or operates in the default, decrease the P06.03 setting value.*
- *If you encounter any problem with the acceleration time, refer to the following guides for troubleshooting.*
  a) Increase the deceleration time to a proper value.
  b) Set P01.44 Auto-Acceleration and Auto-Deceleration Setting to 1, 3 or 4 (auto-acceleration)

Related parameters:

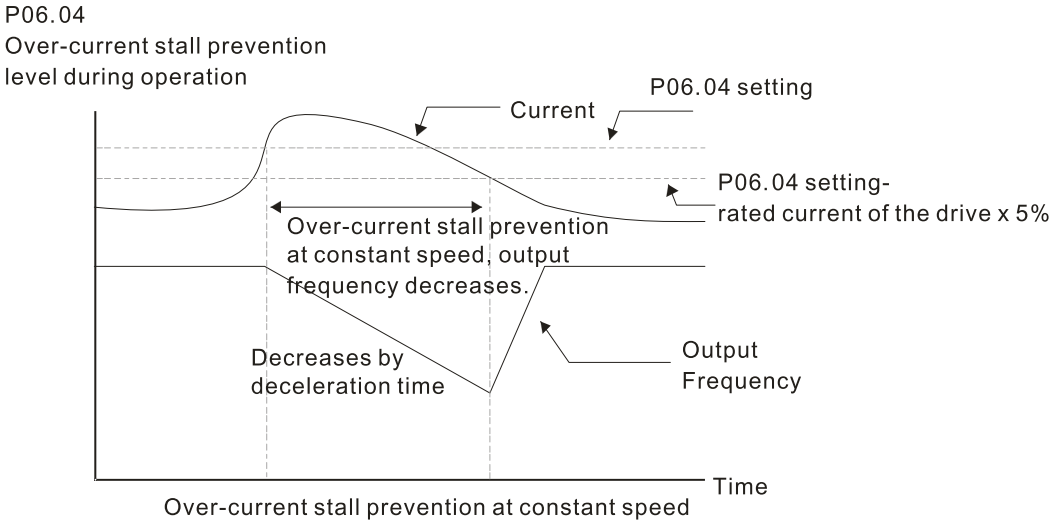
P01.12, P01.14, P01.16, P01.18 (Acceleration Time 1–4), P01.44. Auto-Acceleration and Auto-Deceleration Setting, P02.13 Multi-function Output 1 (Relay 1), P02.16–P02.17 Multi-function Output (DO1, DO2).



		Type	Hex Addr	Dec Addr
P06.04	***Over-current Stall Prevention during Operation***	♦R/W	0604	41541
Range/Units (Format: 16-bit unsigned)		*Default*		
Variable Torque (VT): 0–150% (100% corresponds to the rated current of the drive) Constant Torque (CT): 0–200% (100% corresponds to the rated current of the drive)		120 / 180		

In constant torque mode (P00.16=1), if the DC voltage is higher than the 875VDC (575V series), 700VDC (460V series) or 350VDC (120/230 series), the maximum value for P06.04 is 185%.

- *This is a protection for the drive and decreases output frequency automatically when the motor overloads abruptly during constant motor operation.*
- *If the output current exceeds the setting value for P06.04 when the drive is operating, the drive decelerates according to the P06.05 setting to prevent the motor from stalling. If the output current is lower than the setting value for P06.04, the drive accelerates (according to P06.05) to the setting frequency.*



Over-current stall prevention at constant speed

		Type	Hex Addr	Dec Addr
P06.05	**Acceleration/Deceleration Time Selection for Stall Prevention at Constant Speed**	♦R/W	0605	41542
Range/Units (Format: 16-bit binary)		*Default*		
0: By current acceleration / deceleration time 1: By the first acceleration / deceleration time 2: By the second acceleration / deceleration time 3: By the third acceleration / deceleration time 4: By the fourth acceleration / deceleration time 5: By auto-acceleration / auto-deceleration		0		

P06.05 sets the acceleration / deceleration time selection when stall prevention occurs at constant speed.

		Type	Hex Addr	Dec Addr
P06.06	**Over-torque Detection Selection (Motor 1)**	♦R/W	0606	41543
P06.09	**Over-torque Detection Selection (Motor 2)**	♦R/W	0609	41546
Range/Units (Format: 16-bit binary)		*Default*		
0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN		0		

When you set P06.06 and P06.09 to 1 or 3, a warning message displays but there is no error record.

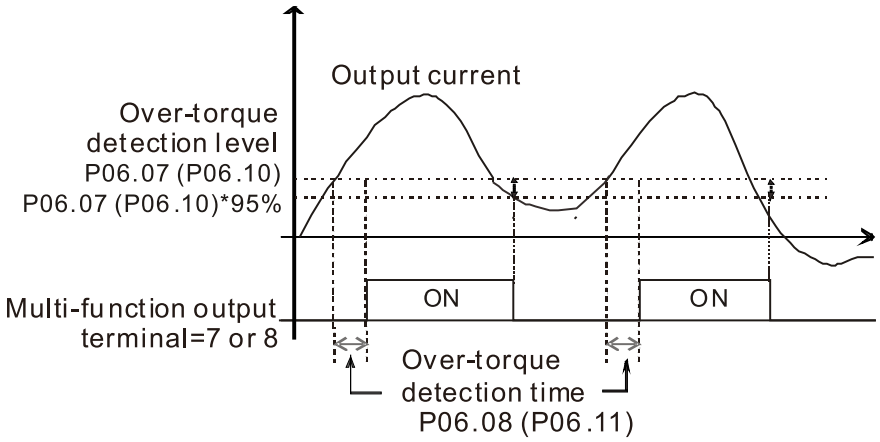
When you set P06.06 and P06.09 to 2 or 4, an error message displays and there is an error record.

		Type	Hex Addr	Dec Addr
P06.07	**Over-torque Detection Level (Motor 1)**	♦R/W	0607	41544
P06.10	**Over-torque Detection Level (Motor 2)**	♦R/W	060A	41547
Range/Units (Format: 16-bit unsigned)		*Default*		
10–250% (100% corresponds to the rated current of the drive)		120		

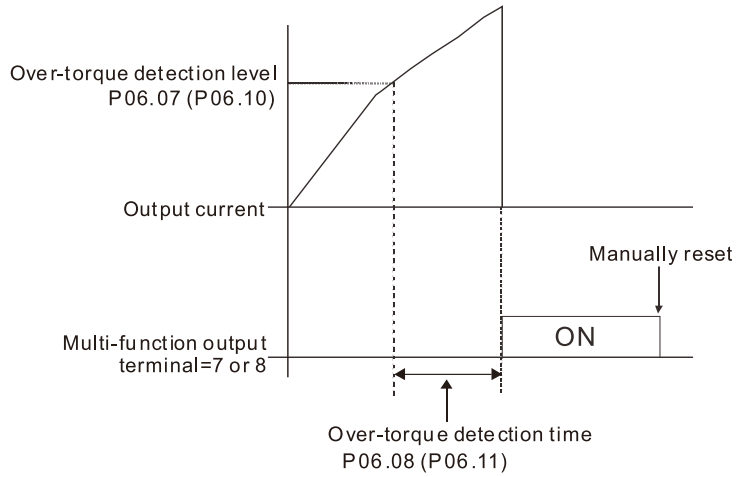
		Type	Hex Addr	Dec Addr
P06.08	**Over-torque Detection Time (Motor 1)**	♦R/W	0608	41545
P06.11	**Over-torque Detection Time (Motor 2)**	♦R/W	060B	41548
Range/Units (Format: 16-bit unsigned)		*Default*		
0.1–60.0 sec.		0.1		

When the output current exceeds the over-torque detection level (P06.07 or P06.10) and also exceeds the over-torque detection time (P06.08 or P06.11), the over-torque detection follows the setting of P06.06 and P06.09.

- *When you set P06.06 or P06.09 to 1 or 3, an ot1 / ot2 warning displays while the drive keeps running after over-torque detection. The warning remains on until the output current is smaller than 5% of the over-torque detection level.*



- *When you set P06.06 or P06.09 to 2 or 4, an ot1 / ot2 warning displays and the drive stops running after over-torque detection. The drive does not run until you manually reset it.*



		Type	Hex Addr	Dec Addr
P06.12	**Current Limit**	♦R/W	060C	41549
Range/Units (Format: 16-bit unsigned)		*Default*		
0–250% (100% corresponds to the rated current of the drive)		150		

This parameter limits the current output of the drive in all control modes.

		Type	Hex Addr	Dec Addr
P06.13	**Electronic Thermal Relay Selection 1 (Motor 1)**	♦R/W	060D	41550
P06.27	**Electronic Thermal Relay Selection 2 (Motor 2)**	♦R/W	061B	41564
Range/Units (Format: 16-bit binary)		*Default*		
0: Inverter motor (with external forced cooling) 1: Standard motor (motor with fan on the shaft) 2: Disable		1		

These parameters prevent self-cooled motors from overheating under low speed. Use an electronic thermal relay to limit the drive's output power. A value of 1 or 2 is recommended for most applications to better protect the motor.

- *Setting the parameter to 0 is suitable for an inverter motor (motor fan using an independent power supply). For this kind of motor, there is no significant correlation between cooling capacity and motor speed. Therefore, the action of electronic thermal relays remains stable in low speed to ensure the load capability of the motor in low speed.*

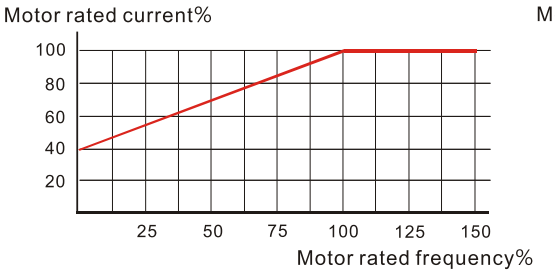
- *Setting the parameter to 1 is suitable for standard motor (motor fan is fixed on the rotor shaft). For this kind of motor, the cooling capacity is lower in low speed; therefore, the action of an electronic thermal relay reduces the action time to ensure the life of motor.*
- *When the power is cycled frequently, the electronic thermal relay protection is reset when the power is switched OFF; therefore, even setting the parameter to 0 or 1 may not protect the motor well. If there are several motors connected to one drive, install an electronic thermal relay in each motor.*

		Type	Hex Addr	Dec Addr
P06.14	**Electronic Thermal Relay Action Time 1 (Motor 1)**	♦R/W	060E	41551
P06.28	**Electronic Thermal Relay Action Time 2 (Motor 2)**	♦R/W	061C	41565
Range/Units (Format: 16-bit unsigned)		Default		
30.0–600.0 sec.		60.0		

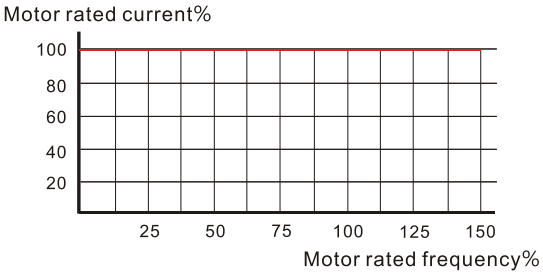
The electronic thermal relay amperage threshold is based on 150% of the parameter value in "Full Load Current for Induction Motor X" (P5.01 for motor 1, P5.13 for motor 2).

Set Parameter 06.14 or 06.28 for the amount of time the motor exceeds this threshold. Proper setup will prevent motor damage due to overheating. When it reaches the setting, the drive displays "EoL3 / EoL4", and the motor coasts to stop.

Use this parameter to set the action time of the electronic thermal relay. It works based on the I2t characteristic curve of electronic thermal relay, the output frequency and current of the drive, and the operation time to prevent the motor from overheating.



Motor cooling curve with shaft-fixed fan

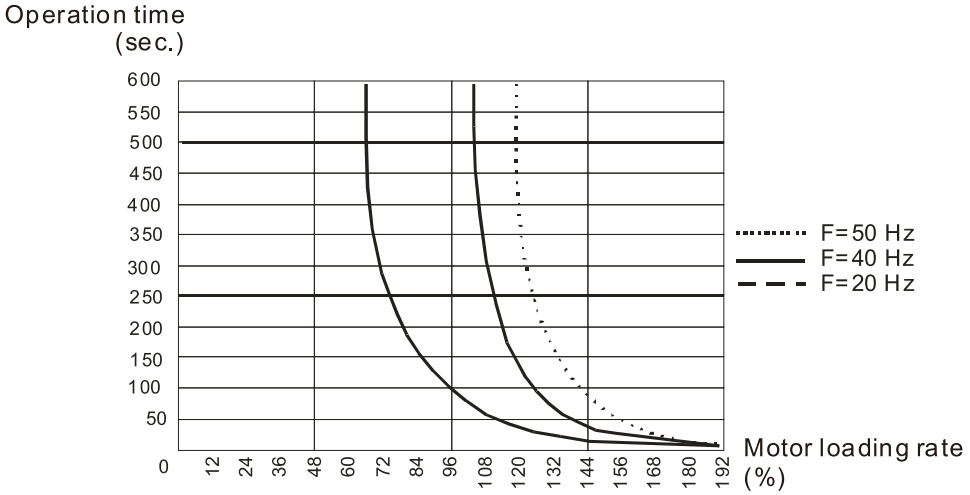


Motor cooling curve with independent fan

The action of the electronic thermal relay depends on the settings for P06.13 and P06.27.

1) P06.13 or P06.27 is set to 0 (using inverter motor):
When the output current of the drive is higher than 150% of the motor rated current (refer to the motor rated current % corresponded to the motor rated frequency in the motor cooling curve with independent fan), the drive starts to count the time. The electronic thermal relay acts when the accumulated time exceeds P06.14 or P06.28.

2) P06.13 or P06.27 is set to 1 (using standard motor):
When the output current of the drive is higher than 150% of the motor rated current (refer to the motor rated current % corresponded to the motor rated frequency in the motor cooling curve with shaft-fixed fan), the drive starts to count the time. The electronic thermal relay acts when the accumulated time exceeds P06.14 or P06.28.
The actual electronic thermal relay action time adjusts according to the drive output current (shown as the motor loading rate %). The action time is short when the current is high, and the action time is long when the current is low. Refer to the following diagram.



		Type	Hex Addr	Dec Addr
P06.15	**Temperature Level Overheat (OH) Warning**	♦R/W	060F	41552
Range/Units (Format: 16-bit unsigned)		Default		
0.0–110.0°C		Model dependent		

P06.15 sets the drive's internal IGBT overheat warning level. When the temperature is higher than P06.15 setting, the oH1 fault displays and the warning remains but it does not affect the drive operation.

- *Use this parameter to check the IGBT temperature in order to take precautionary measures to decrease the temperature and maintain the IGBT's normal operation.*
- *When the IGBT temperature reaches 5ºC higher than the maximum setting value for P06.15, IGBT overheating occurs and the drive stops. Refer to oH1 fault descriptions for details.*

		Type	Hex Addr	Dec Addr
P06.16	**Stall Prevention Limit Level (Weak Magnetic Field Current Stall Prevention Level)**	♦R/W	0610	41553
Range/Units (Format: 16-bit unsigned)		Default		
0–100% (Refer to P06.03–P06.04)		100		

P06.16 only works in VF, VFPG, and SVC control mode.

Sets the over-current stall prevention level when the motor's operation frequency is larger than P01.01 (base frequency).

Example:

When P06.03 = 150%, P06.04 = 100% and P06.16 = 80%.

- *The over-current stall prevention level during acceleration: P06.03 * P06.16 = 150 x 80% = 120%.*
- *The over-current stall prevention level during operation: P06.04 * P06.16 = 100 x 80% = 80%.*

		Type	Hex Addr	Dec Addr
P06.17	Fault Record 1	Read	0611	41554
P06.18	Fault Record 2	Read	0612	41555
P06.19	Fault Record 3	Read	0613	41556
P06.20	Fault Record 4	Read	0614	41557
P06.21	Fault Record 5	Read	0615	41558
P06.22	Fault Record 6	Read	0616	41559

Range/Units (Format: 16-bit binary)	Default
0: No fault record	0
1: Over-current during acceleration (ocA)	
2: Over-current during deceleration (ocd)	
3: Over-current during steady operation (ocn)	
4: Ground fault (GFF)	
6: Over-current at stop (ocS)	
7: Over-voltage during acceleration (ovA)	
8: Over-voltage during deceleration (ovd)	
9: Over-voltage during constant speed (ovn)	
10: Over-voltage at stop (ovS)	
11: Low-voltage during acceleration (LvA)	
12: Low-voltage during deceleration (Lvd)	
13: Low-voltage during constant speed (Lvn)	
14: Low-voltage at stop (LvS)	
15: Phase loss protection (orP)	
16: IGBT overheating (oH1)	
18: IGBT temperature detection failure (tH1o)	
21: Over load (oL)	
22: Electronic thermal relay 1 protection (EoL1)	
23: Electronic thermal relay 2 protection (EoL2)	
24: Motor PTC overheating (oH3)	
26: Over torque 1 (ot1)	
27: Over torque 2 (ot2)	
28: Under current (uC)	
31: EEPROM read error (cF2)	
33: U-phase error (cd1)	
34: V-phase error (cd2)	
35: W-phase error (cd3)	
36: cc (current clamp) hardware error (Hd0)	
37: oc (over-current) hardware error (Hd1)	
40: Auto-tuning error (AUE)	
41: PID loss AI2 (AFE)	
43: PG feedback loss (PGF2)	
44: PG feedback stall (PGF3)	
45: PG slip error (PGF4)	
48: AI2 loss (ACE)	
49: External fault (EF)	
50: Emergency stop (EF1)	
51: External base block (bb)	
52: Password is locked (Pcod)	
54: Illegal command (CE1)	
55: Illegal data address (CE2)	
56: Illegal data value (CE3)	
57: Data is written to read-only address (CE4)	

58: Modbus transmission time-out (CE10)
61: Y-connection / Δ-connection switch error (ydc)
62: Deceleration energy backup error (dEb)
63: Over slip error (oSL)
72: STO Loss (STL1)
76: STO (STo)
77: STO Loss 2 (STL2)
78: STO Loss 3 (STL3)
79: U-phase over-current before run (Aoc)
80: V-phase over-current before run (boc)
81: W-phase over-current before run (coc)
82: Output phase loss U phase (oPL1)
83: Output phase loss V phase (oPL2)
84: Output phase loss W phase (oPL3)
87: Low frequency overload protection (oL3)
89: Rotor position detection error (roPd)
97: Ethernet Card Timeout (CD10)
111: InrCOM time-out error (ictE)
121: Internal communication error (CP20)
123: Internal communication error (CP22)
124: Internal communication error (CP30)
126: Internal communication error (CP32)
127: Internal communication error (CP33)
128: Over-torque 3 (ot3)
129: Over-torque 4 (ot4)
134: Internal communication error (EoL3)
135: Internal communication error (EoL4)
140: Oc hardware error (Hd6)
141: GFF occurs before run (b4GFF)
142: Auto-tune error 1 (DC test stage) (AuE1)
143: Auto-tune error 2 (High frequency test stage) (AuE2)
144: Auto-tune error 3 (Rotary test stage) (AuE3)
149: Auto-tune error 5 (Rotor resistance measure test stage) (AuE5)

These parameters record when the fault occurs and forces a stop.

- *When low-voltage at stop fault (LvS) occurs, the fault is not recorded. When low-voltage during operation faults (LvA, Lvd, Lvn) occur, the faults are recorded.*
- *When dEb function is valid and enabled, the drive executes dEb and records fault code 62 to P06.17–P06.22 and P14.70–P14.73 simultaneously.*

		Type	Hex Addr	Dec Addr
P06.23	**Fault Output Option 1**	♦R/W	0617	41560
P06.24	**Fault Output Option 2**	♦R/W	0618	41561
P06.25	**Fault Output Option 3**	♦R/W	0619	41562
P06.26	**Fault Output Option 4**	♦R/W	061A	41563

Range/Units (Format: 16-bit unsigned) — *Default*

0–65535 (refer to bit table for fault code) — 0

Use these parameters with multi-function output terminal (set P06.23–P06.26 to 35–38) for the specific requirement. When a fault occurs, the corresponding terminals are activated. Convert the binary value to a decimal value before you enter the value for P06.23–P06.26.

Fault Code Table

Fault Code	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6
	current	Volt.	OL	SYS	FBK	EXI	CE
0: No fault record							
1: Over-current during acceleration (ocA)	●						
2: Over-current during deceleration (ocd)	●						
3: Over-current during steady operation (ocn)	●						
4: Ground fault (GFF)	●						
6: Over-current at stop (ocS)	●						
7: Over-voltage during acceleration (ovA)		●					
8: Over-voltage during deceleration (ovd)		●					
9: Over-voltage during constant speed (ovn)		●					
10: Over-voltage at stop (ovS)		●					
11: Low-voltage during acceleration (LvA)		●					
12: Low-voltage during deceleration (Lvd)		●					
13: Low-voltage during constant speed (Lvn)		●					
14: Low-voltage at stop (LvS)		●					
15: Phase loss protection (orP)		●					
16: IGBT over-heat (oH1)			●				
18: IGBT temperature detection failure (tH1o)			●				
21: Drive over-load (oL)			●				
22: Electronics thermal relay 1 protection (EoL1)			●				
23: Electronics thermal relay 2 protection (EoL2)			●				
24: Motor PTC overheating (oH3)			●				
26: Over torque 1 (ot1)			●				
27: Over torque 2 (ot2)			●				
28: Under current (uC)	●						
31: EEPROM read error (cF2)				●			
33: U-phase error (cd1)				●			
34: V-phase error (cd2)				●			
35: W-phase error (cd3)				●			
36: cc (current clamp) hardware error (Hd0)				●			
37: oc (over-current) hardware error (Hd1)				●			
40: Auto-tuning error (AUE)				●			
41: PID loss ACI (AFE)					●		
43: PG feedback loss (PGF2)					●		
44: PG feedback stall (PGF3)					●		
45: PG slip error (PGF4)					●		

Fault Code	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6
	current	Volt.	OL	SYS	FBK	EXI	CE
48: ACI loss (ACE)					●		
49: External fault (EF)						●	
50: Emergency stop (EF1)						●	
51: External base block (bb)						●	
52: Password is locked (Pcod)				●			
54: Illegal command (CE1)							●
55: Illegal data address (CE2)							●
56: Illegal data value (CE3)							●
57: Data is written to read-only address (CE4)							●
58: Modbus transmission time-out (CE10)							●
61: Y-connection / Δ-connection switch error (ydc)						●	
62: Deceleration energy backup error (dEb)		●					
63: Over slip error (oSL)						●	
72: STO Loss (STL1)				●			
76: STO (STo)				●			
77: STO Loss 2 (STL2)				●			
78: STO Loss 3 (STL3)				●			
79: U-phase over-current before run (Aoc)	●						
80: V-phase over-current before run (boc)	●						
81: W-phase over-current before run (coc)	●						
82: U-phase output phase loss (oPL1)	●						
83: V-phase output phase loss (oPL2)	●						
84: W-phase output phase loss (oPL3)	●						
87: Low frequency overload protection (oL3)			●				
89: Rotor position detection error (roPd)					●		
97: Ethercat Card Timeout (CD10)							●
111: InrCOM time-out error (ictE)							●
121: Internal communication error (CP20)							●
123: Internal communication error (CP22)							●
124: Internal communication error (CP30)							●
126: Internal communication error (CP32)							●
127: Internal communication error (CP33)				●			
128: Over-torque 3 (ot3)			●				
129: Over-torque 4 (ot4)			●				
134: Electronics thermal relay 3 protection (EoL3)			●				
135: Electronics thermal relay 4 protection (EoL4)			●				
140: Oc hardware error (Hd6)				●			
141: GFF occurs before run (b4GFF)				●			
142: Auto-tuning error 1 (no feedback current error) (AUE1)				●			
143: Auto-tuning error 2 (motor phase loss error) (AUE2)				●			
144: Auto-tuning error 3 (no-load current I0 measuring error) (AUE3)				●			
149: Auto-tune error 5 (Rotor resistance measuring error) (AUE5)				●			

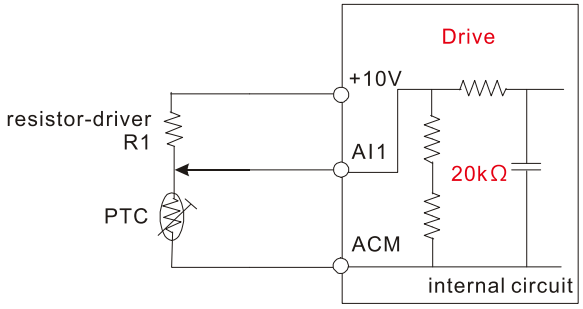
		Type	Hex Addr	Dec Addr
P06.29	**PTC Detection Selection**	♦R/W	061D	41566
Range/Units (Format: 16-bit binary)		Default		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning		0		

P06.29 sets the operation mode of a drive after detecting PTC (Positive Temperature Coefficient).

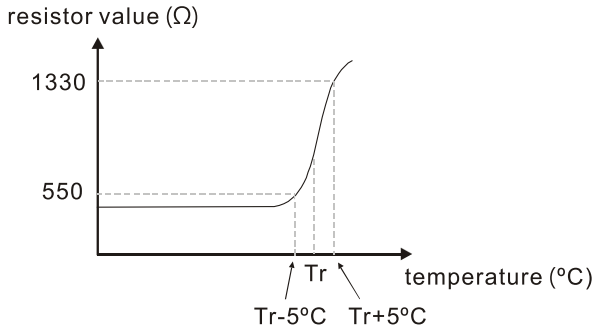
		Type	Hex Addr	Dec Addr
P06.30	**PTC Level**	♦R/W	061E	41567
Range/Units (Format: 16-bit binary)		Default		
0.0–100.0%		50.0		

P06.30 sets AI1 / AI2 analog input function P03.00–03.01 to 6 [thermistor (PTC) input value)].

- *Use this parameter to set the PTC level; 100% PTC level corresponds to the maximum analog input value.*
- *When using the AI1 terminal, you must set P03.28 to 0 and switch AI2 voltage to 0–10 V. At this time, the AI1 input impedance is 20 KΩ.*
- *When the temperature rises to the set protection level, the motor responds according to the settings for P06.29 and displays warning "oH3" (if P06.29 = 1–3). When the temperature is lower than the set protection level, you can press RESET key to clear the fault.*
- *The PTC uses the AI1-input and is connected through divider resistance as shown below:*
  a) The voltage between +10V to ACM: lies within 10–11V.
  b) The impedance for AI1 is around 20K Ω. Recommended value for divider resistance is 1K–10K Ω.
  c) Please contact your motor dealer for the curve of temperature and resistance value for PTC. Protection level (P06.30) = V+10 * (RPTC//20K) / [R1+(RPTC//20K)]
     i) V+10: voltage between +10V-ACM actual value
     ii) RPTC: motor PTC overheat protection level;
     iii) 20K Ω: the AI1 input impedance;
     iv) R1: divider resistance (recommended value: 1–10k Ω)



Take the standard PTC thermistor as an example: if the protection level is 1330 Ω, the actual voltage between +10V-ACM is 10.5 V and divider resistance R1 is 4.4k Ω.



Refer to the following calculation when P06.30 is set to 23% and motor temperature overheating protection level is 1330Ω:

1330//20000 = (1330*20000) / (1330+20000) = 1247.07

10.5 * 1247.07 / (4400+1247.07) = 2.32 (V) = 2.3 (V)

P06.30 = 2.3 / 10 V * % = 23%

		Type	Hex Addr	Dec Addr
P06.31	**Frequency Command at Malfunction**	Read	061F	41568
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		0		

When a malfunction occurs, check the current Frequency command. If it happens again, it overwrites the previous record

		Type	Hex Addr	Dec Addr
P06.32	**Output Frequency at Malfunction**	Read	0620	41569
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		0		

When a malfunction occurs, check the current output frequency. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.33	**Output Voltage at Malfunction**	Read	0621	41570
Range/Units (Format: 16-bit unsigned)		Default		
0.0–6553.5 V		0		

When a malfunction occurs, check the current output voltage. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.34	**DC bus Voltage at Malfunction**	Read	0622	41571
Range/Units (Format: 16-bit unsigned)		Default		
0.0–6553.5 V		0		

When a malfunction occurs, check the current DC bus voltage. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.35	**Output Current at Malfunction**	Read	0623	41572
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 Amp		0		

When a malfunction occurs, check the current output current. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.36	**IGBT Temperature at Malfunction**	Read	0624	41573
Range/Units (Format: 16-bit signed)		Default		
-3276.7–3276.7 °C		0		

When a malfunction occurs, check the current IGBT temperature. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.38	**Motor Speed at Malfunction**	Read	0626	41575
Range/Units (Format: 16-bit signed)		Default		
-32767–32767 rpm		0		

When a malfunction occurs, check the current motor speed in rpm. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.39	**Torque Command at Malfunction**	Read	0627	41576
Range/Units (Format: 16-bit signed)		Default		
-32767–32767%		0		

When a malfunction occurs, check the current torque command. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.40	**Status of the Multi-function Input Terminal at Malfunction**	Read	0628	41577
P06.41	**Status of the Multi-function Output Terminal at Malfunction**	Read	0629	41578
Range/Units (Format: 16-bit unsigned)		Default		
0000h–FFFFh		0		

When a malfunction occurs, check the current status of the multi-function input/output terminals. If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.42	**Drive Status at Malfunction**	Read	062A	41579
Range/Units (Format: 16-bit unsigned)		Default		
0000h–FFFFh		0		

When a malfunction occurs, check the current drive status (communication address 2101H). If it happens again, it overwrites the previous record.

		Type	Hex Addr	Dec Addr
P06.43	**IGBT Temperature**	Read	062B	41580
Range/Units (Format: 16-bit unsigned)		Default		
-3276.7–3276.7 °C		–		

Parameter P06.43 allows the user the monitor the IGBT temperature in degrees Celcius. This register is read only.

		Type	Hex Addr	Dec Addr
P06.44	**STO Latch Selection**	♦R/W	062C	41581
Range/Units (Format: 16-bit binary)		Default		
0: STO Latch 1: STO No Latch		0		

Use P06.44 to select STO latch.

- *P06.44 = 0: STO Alarm Latch. After you clear the cause of the STO Alarm, use a Reset command to clear the STO Alarm.*
- *P06.44 = 1: STO Alarm no Latch. After you clear the cause of the STO Alarm, the STO Alarm clears automatically.*

All of the STL1–STL3 errors are “Alarm Latch” mode (in STL1–STL3 mode, the P06.44 function is not available).

		Type	Hex Addr	Dec Addr
P06.45	**Output Phase Loss Detection Action (OPHL)**	♦R/W	062D	41582
Range/Units (Format: 16-bit binary)		Default		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning		3		

The OPHL protection is enabled when P06.45 is not set to 3.

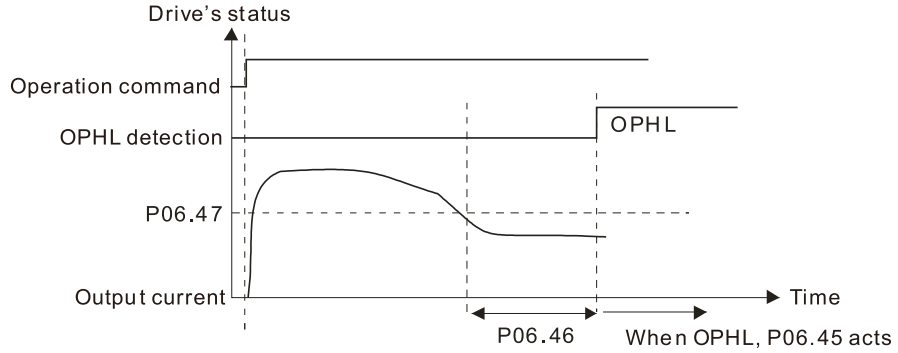
		Type	Hex Addr	Dec Addr
P06.46	**Detection Time for Output Phase Loss**	♦R/W	062E	41583
Range/Units (Format: 16-bit unsigned)		Default		
0.000–65.535 sec.		0.500		

		Type	Hex Addr	Dec Addr
P06.47	**Current Detection Level for Output Phase Loss**	♦R/W	062F	41584
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00%		1.00		

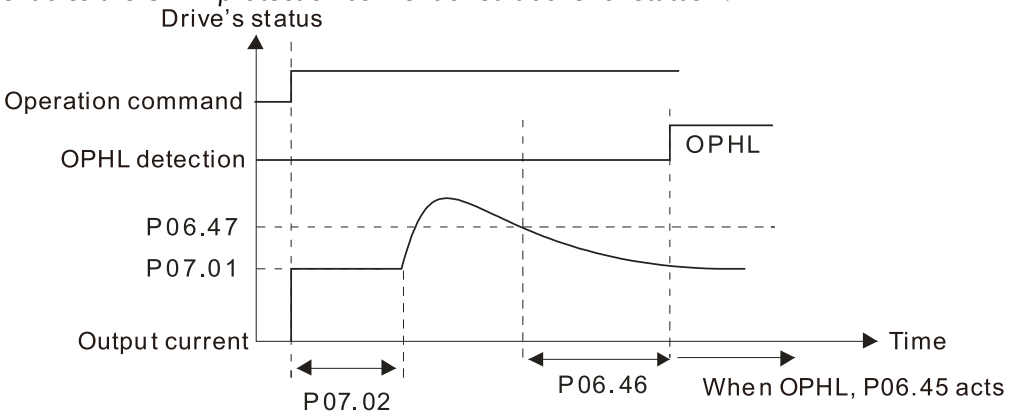
		Type	Hex Addr	Dec Addr
P06.48	**DC Brake Time for Output Phase Loss**	♦R/W	0630	41585
Range/Units (Format: 16-bit unsigned)		Default		
0.000–65.535 sec.		0.000		

Setting P06.48 to 0 disables the OPHL detection function before operation.

- *Status 1:*
  The drive is in operation
  When any phase is less than the P06.47 setting, and exceeds the P06.46 setting time, the drive executes according to the P06.45 setting.

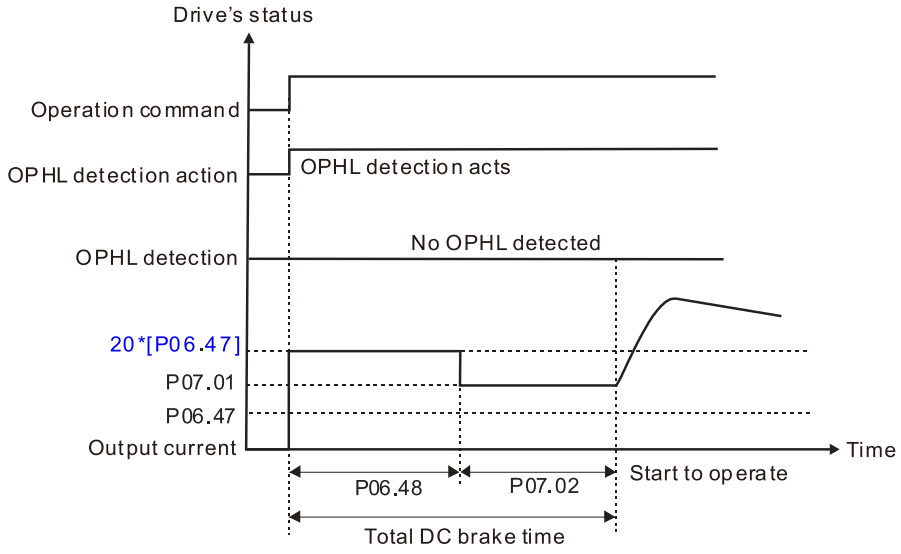


- *Status 2:*
  The drive is in STOP; P06.48 = 0; P07.02 ≠ 0
  After the drive starts, the DC brake operates according to P07.01 and P07.02. During this period, OPHL detection is not active. After the DC brake action is completed, the drive starts to run, and enables the OPHL protection as mentioned above for status 1.

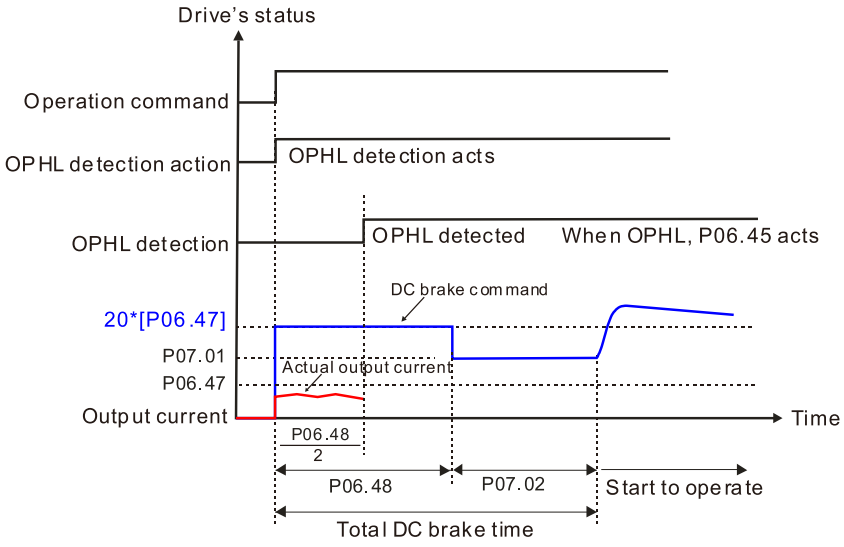


- *Status 3:*
  The drive is in STOP; P06.48 ≠ 0; P07.02 ≠ 0
  When the drive starts, it executes P06.48 first, and then executes P07.02 (DC brake). The DC brake current level in this state includes two parts: one is 20 times the P06.47 setting value in P06.48 setting time; the other is the P07.01 setting value in P07.02 setting time. The total DC brake time T = P06.48 + P07.02. In this period, if an OPHL occurs within the time for P06.48, the drive executes the P06.45 setting after the drive starts counting for half the time of P06.48.

Status 3-1: P06.48≠0, P07.02≠0 (No OPHL detected before operation)

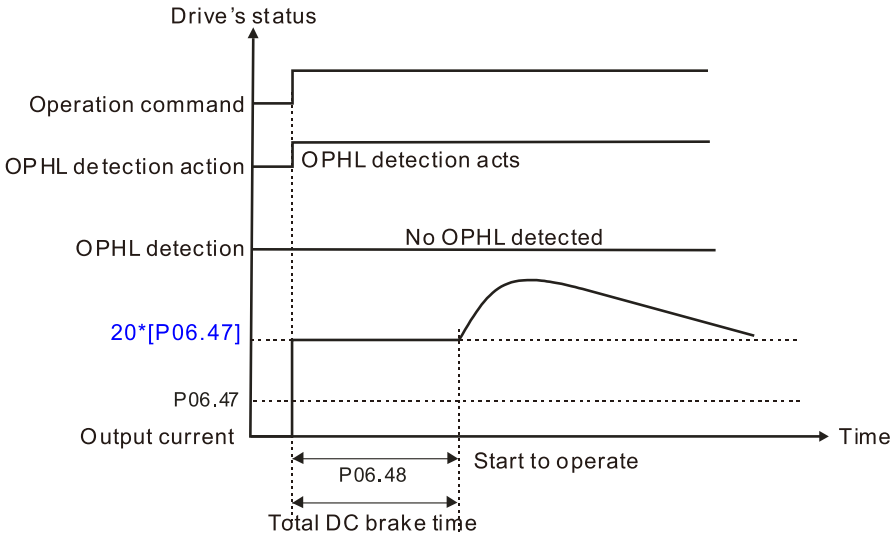


Status 3-2: P06.48≠0, P07.02≠0 (OPHL detected before operation)

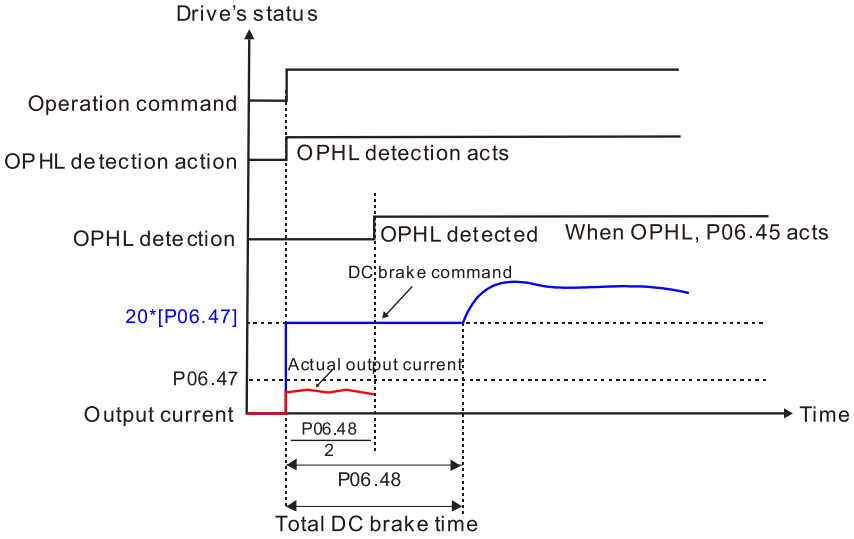


- *Status 4:*
  The drive is in STOP; P06.48 ≠ 0; P07.02=0
  When the drive starts, it executes P06.48 as the DC brake. The DC brake current level is 20 times the P06.47 setting value. In this period, if an OPHL occurs within the time for P06.48, the drive executes the P06.45 setting after the drive starts counting for half the time of P06.48.

Status 4-1: P06.48≠0, P07.02=0 (No OPHL detected before operation)



Status 4-2: P06.48≠0, P07.02=0 (OPHL detected before operation)



		Type	Hex Addr	Dec Addr
P06.49	**LvX Auto-reset**	R/W	0631	41586
	Range/Units (Format: 16-bit binary)	Default		
	0: Disable 1: Enable	0		

In the event of any low voltage fault on the DC bus (LvS, LvN, LvA, LvD faults), this parameter will automatically reset the drive if enabled.

P06.53	Input Phase Loss Detection Action (OrP)	Type	Hex Addr	Dec Addr
		♦R/W	0635	41590
	Range/Units (Format: 16-bit binary)	Default		
	0: Fault and ramp to stop 1: Fault and coast to stop	0		

The drive executes the input phase loss protection according to P06.53.

P06.55	Derating Protection	Type	Hex Addr	Dec Addr
		♦R/W	0637	41592
	Range/Units (Format: 16-bit binary)	Default		
	0: Constant rated current and limit carrier frequency by load current and temperature 1: Constant carrier frequency and limit load current by setting carrier frequency 2: Constant rated current (same as setting 0), but close current limit	0		

Allowable maximum output frequency and the minimum carrier frequency limit in control mode:

For VF, SVC, VFPG modes:

When the maximum output frequency is 599 Hz, the minimum carrier frequency is 6k.

Setting 0:

- *When the operating point is greater than the derating curve (when the operating carrier frequency is greater than the rated carrier frequency), the rated current is constant, and carrier frequency (Fc) output by the drive decreases automatically according to the ambient temperature, overload output current and overload time. If overloads are not frequent, and the concern is only about the carrier frequency operating with the rated current for a long time, and changes to the carrier frequency due to short overload are acceptable, set to 0.*
- *Refer to Derating for Ambient Temperature, Altitude and Carrier Frequency for the carrier frequency derating level.*
- *Take GS23-45P0 in normal load as an example: ambient temperature 50°C, UL open-type, and independent installation. When the carrier frequency is set to 10kHz, it corresponds to 55% of the rated output current. In the same condition for ambient temperature 40°C, it corresponds to 75% of rated output current. When the output current is higher than this value, it automatically decreases the carrier frequency according to the ambient temperature, output current and overload time. At this time, the overload capacity of the drive is 150% of the rated current.*

Setting 1:

- *When the operating point exceeds the derating curve 1, the carrier frequency is the setting value. Select this mode if the change of carrier frequency and motor noise caused by ambient temperature and frequent overload are not allowed. (Refer to P00.17.)*
- *Refer to Derating for Ambient Temperature, Altitude and Carrier Frequency for the rated current derating level. Take GS23-45P0 in variable torque as an example. If you need to maintain the carrier frequency at 10kHz, decrease the rated current to 55%. The OL protection executes when the current is 120% * 55% = 66% for one minute; therefore, you must operate using the values within the derating curve to keep the carrier frequency constant.*

Setting 2:

- *The protection method and action are the same as setting value 0, but it disables the current limit when output current is the derating ratio ×120% (default value) in variable torque and when the output current is the derating ratio ×180% (default value) in constant torque. The advantage is that it provides a higher starting output current when the carrier frequency setting is higher than the default. However, the carrier frequency derates easily when it overloads.*
  *Example: when P06.55 = 0 or 1, over-current stall prevention level = Ratio * P06.03. When P06.55 = 2, the over-current stall prevention level = P06.03.*

Use this parameter with P00.16 and P00.17.

The ambient temperature also affects the derating. Refer to Derating Curve for Ambient Temperature and Altitude.

Example:

Take *GS23-45P0* in variable torque with ambient temperature 50°C, UL open-type, and independent installation. When the carrier frequency is set to 10kHz, it corresponds to 55% of the rated output current. If used for ambient temperature 60°C, it corresponds to 55% * 75% of the rated output current.

		Type	Hex Addr	Dec Addr
P06.56	**PT100 RTD Voltage Level 1**	♦R/W	0638	41593
Range/Units (Format: 16-bit unsigned)		*Default*		
0.000–10.000 V		5.000		

		Type	Hex Addr	Dec Addr
P06.57	**PT100 RTD Voltage Level 2**	♦R/W	0639	41594
Range/Units (Format: 16-bit unsigned)		*Default*		
0.000–10.000 V		7.000		

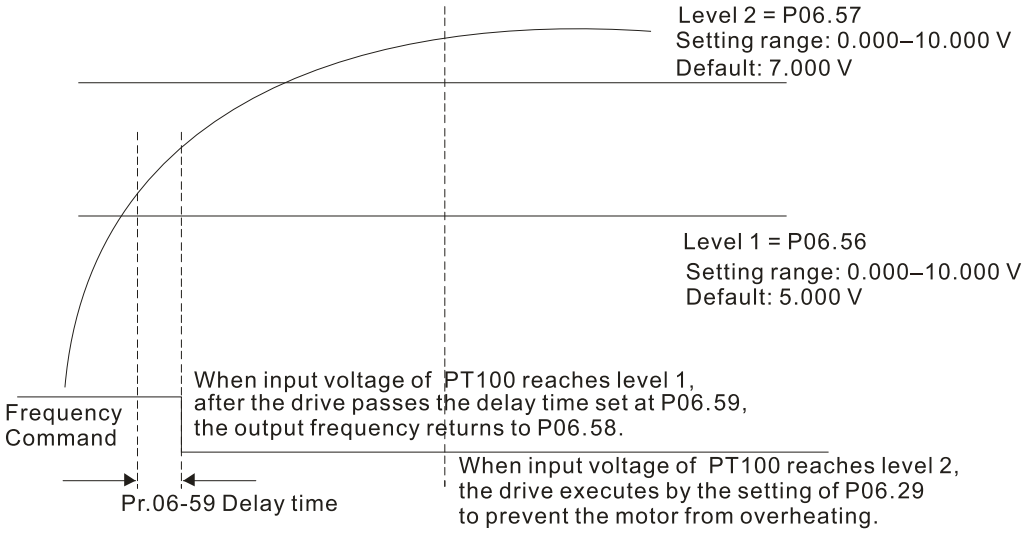
Condition settings: PT100 RTD voltage level P06.57 > P06.56.

		Type	Hex Addr	Dec Addr
P06.58	**PT100 RTD Level 1 Frequency Protection**	♦R/W	063A	41595
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	0.00		

		Type	Hex Addr	Dec Addr
P06.59	**PT100 RTD Activation Level 1 Protection Frequency Delay Time**	♦R/W	063B	41596
	Range/Units (Format: 16-bit binary)	*Default*		
	0–6000 sec.	60		

PT100 RTD operation instructions:

1) Use voltage type analog input (AI1, AI2 voltage 0–10 V) and select PT100 RTD mode.
2) Select one of the voltage type analog inputs below:
   (a) P03.00 =11, (b) P03.01 = 11 and P03.29 = 1
3) When selecting P03.01 = 11 and P03.29 = 1, you must switch A01 to 0–10 V.
4) The A01 outputs constant voltage or current, then P03.20 = 23. You must switch ACM to 0–20 mA, and set A01 output level to 45% (Pr.03-32 = 45%) of 20 mA = 9 mA.
5) Use P03.32 to adjust the constant voltage or constant current of the A01 output; the setting range is 0.00–100.00%.
6) There are two types of action levels for PT100 RTD. The diagram below shows the PT100 RTD protection action.



When P06.58 = 0.00 Hz, PT100 RTD function is disabled.

Case:

When using PT100 RTD, if the motor temperature is higher than 135°C (275°F), the drive starts to count the delay time for auto-deceleration (P06.59). The drive decreases the motor frequency to the setting for P06.58 when it reaches the delay time count value. The drive operates at the frequency set for P.06.58 until the motor temperature is lower than 135°C (275°F). If the motor temperature is higher than 150°C (302°F), the drive automatically decelerates to STOP and displays the warning “oH3”.

Set up process:

1) Switch A01 to 0–20 mA on the control board dip switch.
2) Wiring:
   Connect external terminal A01 to “+”
   Connect external terminal ACM to “-“
   Connect A01 and AI1 to “short circuit”

3) P03.00 = 11, P03.20 = 23, P03.32 = 45% (9 mA)
4) Refer to the PT100 RTD temperature and resistance comparison table
   Temperature = 135°C, resistance = 151.71 Ω, input current: 9 mA, voltage: about 1.37 VDC
   Temperature = 150°C, resistance = 157.33 Ω, input current: 9 mA, voltage: about 1.42 VDC
5) When the PT100 RTD temperature > 135°C, the drive decelerates to the specified operation frequency automatically. Then, P06.56 = 1.37 V and P06.58 = 10Hz. (When P06.58 = 0, it disables the specified operation frequency.)
6) When PT100 RTD temperature > 150°C, the drive outputs a fault, decelerates to STOP, and displays the warning "oH3". Then, P06.57 = 1.42 V and P06.29 = 1 (fault and ramp to stop).

		Type	Hex Addr	Dec Addr
P06.60	**Software Detection GFF Current Level**	♦R/W	063C	41597
	Range/Units (Format: 16-bit unsigned)	Default		
	0.0–6553.5%	60.0		

		Type	Hex Addr	Dec Addr
P06.61	**Software Detection GFF Filter Time**	♦R/W	063D	41598
	Range/Units (Format: 16-bit unsigned)	Default		
	0.00–655.35 sec.	0.10		

When the drive detects that the unbalanced three-phase output current is higher than the setting for P06.60, GFF protection activates. The drive then stops output.

		Type	Hex Addr	Dec Addr
P06.63	**Operation Time of Fault Record 1 (Day)**	Read	063F	41600
P06.65	**Operation Time of Fault Record 2 (Day)**	Read	0641	41602
P06.67	**Operation Time of Fault Record 3 (Day)**	Read	0643	41604
P06.69	**Operation Time of Fault Record 4 (Day)**	Read	0645	41606
P06.90	**Operation Time of Fault Record 5 (Day)**	Read	065A	41627
P06.92	**Operation Time of Fault Record 6 (Day)**	Read	065C	41629
	Range/Units (Format: 16-bit unsigned)	Default		
	0–65535 days	0		

		Type	Hex Addr	Dec Addr
P06.64	**Operation Time of Fault Record 1 (Min.)**	Read	0640	41601
P06.66	**Operation Time of Fault Record 2 (Min.)**	Read	0642	41603
P06.68	**Operation Time of Fault Record 3 (Min.)**	Read	0644	41605
P06.70	**Operation Time of Fault Record 4 (Min.)**	Read	0646	41607
P06.91	**Operation Time of Fault Record 5 (Min.)**	Read	065B	41628
P06.93	**Operation Time of Fault Record 6 (Min.)**	Read	065D	41630
	Range/Units (Format: 16-bit unsigned)	Default		
	0–1439 min.			

If there is any malfunction when the drive operates, P06.17–P06.22 records the malfunctions, and P06.63–P06.70 records the operation time for four sequential malfunctions. Check if there is any problem with the drive according to the interval of the recorded fault.

Example:

The first error: ocA occurs after motor drive operates for 1000 minutes.

The second error: ocd occurs after another 1000 minutes.

The third error: ocn occurs after another 1000 minutes.

The fourth error: ocA occurs after another 1000 minutes.

The fifth error: ocd occurs after another 1000 minutes.

The sixth error: ocn occurs after another 1000 minutes.

Then, P06.17–P06.22 and P06.63–P06.70 are recorded as follows:

Parameter	1st fault	2nd fault	3rd fault	4th fault	5th fault	6th fault
Pr.06-17	ocA	ocd	ocn	ocA	ocd	ocn
Pr.06-18	0	ocA	ocd	ocn	ocA	ocd
Pr.06-19	0	0	ocA	ocd	ocn	ocA
Pr.06-20	0	0	0	ocA	ocd	ocn
Pr.06-21	0	0	0	0	ocA	ocd
Pr.06-22	0	0	0	0	0	ocA
Pr.06-63	1000	560	120	1120	680	240
Pr.06-64	0	1	2	2	3	4
Pr.06-65	0	1000	560	120	1120	680
Pr.06-66	0	0	1	2	2	3
Pr.06-67	0	0	1000	560	120	1120
Pr.06-68	0	0	0	1	2	2
Pr.06-69	0	0	0	1000	560	120
Pr.06-70	0	0	0	0	1	2

By examining the time record, you can see that the last fault (P06.17) happened after the drive ran for four days and 240 minutes.

		Type	Hex Addr	Dec Addr
P06.71	**Low Current Setting Level**	♦R/W	0647	41608
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–100.0%		0.0		

		Type	Hex Addr	Dec Addr
P06.72	**Low Current Detection Time**	♦R/W	0648	41609
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–360.00 sec.		0.00		

		Type	Hex Addr	Dec Addr
P06.73	**Low Current Action**	♦R/W	0649	41610
Range/Units (Format: 16-bit binary)		*Default*		
0 : No function		0		
1 : Fault and coast to stop				
2 : Fault and ramp to stop by the second deceleration time				
3 : Warn and continue operation				

The drive operates according to the setting for P06.73 when the output current is lower than the setting for P06.71 and when the time of the low current exceeds the detection time for P06.72. Use this parameter with the external multi-function output terminal setting 44 (low current output).

The low current detection function does not execute when drive is in sleep or standby status.

		Type	Hex Addr	Dec Addr
P06.80	**Fire Mode**	R/W	0650	41617
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Operates in a counterclockwise direction 2: Operates in a clockwise direction		0		

Use this parameter with multi-function input terminal setting 58 or 59, and multi-function output terminal setting 53.

0: Fire detection is invalid.

1: The motor operates in a counterclockwise direction (U, V, W).

2: The motor operates in a clockwise direction (U, W, V).

		Type	Hex Addr	Dec Addr
P06.81	**Operating Frequency in Fire Mode**	♦R/W	0651	41618
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		60.00		

		Type	Hex Addr	Dec Addr
P06.88	**Operation Times in Fire Mode**	Read	0658	41625
Range/Units (Format: 16-bit unsigned)		Default		
0–65535 times		0		

Group P07.xx Details – Special Parameters

		Type	Hex Addr	Dec Addr
P07.00	**Software Brake Chopper Action Level**	♦R/W	0000	41793
Range/Units (Format: 16-bit unsigned)		*Default*		
120V / 230V models: 350.0–450.0 VDC		370.0		
460V models: 700.0–900.0 VDC		740.0		
575V models: 875.0–1000.0 VDC		950.0		

P07.00 sets the DC bus voltage at which the brake chopper is activated. Choose a suitable braking resistor to achieve the optimal deceleration performance. Refer to the Accessories chapter for information about braking resistors.

		Type	Hex Addr	Dec Addr
P07.01	**DC Brake Current Level**	♦R/W	0701	41794
Range/Units (Format: 16-bit unsigned)		*Default*		
0–100%		0		

P07.01 sets the level of the DC brake current output to the motor at start-up and stop. When setting the DC brake current, the rated current (P00.01) is 100%. It is recommended that you start with a low DC brake current level and then increase until you reach the proper holding torque. However, the DC brake current cannot exceed the motor's rated current to prevent the motor from burnout. Therefore, DO NOT use the DC brake for mechanical retention, otherwise injury or accident may occur.

		Type	Hex Addr	Dec Addr
P07.02	**DC Brake Time at Start-up**	♦R/W	0702	41795
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–60.0 sec		0.0		

The motor may continue rotating due to external forces or the inertia of the motor itself. If you use the drive with the motor rotating, it may cause motor damage or trigger drive protection due to over-current. This parameter outputs DC current, generating torque to force the motor stop to get a stable start before motor operation. This parameter determines the duration of the DC brake current output to the motor when the drive starts up. Set this parameter to 0.0 to disable the DC brake at start-up.

		Type	Hex Addr	Dec Addr
P07.03	**DC Brake Time at STOP**	♦R/W	0703	41796
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–60.0 sec		0.0		

The motor may continue rotating after the drive stops output due to external forces or the inertia of the motor itself. This parameter outputs DC current, generating torque to force the motor stop after the drive stops output to make sure that the motor stops.

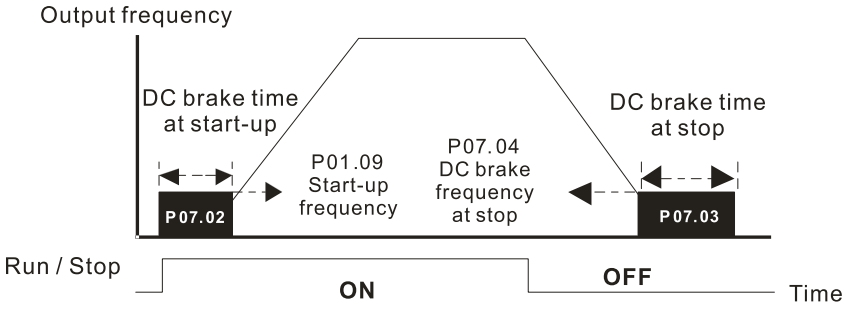
This parameter determines the duration of the DC Brake current output to the motor when braking. To enable the DC brake at STOP, you must set P00.22 (Stop Method) to 0 (ramp to stop). Set this parameter to 0.0 to disable the DC brake at stop.

Related parameters:

P00.22 Stop Method, P07.04 DC Brake Frequency at Start-up

		Type	Hex Addr	Dec Addr
P07.04	**DC Brake Frequency at STOP**	♦R/W	0704	41797
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 0 Hz		0.00		

Determines the start frequency of the DC brake before the drive ramps to stop. When this setting is less than P01.09 (Start-up Frequency), the start frequency for the DC brake begins at the minimum frequency.



DC Brake Output Timing Diagram

- *Use the DC brake before running the motor when the load is movable at stop, such as with fans and pumps. The motor is in free running status and in unknown rotation direction before the drive starts up. Execute the DC brake before you start the motor.*
- *Use the DC Brake at STOP when you need to brake the motor quickly or to control the positioning, such as with cranes or cutting machines.*

		Type	Hex Addr	Dec Addr
P07.05	**Voltage Increasing Gain**	♦R/W	0705	41798
Range/Units (Format: 16-bit unsigned)		Default		
1–200%		100		

When using speed tracking, adjust P07.05 to slow down the increasing voltage gain if there are errors such as oL or oc; however, the speed tracking time will be longer.

		Type	Hex Addr	Dec Addr
P07.06	**Restart after Momentary Power Loss**	♦R/W	0706	41799
Range/Units (Format: 16-bit binary)		Default		
0: Stop operation 1: Speed tracking by the speed before the power loss 2: Speed tracking by the minimum output frequency		0		

P07.06 determines the operation mode when the drive restarts from a momentary power loss.

The power system connected to the drive may power off momentarily for many reasons. This function allows the drive to keep outputting voltages after the drive is repowered and does not cause the drive to stop.

1) Frequency tracking begins before momentary power loss and accelerates to the master Frequency command after the drive output frequency and motor rotator speed are synchronous. Use this setting when there is a lot of inertia with little resistance on the motor load. For example, in equipment with a large inertia flywheel, there is NO need to wait until the flywheel stops completely after a restart to execute the operation command; therefore, it saves time.
2) Frequency tracking starts from the minimum output frequency and accelerates to the master Frequency command after the drive output frequency and motor rotator speed are synchronous. Use this setting when there is little inertia and large resistance.

In PG control mode, the AC motor drive executes the speed tracking function automatically according to the PG speed when this setting is NOT set to 0.

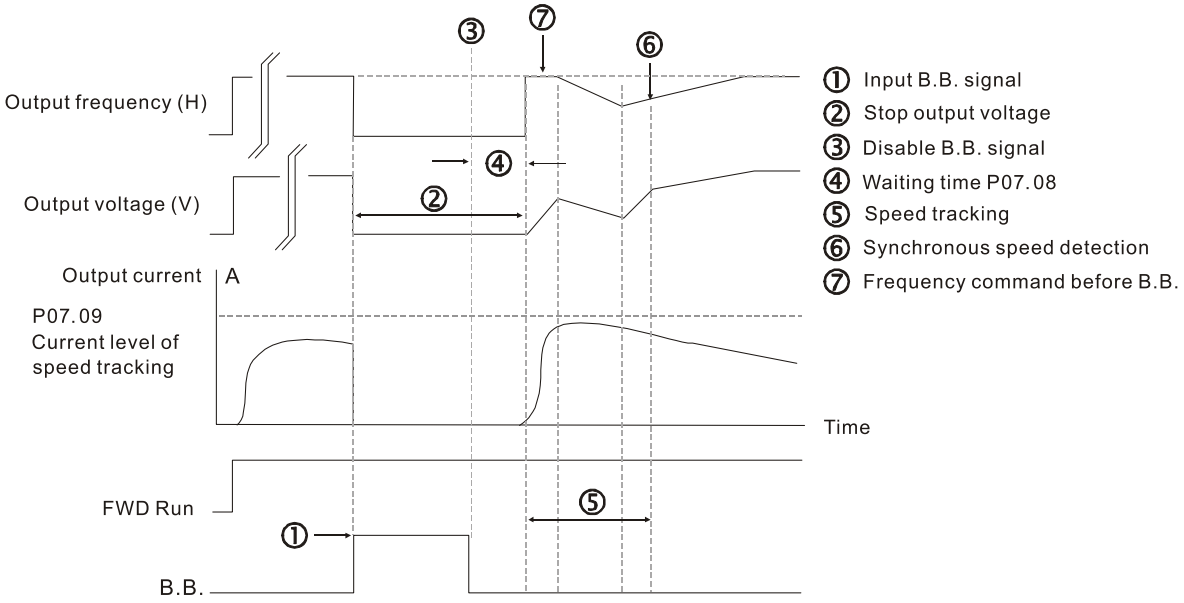
		Type	Hex Addr	Dec Addr
P07.07	**Allowed Power Loss Duration**	♦R/W	0707	41800
Range/Units (Format: 16-bit binary)		Default		
0.0–20.0 sec.		2.0		

Determines the maximum time of allowable power loss. If the duration of a power loss exceeds this parameter setting, the AC motor drive stops output after the power recovers.

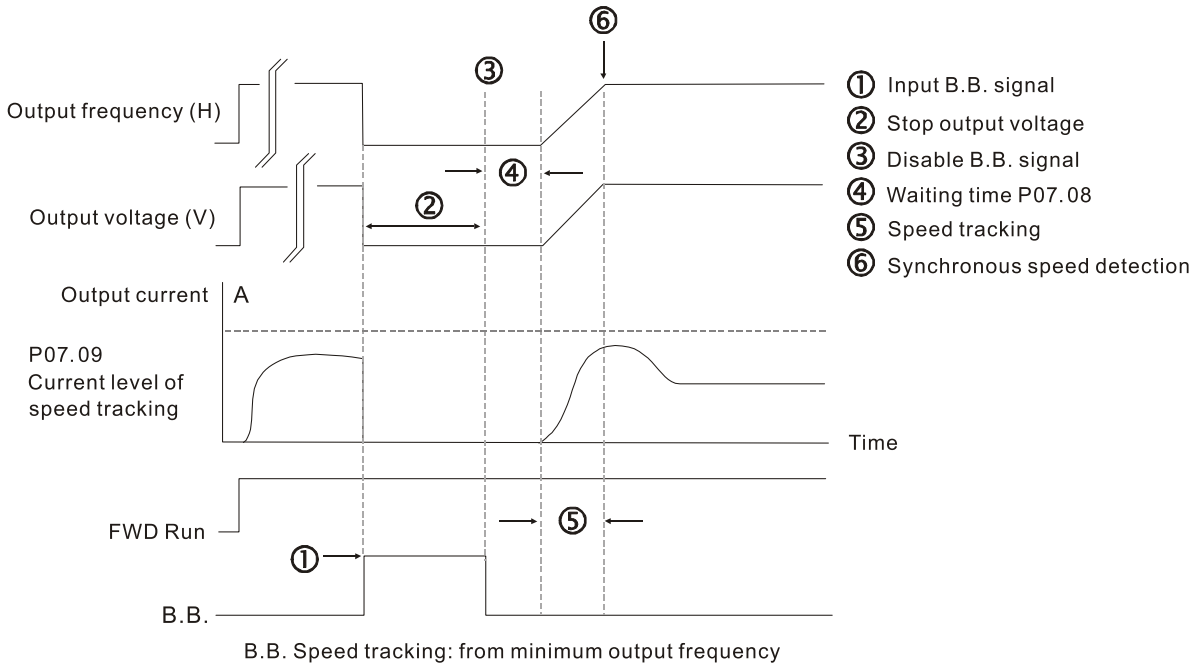
P07.06 is valid when the maximum allowable power loss time is ≤ 20 seconds and the AC motor drive displays "LU". If the AC motor drive is powered off due to overload, even if the maximum allowable power loss time is ≤ 20 seconds, P07.06 is invalid after the power recovers.

		Type	Hex Addr	Dec Addr
P07.08	**Base Block Time**	♦R/W	0708	41801
Range/Units (Format: 16-bit binary)		Default		
0.0–60.0 sec.		0.5		

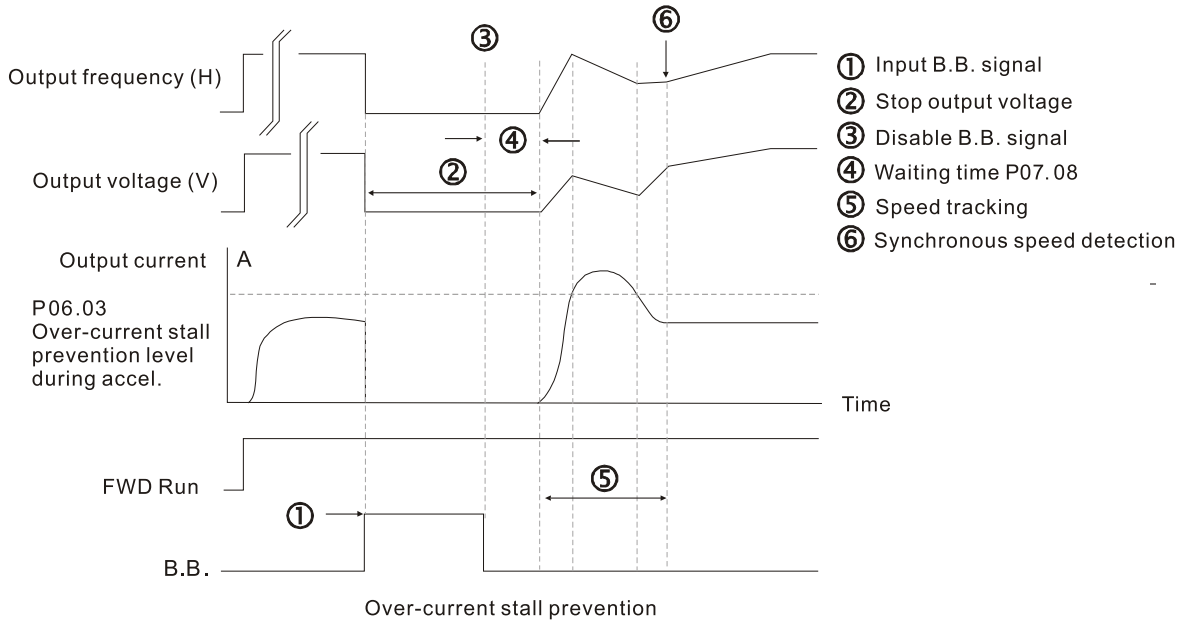
When momentary power loss is detected, the AC motor drive blocks its output and then waits for a specified period of time (determined by P07.08, called Base Block Time) before resuming operation. Set this parameter to the time that allows the residual voltage at the output side to decrease to 0V before activating the drive again.



B.B. Speed tracking: from last output frequency



B.B. Speed tracking: from minimum output frequency



Over-current stall prevention

		Type	Hex Addr	Dec Addr
P07.09	**Current Limit of Speed Tracking**	♦R/W	0709	41802
Range/Units (Format: 16-bit unsigned)		Default		
20–200%		100		

The AC motor drive executes speed tracking only when the output current is greater than the value set in P07.09.

The maximum current for speed tracking affects the synchronous time. The larger the parameter setting, the faster the synchronization occurs. However, if the parameter setting is too large, the overload protection function may be activated.

		Type	Hex Addr	Dec Addr
P07.10	**Restart after Fault Action**	♦R/W	070A	41803
Range/Units (Format: 16-bit binary)		Default		
0: Stop operation 1: Speed tracking by current speed 2: Speed tracking by minimum output frequency		0		

In PG control mode, the AC motor drive executes the speed tracking function automatically according to the PG speed when this setting is NOT set to 0.

Faults include: bb, oc, ov, occ. To restart after oc, ov, occ, you can NOT set P07.11 to 0.

		Type	Hex Addr	Dec Addr
P07.11	**Number of Times of Restart after Fault**	♦R/W	070B	41804
Range/Units (Format: 16-bit unsigned)		Default		
0–10		0		

After fault (allowed fault: oc, ov, occ) occurs, the AC motor drive can reset and restart automatically up to 10 times. If P07.11 is set to 0, the drive resets or restarts automatically after faults occur. The drive starts according to the P07.10 setting after restarting after fault.

If the number of faults exceeds the P07.11 setting, the drive does not reset and restart until you press "RESET" manually and execute the operation command again.

		Type	Hex Addr	Dec Addr
P07.12	**Speed Tracking during Start-up**	♦R/W	070C	41805
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Speed tracking by the maximum output frequency 2: Speed tracking by the motor frequency at start-up 3: Speed tracking by the minimum output frequency		0		

Speed tracking is suitable for punch presses, fans, and other large inertia loads. For example, a punch press usually has a large inertia flywheel, and the general stop method is coast to stop. If it needs to be restarted again, the flywheel may take 2–5 minutes or longer to stop. This parameter setting allows you to start the flywheel operating again without waiting until the flywheel stops completely.

In PG control mode, the AC motor drive executes the speed tracking function automatically according to the PG speed when this setting is NOT set to 0.

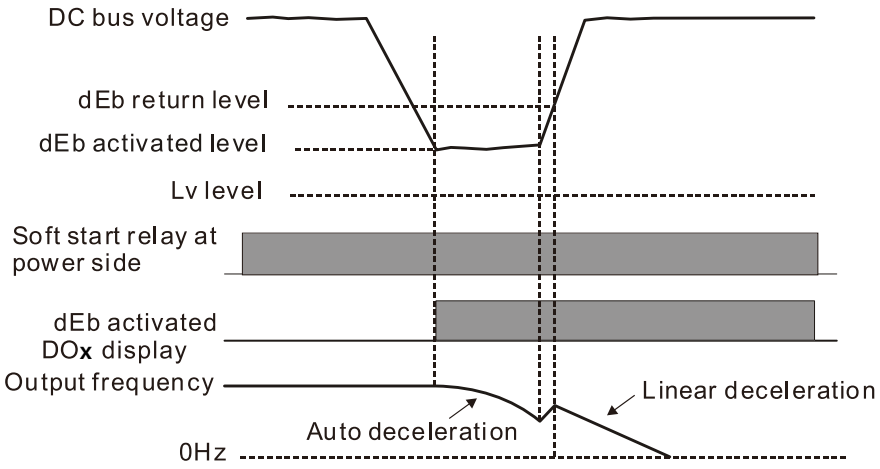
		Type	Hex Addr	Dec Addr
P07.13	**dEb Function Selection**	♦R/W	070D	41806
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: dEb with auto-acceleration / auto-deceleration, the drive does not output the frequency after the power is restored. 2: dEb with auto-acceleration / auto-deceleration, the drive outputs the frequency after the power is restored. 3: dEb low-voltage control, then the drive's voltage increases to 350 VDC / 700 VDC and ramps to stop after low frequency 4: dEb high-voltage control of 350 VDC / 700 VDC, and the drive ramps to stop		0		

- *dEb (Deceleration Energy Backup) lets the motor decelerate to stop when momentary power loss occurs. When the power loss is instantaneous, use this function to let the motor decelerate to zero speed. If the power recovers at this time, the drive restarts the motor after the dEb return time.*
- *Lv return level: Default value depends on the drive power model.*
  a) Models for frame A, B, C, D = P06.00 + 75V (575V series) / 60V (460V series) / 30V (120V/230V series)
  b) Models for frame E and above = P06.00 + 80V / 40V (120V/230V series)
- *Lv level: Default is P06.00.*
- *During dEb operation, other protection, such as ryF, ov, oc, occ, and EF may interrupt it, and these error codes are recorded.*
- *The STOP (RESET) command does not work during the dEb auto-deceleration, and the drive continues decelerating to stop. To make the drive coast to stop immediately, use another function (EF) instead.*
- *The B.B. function does not work when executing dEb. The B.B. function is enabled after the dEb function finishes.*
- *Even though the Lv warning does not display during dEb operation, if the DC bus voltage is lower than the Lv level, DOx = 10 (Low voltage warning) still operates.*
- *The following explains the dEb action:*
  When the DC bus voltage drops below the dEb setting level, the dEb function starts to work (soft start relay remains closed), and the drive executes auto-deceleration.

Situation 1:

Momentary power loss, or too low and unstable power voltage, or power supply sliding down because of sudden heavy load. P07.13 = 1 and power recovers.

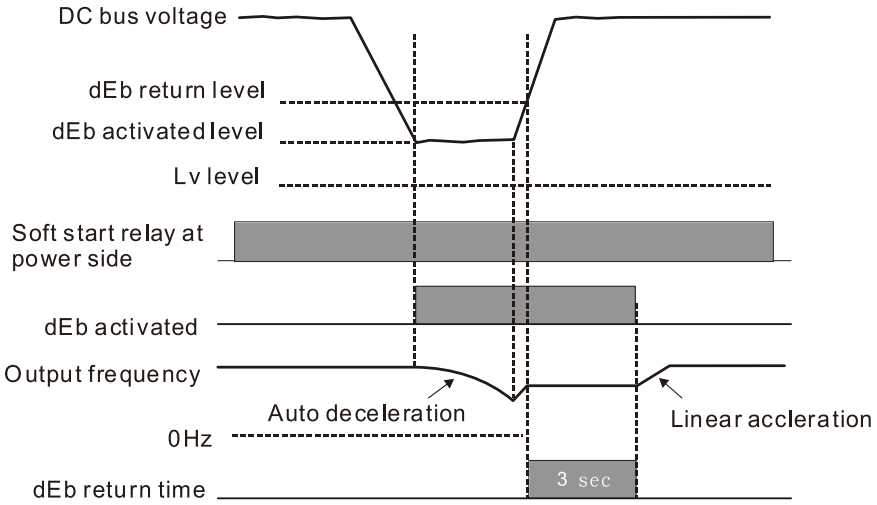
When the power recovers and DC bus voltage exceeds the dEb return level, the drive linearly decelerates to 0Hz and stops. The keypad displays the “dEb” warning until you manually reset it, so you can see the reason for the stop.



Situation 2:

Momentary power loss, or too low and unstable power voltage, or power supply sliding down because of sudden heavy load. P07.13 = 2 and power recovers.

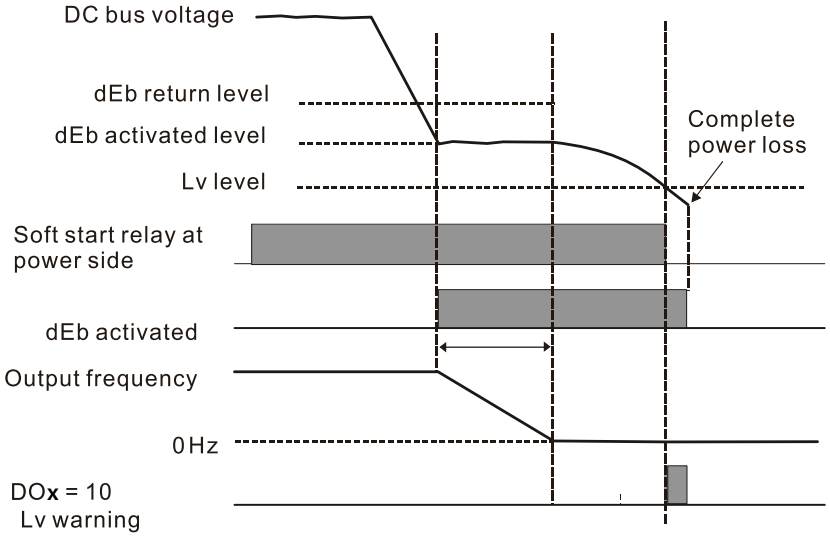
During the dEb deceleration (includes 0Hz run), if the power recovers to a voltage higher than dEb return level, the drive maintains the frequency for three seconds and then accelerates again. The “dEb” warning on the keypad is automatically cleared.



Situation 3:

Unexpected power shut down or power loss. P07.13 = 1 and power does not recover.

The keypad displays the "dEb" warning and the drive stops after decelerating to the lowest operating frequency. When the DC bus voltage is lower than the Lv level, the drive disconnects the soft start relay until the power completely runs out.



Situation 4:

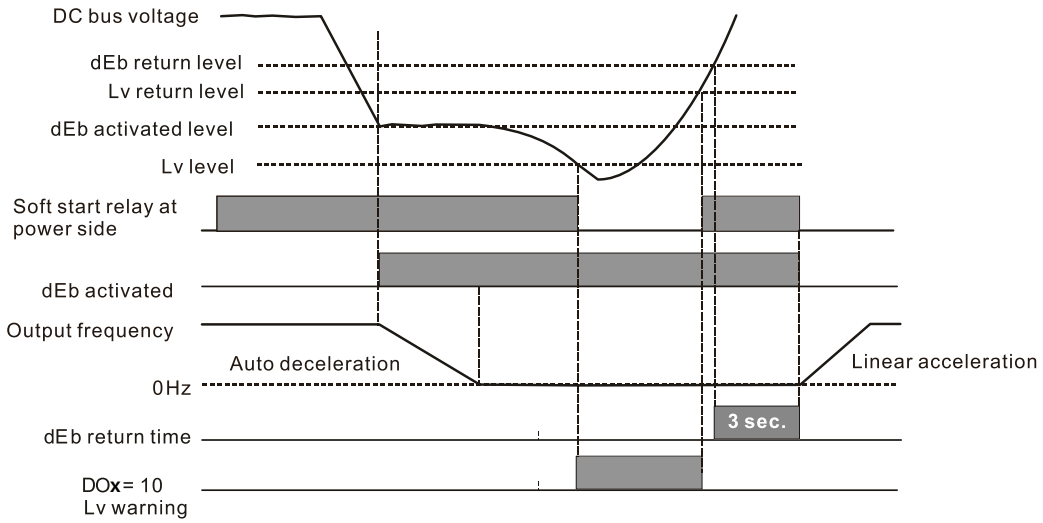
Unexpected power shut down or power loss. P07.13 = 2 and power does not recover.

The drive decelerates to 0Hz. The DC bus voltage continues to decrease until the voltage is lower than the Lv level, and then the drive disconnects the soft start relay. The keypad displays "dEb" warning until the drive completely runs out of power.

Situation 5:

P07.13 = 2 and power recovers after the DC bus voltage is lower than the Lv level.

The drive decelerates to 0Hz. The DC bus voltage continues to decrease until the voltage is lower than the Lv level, and then the drive disconnects the soft start relay. The soft start relay closes again after the power recovers and the DC bus voltage is higher than the Lv return level. When the DC bus voltage is higher than the dEb return level, the drive maintains the frequency for three seconds and starts to accelerate linearly. The "dEb" warning on the keypad is automatically cleared.

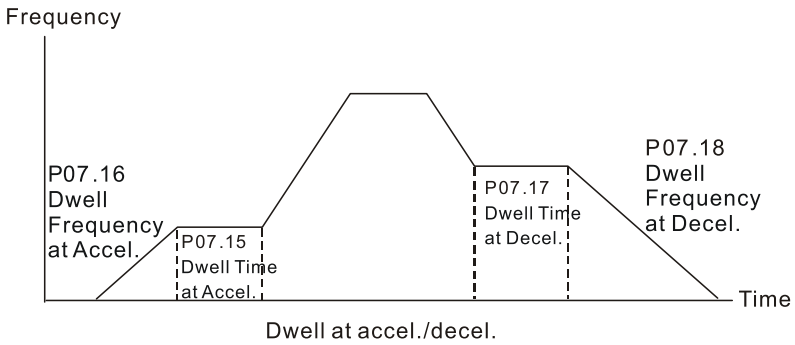


		Type	Hex Addr	Dec Addr
P07.15	***Dwell Time at Acceleration***	♦R/W	070F	41808
P07.17	***Dwell Time at Deceleration***	♦R/W	0711	41810
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–600.00 sec	0.00		

		Type	Hex Addr	Dec Addr
P07.16	***Dwell Frequency at Acceleration***	♦R/W	0710	41809
P07.18	***Dwell Frequency at Deceleration***	♦R/W	0712	41811
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	0.00		

In constant torque situations, the Dwell temporarily maintains stable output frequency. Use this parameter for cranes, elevators, and so on.

For constant torque applications, use P07.15–P07.18 to avoid OV or OC protection.



P07.19	Fan Cooling Control	Type	Hex Addr	Dec Addr
		♦R/W	0713	41812
Range/Units (Format: 16-bit binary)		Default		
0: Fan is always ON 1: Fan is OFF after the AC motor drive stops for one minute. 2: Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops 3: Fan turns ON when the temperature (IGBT) reaches around 60°C.		3		

Use P07.19 to control the fan.

- *P07.19 = 0: Fan runs immediately when the drive power is turned ON.*
- *P07.19 = 1: Fan runs when the AC motor drive runs. One minute after the AC motor drive stops, the fan is OFF.*
- *P07.19 = 2: Fan runs when the AC motor drive runs and stops immediately when the AC motor drive stops.*
- *P07.19 = 3: When temperature of the IGBT or capacitors is higher than 60°C, the fan runs. When both the temperature of the IGBT and capacitors are lower than 40°C, the fan stops.*

P07.20	Emergency Stop (EF) & Force to Stop Selection	Type	Hex Addr	Dec Addr
		♦R/W	0714	41813
Range/Units (Format: 16-bit binary)		Default		
0: Coast to stop 1: Stop by the first deceleration time 2: Stop by the second deceleration time 3: Stop by the third deceleration time 4: Stop by the fourth deceleration time 5: System deceleration 6: Automatic deceleration		0		

When the multi-function input terminal setting is set to 10 (EF input) or 18 (force to stop) and the terminal contact is ON, the drive stops according to the setting of this parameter.

- *When P07.20 = 5 (system deceleration), the EF deceleration behavior will follow P01.44 setting. If P01.44=0 or 1 & P07.20=5. when EF is ON, the deceleration will be Linear. If P01.44=2 or 3 & P07.20=5, when EF is ON, the deceleration will be Auto deceleration.*
- *When P07.20 = 6 (auto deceleration), the drive automatically determines the loaded regenerative energy to steadily and smoothly stop the motor in the fastest deceleration time.*

P07.21	Automatic Energy-saving Setting	Type	Hex Addr	Dec Addr
		♦R/W	0715	41814
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Enable		0		

When energy-saving is enabled, the motor acceleration/deceleration operates with full voltage. During constant speed operation, it automatically calculates the best voltage value according to the load power. This function is not suitable for fluctuating loads or loads which are nearly full during operation.

When the output frequency is constant (that is, constant operation), the output voltage decreases automatically as the load decreases. Therefore, the drive operates with minimum multiplication of voltage and current (electric power) to reach the energy-saving.

		Type	Hex Addr	Dec Addr
P07.22	**Energy-saving Gain**	♦R/W	0716	41815
Range/Units (Format: 16-bit unsigned)		Default		
10–1000%		100		

When P07.21 is set to 1, use this parameter to adjust the energy-saving gain. The default is 100%. If the result is not satisfactory, adjust it by decreasing the setting value. If the motor oscillates, then increase the setting value.

In certain applications such as high speed spindles, the temperature rise in the motor is a major concern. When the motor is not in working state, reduce the motor current to a lower level. Reduce this parameter setting to meet this requirement.

		Type	Hex Addr	Dec Addr
P07.23	**Automatic Voltage Regulation (AVR) Function**	♦R/W	0717	41816
Range/Units (Format: 16-bit binary)		Default		
0: Enable AVR 1: Disable AVR 2: Disable AVR during deceleration		0		

The rated voltage of a 220V motor is usually 200VAC, 60Hz / 50Hz, and the input voltage of the AC motor drive may vary from 180–264 VAC, 50Hz / 60Hz. Therefore, when the AC motor drive is used without the AVR function, the output voltage is the same as the input voltage. When the motor runs at the voltage exceeding 12–20% of the rated voltage, it causes higher temperatures, damaged insulation, and unstable torque output, which result in shortened motor lifetime.

The AVR function automatically regulates the output voltage of the AC motor drive to the motor's rated voltage when the input voltage exceeds the motor's rated voltage. For example, if the V/F curve is set at 200VAC, 50Hz and the input voltage is at 200–264 VAC, then the drive automatically reduces the output voltage to the motor to a maximum of 200VAC, 50Hz. If the input voltage is at 180–200 VAC, the output voltage to motor is in direct proportion to the input voltage.

- *P07.23 = 0: When the AVR function is enabled, the drive calculates the output voltage according to the actual DC bus voltage. The output voltage does NOT change when the DC bus voltage changes.*
- *P07.23 = 1: When the AVR function is disabled, the drive calculates the output voltage according to the actual DC bus voltage. The output voltage changes with the DC bus voltage, and may cause insufficient current, over-current or oscillation.*
- *P07.23 = 2: The drive disables the AVR function only during deceleration to stop, and at this time, you can accelerate the braking to achieve the same result.*

When the motor ramps to stop, disable the AVR function to shorten the deceleration time. Then, use with the auto-acceleration and auto-deceleration functions to make the motor's deceleration faster and more stable.

AVR applies to all control modes (P00.10/P00.11). Refer to page 4–59 for function block diagrams of AVR in the drive control loop.

		Type	Hex Addr	Dec Addr
P07.24	**Torque Command Filter Time (V/F and SVC Control Mode)**	♦R/W	0718	41817
Range/Units (Format: 16-bit unsigned)		Default		
0.001–10.000 sec.		0.050		

When the time constant setting is too large, the control is stable but the control response is slow. When the time constant setting is too small, the control response is faster but the control may be unstable. For optimal setting, adjust the setting based on the control stability or the control response.

		Type	Hex Addr	Dec Addr
P07.25	**Slip Compensation Filter Time (V/F and IMSVC Control Mode)**	♦R/W	0719	41818
Range/Units (Format: 16-bit unsigned)		*Default*		
0.001–10.000 sec.		0.100		

Change the compensation response time with P07.24 and P07.25.

If you set P07.24 and P07.25 to 10 seconds, the compensation response time is the slowest; however, the system may be unstable if you set the time too short.

P07.25 is only used for V/F mode (P00.11=0) and IM-SVC mode (P00.11=2). See function block diagram under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P07.26	**Torque Compensation Gain (Motor 1)**	♦R/W	071A	41819
P07.71	**Torque Compensation Gain (Motor 2)**	♦R/W	0747	41864
P07.73	**Torque Compensation Gain (Motor 3)**	♦R/W	0749	41866
P07.75	**Torque Compensation Gain (Motor 4)**	♦R/W	074B	41868
Range/Units (Format: 16-bit unsigned)		*Default*		
IM: 0–10 (when P05.33=0) PM: 0–5000 (when P05.33=1 or 2)		1		

These parameters apply to P00.11 V/F and SVC control modes.

With a large motor load, a part of the drive output voltage is absorbed by the stator winding resistor; therefore, the air gap magnetic field is insufficient. This causes insufficient voltage at motor induction and results in excessive output current but insufficient output torque. Auto-torque compensation can automatically adjust the output voltage according to the load and keep the air gap magnetic fields stable to get the optimal operation.

In the V/F control, the voltage decreases in direct proportion with decreasing frequency. The torque decreases at low speed because of a decreasing AC resistor and an unchanged DC resistor. The auto-torque compensation function increases the output voltage at low frequency to get a higher starting torque.

When the compensation gain is set too high, it may cause motor over-flux and result in a too great an output current from the drive, motor overheating or trigger the drive's protection function.

See function block diagrams under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P07.27	**Slip Compensation Gain (Motor 1)**	♦R/W	071B	41820
P07.72	**Slip Compensation Gain (Motor 2)**	♦R/W	0748	41865
P07.74	**Slip Compensation Gain (Motor 3)**	♦R/W	074A	41867
P07.76	**Slip Compensation Gain (Motor 4)**	♦R/W	074C	41869
Range/Units (Format: 16-bit unsigned)		*Default*		
0.00–10.00		0.00 (1 in SVC mode)		

These parameters apply to P00.11 V/F and SVC control modes.

The induction motor needs constant slip to produce electromagnetic torque. It can be ignored at higher motor speeds, such as rated speed or 2–3% of slip.

However, during the drive operation, the slip and the synchronous frequency are in reverse proportion to produce the same electromagnetic torque. The slip is larger with the reduction of the synchronous frequency. Moreover, the motor may stop when the synchronous frequency decreases to a specific value. Therefore, the slip seriously affects the motor speed accuracy at low speed.

In another situation, when you use an induction motor with the drive, the slip increases when the load increases. It also affects the motor speed accuracy.

Use this parameter to set the compensation frequency, and reduce the slip to maintain the synchronous speed when the motor runs at the rated current in order to improve the accuracy of the drive. When the drive output current is higher than P05.05 (No-load Current for Induction Motor 1 (A)), the drive compensates the frequency according to this parameter.

This parameter is set to 1.00 automatically when P00.11 (Speed Control Mode) is changed from V/F mode to vector mode. Otherwise, it is automatically set to 0.00. Apply the slip compensation after load and acceleration. Increase the compensation value from small to large gradually; add the output frequency to the [motor rated slip x P07.27 (Slip Compensation Gain)] when the motor is at the rated load. If the actual speed ratio is slower than expected, increase the parameter setting value; otherwise, decrease the setting value.

See function block diagrams under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P07.29	**Slip Deviation Level**	♦R/W	071D	41822
Range/Units (Format: 16-bit unsigned)		Default		
0.0–100.0% 0: No detection		0		

		Type	Hex Addr	Dec Addr
P07.30	**Over-slip Deviation Detection Time**	♦R/W	071E	41823
Range/Units (Format: 16-bit unsigned)		Default		
0.0–10.0 sec.		1.0		

		Type	Hex Addr	Dec Addr
P07.31	**Over-slip Deviation Treatment**	♦R/W	071F	41824
Range/Units (Format: 16-bit binary)		Default		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning		0		

P07.29–P07.31 set the allowable slip level/time and the over-slip treatment when the drive is running.

		Type	Hex Addr	Dec Addr
P07.32	**Motor Oscillation Compensation Factor**	♦R/W	0720	41825
Range/Units (Format: 16-bit unsigned)		Default		
0–10000		1000		

If there are current wave motions which cause severe motor oscillation in some specific area, setting P07.32 can effectively improve this situation. (When running with high frequency or PG, set this parameter to 0. When the current wave motion occurs in low frequency and high power, increase the value for P07.32.)

		Type	Hex Addr	Dec Addr
P07.33	**Auto-restart Interval of Fault**	♦R/W	0721	41826
Range/Units (Format: 16-bit unsigned)		Default		
0.0–6000.0 sec.		60.0		

When a reset/restart occurs after a fault, the drive uses P07.33 as a timer and starts counting the number of faults within this time period. Within this period, if the number of faults does not exceed the setting for P07.11, the counting clears and starts from 0 when the next fault occurs.

		Type	Hex Addr	Dec Addr
P07.38	**PMSVC Voltage Feed Forward Gain**	R/W	0726	41831
Range/Units (Format: 16-bit unsigned)		Default		
0.50–2.00		1.00		

		Type	Hex Addr	Dec Addr
P07.46	**OOB Sampling Time**	R/W	072E	41839
Range/Units (Format: 16-bit unsigned)		Default		
0.1–120.0 sec.		1.0		

		Type	Hex Addr	Dec Addr
P07.47	**Number of OOB Sampling Times**	R/W	072F	41840
Range/Units (Format: 16-bit unsigned)		Default		
00–32		20		

		Type	Hex Addr	Dec Addr
P07.48	**OOB Average Sampling Angle**	Read	0730	41841
Range/Units (Format: 16-bit unsigned)		Default		
Read only		0		

You can use the OOB (Out Of Balance Detection) function with a PLC program in a washing machine system. When the multi-function input terminal P02.01–P02.07 is set to 82 (OOB loading balance detection), the P07.48 (OOB Average Sampling Angle) Δθ value is set according to P07.46 (OOB Sampling Time) and P07.47 (Number of OOB Sampling Times).

The PLC or host controller would be configured to read P07.48 and programmed to determine the motor speed according to P07.48 (OOB Average Sampling Angle) Δθ value. When the Average Sampling Angle Δθ value is large, the load is unbalanced. In this case, the PLC or host controller must decrease the Frequency command. Otherwise, increase the Frequency command to execute high speed operations when P07.48 Δθ value is small.

Related parameters:

P02.01–P02.07 (Multi-function Input Commands).

		Type	Hex Addr	Dec Addr
P07.62	**dEb Gain (Kp)**	♦R/W	073E	41855
Range/Units (Format: 16-bit unsigned)		Default		
0–65535		8000		

		Type	Hex Addr	Dec Addr
P07.63	**dEb Gain (Ki)**	♦R/W	073F	41856
Range/Units (Format: 16-bit unsigned)		Default		
0–65535		150		

These parameters set the PI gain of DC bus voltage controller when the dEb function activates.

If the DC bus voltage drops too fast, or the speed oscillation occurs during deceleration after the dEb function activates, adjust P07.62 and P07.63. Increase the Kp setting to quicken the control response, but oscillation may occur if the setting is too large. Use Ki parameter to decrease the steady-state error to zero, and increase the setting to quicken the response speed.

Group P08.xx Details – High-function PID Parameters

		Type	Hex Addr	Dec Addr
P08.00	**Terminal Selection of PID Feedback**	♦R/W	0800	42049
Range/Units (Format: 16-bit binary)		*Default*		
0: No function 1: Negative PID feedback: by analog input (P03.00, P03.01) 2: Negative PID feedback: by single-phase input (PG/DI7), without direction (P10.16=5) 4: Positive PID feedback: by analog input (P03.00, P03.01) 5: Positive PID feedback: by single-phase input (PG/DI7), without direction (P10.16=5) 7: Negative PID feedback: by communication protocols 8: Positive PID feedback: by communication protocols		0		

Negative feedback:

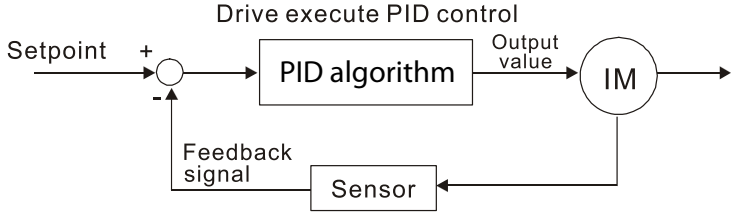
Error = + Target value (set point) – Feedback. Use negative feedback when the detection value increases if the output frequency increases.

Positive feedback:

Error = Target value (set point)+ Feedback. Use positive feedback when the detection value decreases if the output frequency increases.

When P08.00 ≠ 7 or ≠ 8, the input value is disabled. The setting value does not remain when the drive is powered off.

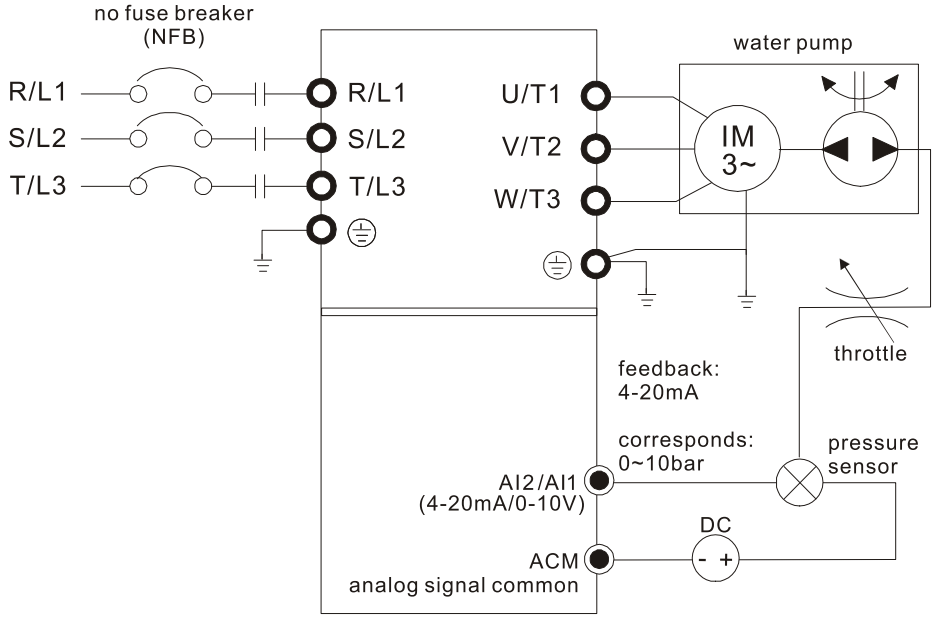
1) Common applications for PID control:
   a) Flow control: Use a flow sensor to feedback the flow data and perform accurate flow control.
   b) Pressure control: Use a pressure sensor to feedback the pressure data and perform precise pressure control.
   c) Air volume control: Use an air volume sensor to feedback the air volume data to achieve excellent air volume regulation.
   d) Temperature control: Use a thermocouple or thermistor to feedback temperature data for comfortable temperature control.
   e) Speed control: Use a speed sensor to feedback motor shaft speed or input another machine speed as a target value for synchronous control.
2) PID control loop:



3) Concept of PID control:
   a) Proportional gain (P): The output is proportional to input. With only a proportional gain control, there is always a steady-state error.
   b) Integral time (I): The controller output is proportional to the integral of the controller input. When an automatic control system is in a steady state and a steady-state error occurs, the system is called a System with Steady-state Error. To eliminate the steady-state error, add an "integral part" to the controller. The integral time controls the relation between the integral part and the error. The integral part increases over time even if the error is small. It gradually increases the controller output to eliminate the error until it is zero. This stabilizes the system without a steady-state error by using proportional gain control and integral time control.

c) Differential control (D): The controller output is proportional to the differential of the controller input. During elimination of the error, oscillation or instability may occur. Use the differential control to suppress these effects by acting before the error. That is, when the error is near 0, the differential control should be 0. Use proportional gain (P) and differential control (D) to improve the system state during PID adjustment.

4) Using PID control in a constant pressure pump feedback application:
Set the application's constant pressure value (bar) to be the set point of PID control. The pressure sensor sends the actual value as the PID feedback value. After comparing the PID set point and PID feedback, an error displays. The PID controller calculates the output by using proportional gain (P), integral time (I) and differential time (D) to control the pump. It controls the drive to use a different pump speed and achieves constant pressure control by using a 4–20 mA signal corresponding to 0–10 bar as feedback to the drive.



- *P00.04 = 10 (display PID feedback (b) (%))*
- *P01.12 Acceleration Time is set according to actual conditions.*
- *P01.13 Deceleration Time is set according to actual conditions.*
- *P00.21 = 0, operate through the digital keypad*
- *P00.20 = 0, the digital keypad controls the set point.*
- *P08.00 = 1 (negative PID feedback from analog input)*
- *AI2 analog input P03.01 = 5, PID feedback signal.*
- *P08.01-P08.03 is set according to actual conditions.*
- *If there is no oscillation in the system, increase P08.01 (Proportional Gain (P))*
- *If there is no oscillation in the system, decrease P08.02 (Integral Time (I))*
- *If there is no oscillation in the system, increase P08.03 (Differential Time (D))*
- *Refer to P08.00–P08.21 for PID parameter settings.*

		Type	Hex Addr	Dec Addr
P08.01	**Proportional Gain (P)**	♦R/W	0801	42050
Range/Units (Format: 16-bit unsigned)		Default		
0.0–1000.0 (When P08.23 bit 1 = 0) 0.00–100.00 (When P08.23 bit 1 = 1)		1.00		

Sets the proportional gain to determine the deviation response speed. The higher the proportional gain, the faster the response speed. Eliminates the system deviation; usually used to decrease the deviation and get faster response speed. If you set the value too high, overshoot occurs and it may cause system oscillation and instability.

When P08.01 = 1.0: Kp gain is 100%; if the setting is 0.5, Kp gain is 50%.

If you set the other two gains (I and D) to zero, proportional control is the only effective parameter.

		Type	Hex Addr	Dec Addr
P08.02	**Integral Time (I)**	♦R/W	0802	42051
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00 sec.		1.00		

Use the integral controller to eliminate deviation during stable system operation. The integral control does not stop working until the deviation is zero. The integral is affected by the integral time. The smaller the integral time, the stronger the integral action. It is helpful to reduce overshoot and oscillation for a stable system. Accordingly, the speed to lower the steady-state deviation decreases. Integral control is often used with the other two controls for the PI controller or PID controller.

Sets the integral time of the I controller. When the integral time is long, there is a small I controller gain, with slower response and slow external control. When the integral time is short, there is a large I controller gain, with faster response and rapid external control.

- *When the integral time is too short, it may cause overshoot or oscillation for the output frequency and system.*
- *Set Integral Time to 0.00 to disable the I controller.*

		Type	Hex Addr	Dec Addr
P08.03	**Differential Time (D)**	♦R/W	0803	42052
Range/Units (Format: 16-bit unsigned)		Default		
0.00–1.00 sec.		0.00		

Use the differential controller to show the system deviation change, as well as to preview the change in the deviation. You can use the differential controller to eliminate the deviation in order to improve the system state. Using a suitable differential time can reduce overshoot and shorten adjustment time; however, the differential operation increases noise interference. Note that a too large differential causes more noise interference. In addition, the differential shows the change and the differential output is 0 when there is no change. Note that you cannot use the differential control independently. You must use it with the other two controllers for the PD controller or PID controller.

Sets the D controller gain to determine the deviation change response. Using a suitable differential time reduces the P and I controllers overshoot to decrease the oscillation for a stable system. A differential time that is too long may cause system oscillation.

The differential controller acts on the change in the deviation and cannot reduce interference. Do not use this function when there is significant interference.

		Type	Hex Addr	Dec Addr
P08.04	**Upper Limit of Integral Control**	♦R/W	0804	42053
Range/Units (Format: 16-bit unsigned)		Default		
0.0–100.0%		100.0		

P08.04 defines an upper bound for the integral gain (I) and therefore limits the master frequency.

The formula is: Integral upper bound = Maximum Operation Frequency (P01.00) x (P08.04%).

An excessive integral value causes a slow response due to sudden load changes and may cause motor stall or machine damage. If so, decrease it to a proper value.

		Type	Hex Addr	Dec Addr
P08.05	**PID Output Command Limit (Positive Limit)**	♦R/W	0805	42054
Range/Units (Format: 16-bit unsigned)		Default		
0.0–110.0%		100.0		

P08.05 defines the percentage of the output frequency limit during the PID control. The formula is Output Frequency Limit = Maximum Operation Frequency (P01.00) × P08.05%.

		Type	Hex Addr	Dec Addr
P08.06	**PID Feedback Value by Communication Protocol**	♦R/W	0806	42055
Range/Units (Format: 16-bit signed)		Default		
-200.00–200.00%		0.00		

Use communications to set the PID feedback value when the PID feedback input is set to communications (P08.00 = 7 or 8).

		Type	Hex Addr	Dec Addr
P08.07	**PID Delay Time**	♦R/W	0807	42056
Range/Units (Format: 16-bit unsigned)		Default		
0.0–2.5 sec.		0.0		

P08.07 determines the primary low pass filter time when in PID control. Setting a large time constant may slow down the drive's response speed.

PID control output frequency is filtered with a primary low pass function. This function can filter a mix of frequencies. A long primary low pass time means the filter degree is high and a short primary low pass time means the filter degree is low.

Inappropriate delay time setting may cause system oscillation.

		Type	Hex Addr	Dec Addr
P08.08	**Feedback Signal Detection Time**	♦R/W	0808	42057
Range/Units (Format: 16-bit unsigned)		Default		
0.0–3600.0 sec.		0.0		

Valid only when the feedback signal is AI2 (4–20 mA).

P08.08 sets the detection time for abnormal PID signal feedback. You can also use it when the system feedback signal response is extremely slow. (Setting the detection time to 0.0 disables the detection function.)

		Type	Hex Addr	Dec Addr
P08.09	**Feedback Signal Fault Treatment**	♦R/W	0809	42058
Range/Units (Format: 16-bit binary)		Default		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: Warn and operate at last frequency		0		

Valid only when the feedback signal is AI2 (4–20 mA).

Sets the treatments when the PID feedback signal is abnormal.

		Type	Hex Addr	Dec Addr
P08.10	**Sleep Frequency**	♦R/W	080A	42059
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz (P08.18=0) 0.00–200.00% (P08.18=1)		0.00		

P08.10 determines the sleep frequency, and if the sleep time and the wake-up frequency are enabled or disabled.

- *P08.10 = 0: Disabled*
- *P08.10 ≠ 0: Enabled*

		Type	Hex Addr	Dec Addr
P08.11	**Wake-up Frequency**	♦R/W	080B	42060
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz (P08.18=0) 0.00–200.00% (P08.18=1)		0.00		

When P08.18=0, the unit for P08.10 and that for P08.11 switch to frequency. The settings are between 0.00–599.00 Hz.

When P08.18=1, the unit for P08.10 and that for P08.11 switch to percentage. The settings are between 0.00–200.00%.

- *The percentage is based on the current setpoint value, not the maximum value. For example, if the maximum value is 100kg, and the current setpoint value is 30kg, then if P08.11=40%, the value is 12kg.*
- *P08.10 uses the same logic for calculation.*

		Type	Hex Addr	Dec Addr
P08.12	**Sleep Time**	♦R/W	080C	42061
Range/Units (Format: 16-bit unsigned)		Default		
0.0–6000.0 sec.		0.0		

When the Frequency command is smaller than the sleep frequency and less than the sleep time, the Frequency command is equal to the sleep frequency. However, the Frequency command remains at 0.00 Hz until the Frequency command becomes equal to or larger than the wake-up frequency.

		Type	Hex Addr	Dec Addr
P08.13	**PID Feedback Signal Error Deviation Level**	♦R/W	080D	42062
Range/Units (Format: 16-bit unsigned)		Default		
1.0–50.0%		10.0		

		Type	Hex Addr	Dec Addr
P08.14	**PID Feedback Signal Error Deviation Detection Time**	♦R/W	080E	42063
Range/Units (Format: 16-bit unsigned)		Default		
0.1–300.0 sec.		5.0		

When the PID control function is normal, it should calculate the value within a period of time that is close to the target value.

Refer to the PID control diagram for details. When executing PID feedback control, if |PID reference target value - detection value| > P08.13 PID Feedback Signal Error Deviation Level and time exceeds P08.14 setting, it is regarded as a PID control fault, and the multi-function output terminal setting 15 (PID feedback error) activates.

		Type	Hex Addr	Dec Addr
P08.15	**PID Feedback Signal Filter Time**	♦R/W	080F	42064
Range/Units (Format: 16-bit unsigned)		Default		
0.1–300.0 sec.		5.0		

		Type	Hex Addr	Dec Addr
P08.16	**PID Compensation Selection**	♦R/W	0810	42065
Range/Units (Format: 16-bit binary)		Default		
0: Parameter setting 1: Analog input		0		

When P08.16=0: the setting for P08.17 determines the PID compensation value.

		Type	Hex Addr	Dec Addr
P08.17	**PID Compensation**	♦R/W	0811	42066
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0%		0		

The PID compensation value = maximum PID target value × P08.17.

Example:

If the maximum operation frequency P01.00 = 60Hz, and P08.17 = 10.0%, the PID compensation value increases the output frequency 6.00 Hz (60.00 Hz × 100.00% × 10.0% = 6.00 Hz).

		Type	Hex Addr	Dec Addr
P08.18	**Sleep Mode Function Setting**	R/W	0812	42067
Range/Units (Format: 16-bit binary)		Default		
0: Refer to PID output command 1: Refer to PID feedback signal		0		

P08.18 determines the setting type for P08.10 and P08.11.

- *P08.18 = 0: The unit for P08.10 and P08.11 switch to frequency. The settings are between 0.00–599.00 Hz.*
- *P08.18 = 1: The unit for P08.10 and P08.11 switch to percentage. The settings are between 0.00–200.00%.*

		Type	Hex Addr	Dec Addr
P08.19	**Wake-up Integral Limit**	♦R/W	0813	42068
Range/Units (Format: 16-bit unsigned)		Default		
0.0–200.0%		50.0		

P08.19 reduces the reaction time from sleep to wake-up.

Defines the wake-up integral frequency limit = (P01.00 × P08.19%)

		Type	Hex Addr	Dec Addr
P08.20	**PID Mode Selection**	R/W	0814	42069
Range/Units (Format: 16-bit binary)		Default		
0: Dependent ISA PID structure 1: Independent/Parallel PID structure		0		

- *P08.20 = 0: Use Dependent (ISA) PID control structure (Kp, Kp*Ki, Kp*Kd).*
- *P08.20 = 1: Use Independent/Parallel PID control structure. The proportional gain, integral gain, and differential gain are independent (Kp, Ki, Kd). You can customize the P, I, and D value to fit your application.*

PI Control:

Controlled only by the P action, so the deviation cannot be entirely eliminated. In general, to eliminate residual deviations, use the P + I controls. When you use the PI control, it eliminates the deviation caused by the targeted value changes and the constant external interferences. However, if the I action is too powerful, it delays the response when there is rapid variation. You can use the P action by itself to control the loading system with the integral components.

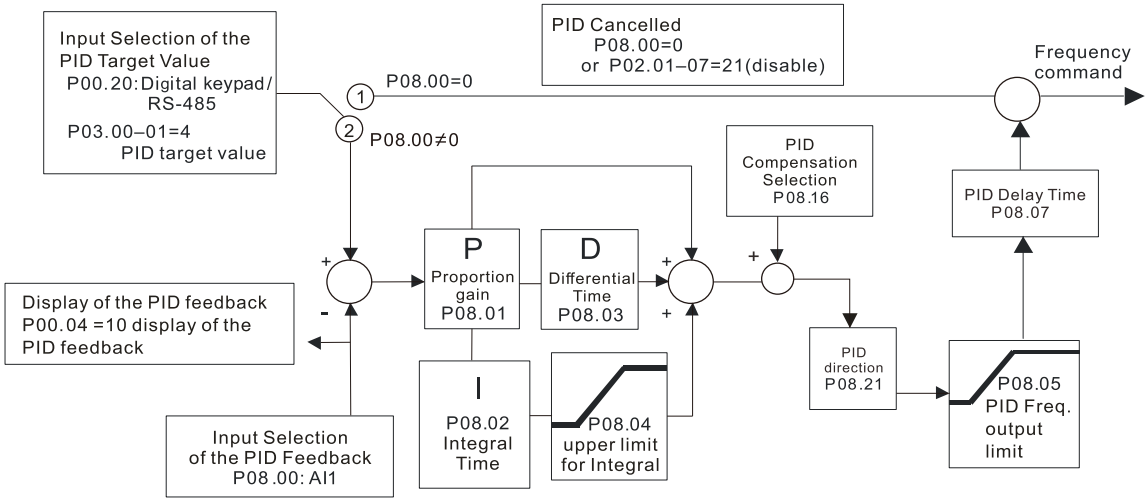
PD Control:

When deviation occurs, the system immediately generates an operation load that is greater than the load generated only by the D action to restrain the deviation increment. If the deviation is small, the effectiveness of the P action decreases as well. The control objects include applications with integral component loads, which are controlled by the P action only. Sometimes, if the integral component is functioning, the whole system may oscillate. In this case, use the PD control to reduce the P action's oscillation and stabilize the system. In other words, this control is useful with no brake function's loading over the processes.

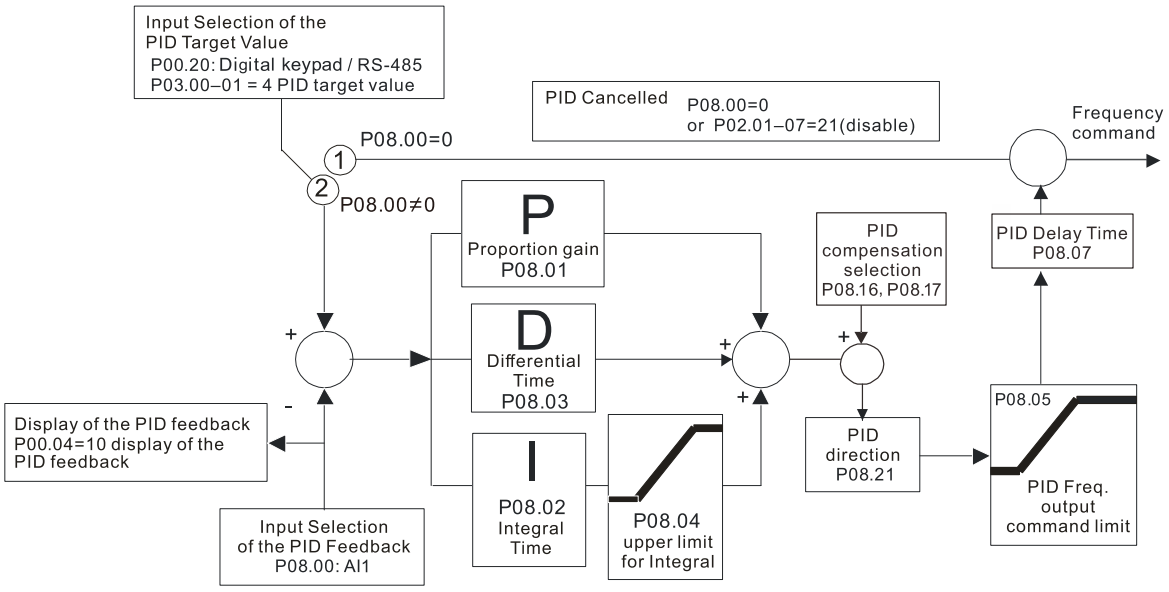
PID Control:

Use the I action to eliminate the deviation and the D action to reduce oscillation; then combine this with the P action for the PID control. Use the PID method for a control process with no deviations, high accuracy, and a stable system.

Dependent (ISA Control):



Independent (Parallel) control:



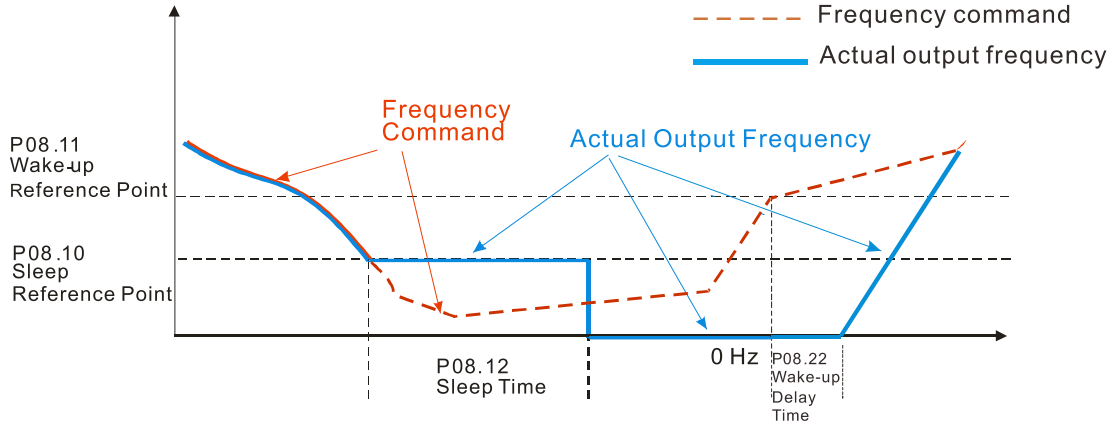
		Type	Hex Addr	Dec Addr
P08.21	**Enable PID to Change the Operation Direction**	R/W	0815	42070
Range/Units (Format: 16-bit binary)		*Default*		
0: Operation direction cannot be changed 1: Operation direction can be changed		0		

		Type	Hex Addr	Dec Addr
P08.22	**Wake-up Delay Time**	♦R/W	0816	42071
Range/Units (Format: 16-bit binary)		*Default*		
0.00–600.00 sec.		0.00		

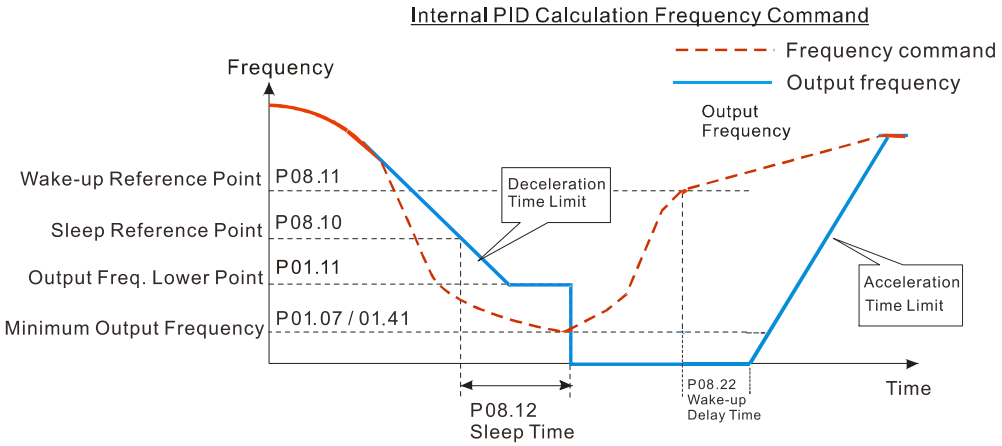
Refer to P08.18 and the diagrams in P08.23 for more information.

There are three scenarios for the sleep and wake-up frequency.

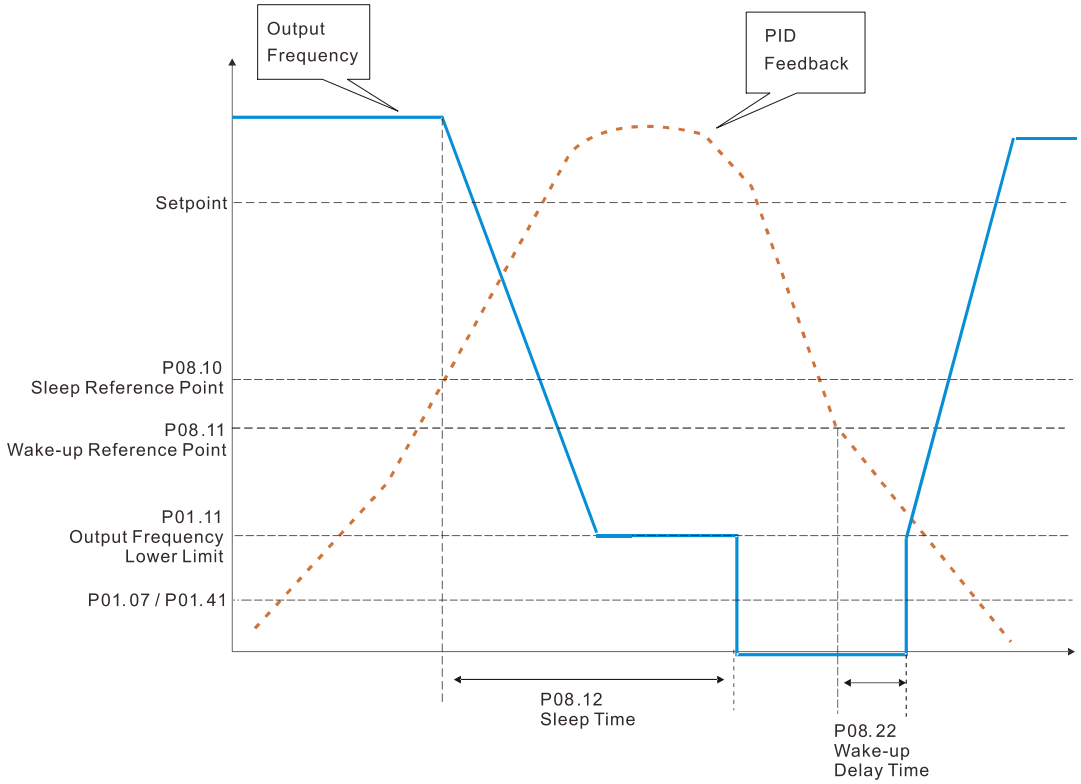
1) Frequency Command (PID is not in use, P08.00 = 0. Works only in V/F mode)
When the output frequency ≤ the sleep frequency and the drive reaches the preset sleep time, then the drive is in sleep mode (0Hz). When the Frequency command reaches the wake-up frequency, the drive starts to count the wake-up delay time. When the drive reaches the wake-up delay time, it starts to catch up to reach the Frequency command value by the acceleration time.



2) Internal PID Calculation Frequency Command (PID is in use, P08.00 ≠ 0 and P08.18=0.)
When the PID calculation Frequency command reaches the sleep frequency, the drive starts to count the sleep time and the output frequency starts to decrease. If the drive exceeds the preset sleep time, then the drive is in sleep mode (0Hz). If the drive does not reach the preset sleep time, it remains at the lower frequency limit (if there is a preset lower limit.), or it remains at the minimum output frequency set for P01.07 and waits until it reaches the sleep time before going into sleep mode (0Hz). When the PID calculated Frequency command reaches the wake-up frequency, the drive starts to count the wake-up delay time. Once it reaches the wake-up delay time, the drive starts to catch up to reach the PID Frequency command value by the acceleration time.



3) PID Feedback Value Percentage (PID is in use, P08.00 ≠ 0 and P08.18 = 1)
When the PID feedback value reaches the sleep level percentage, the drive starts to count the sleep time and the output frequency starts to decrease. If the drive exceeds the preset sleep time, then the drive is in sleep mode (0Hz). If the drive does not reach preset the sleep time, it remains at the lower frequency limit (if there is a preset of lower limit.), or it remains at the minimum output frequency set for P01.07 and waits until it reaches the sleep time before going into sleep mode (0Hz).
When the PID feedback value reaches the wake-up percentage, the drive starts to count the wake-up delay time. Once it reaches the wake-up delay time, the drive starts to catch up to reach the PID Frequency command value by the acceleration time.



		Type	Hex Addr	Dec Addr
P08.23	**PID Control Flag**	♦R/W	0817	42072
Range/Units (Format: 16-bit binary)		*Default*		
bit 0 = 1, PID running in reverse follows the setting for P00.23. bit 0 = 0, PID running in reverse refers to PID's calculated value. bit 1 = 1, two decimal places for PID Kp bit 1 = 0, one decimal place for PID Kp		2		

P08.23 sets the PID control flag.

- *P08.23 bit 0 = 1: PID running in reverse function is valid only when P08.21=1.*
- *P08.23 bit 0 = 0: If the PID calculated value is positive, the direction is forward. If the PID calculated value is negative, the direction is reverse.*

When the bit1 setting changes, the Kp gain does not change. For example: Kp = 6. When P08.23 bit1 = 0, Kp = 6.0; when P08.23 bit1 = 1, Kp = 6.00.

		Type	Hex Addr	Dec Addr
P08.26	**PID Output Command Limit (Reverse Limit)**	♦R/W	081A	42075
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–100.0%		100.0		

When PID enables the reverse direction, the PID output is a negative value, and the PID output value is limited by the setting for P08.26. Use this function with P08.21.

		Type	Hex Addr	Dec Addr
P08.27	**Acceleration / Deceleration Time for PID Command**	♦R/W	081B	42076
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35 sec.		0.00		

When P08.27 = 0.00 seconds: Disables the PID acceleration/deceleration command, and the target value is equal to the PID command.

When P08.27 ≠ 0.00 seconds: Enables the PID acceleration/deceleration command. For PID acceleration and deceleration, when the PID target value changes, the command value increment/decrement is executed according to this parameter.

Example:

If we set P08.27 to 10.00 seconds, when PID target value changes from 0% to 100%, it takes 10 seconds for the PID command to change from 0% to 100%. In a similar way, when PID target value changes from 100% to 0%, it takes 10 seconds for the PID command to change from 100% to 0%.

		Type	Hex Addr	Dec Addr
P08.29	**Frequency Base Corresponding to 100.00% PID**	R/W	081D	42078
Range/Units (Format: 16-bit binary)		Default		
0: PID control output 100.00% corresponding to maximum operation frequency (P01.00) 1: PID control output 100.00% corresponding to the input value of the auxiliary frequency		0		

Valid only when you enable the master and auxiliary frequency functions.

When P08.29 = 0, PID control outputs 100.00% corresponding to the maximum operation frequency. When P08.29 = 1, PID control outputs 100.00% corresponding to the auxiliary frequency. (The PID output frequency changes when the auxiliary frequency command changes.)

		Type	Hex Addr	Dec Addr
P08.31	**Proportional gain 2**	♦R/W	081F	42080
Range/Units (Format: 16-bit unsigned)		Default		
0.0–1000.0 (when P08.23 setting bit 1=0) 0.00–100.00 (when P08.23 setting bit 1=1)		1.00		

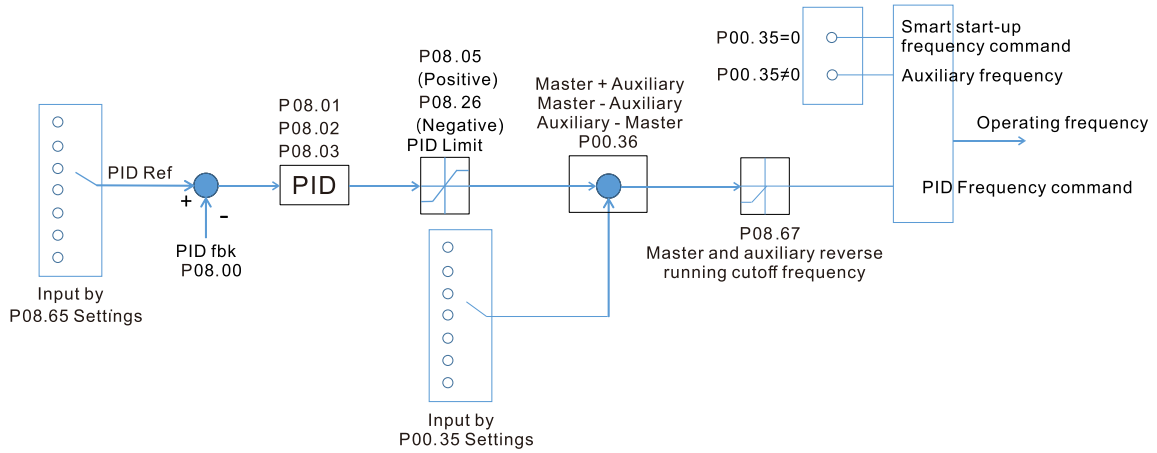
		Type	Hex Addr	Dec Addr
P08.32	**Integral time 2**	♦R/W	0820	42081
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00 sec.		1.00		

		Type	Hex Addr	Dec Addr
P08.33	**Differential time 2**	♦R/W	0821	42082
Range/Units (Format: 16-bit binary)		Default		
0.00–1.00 sec.		0.00		

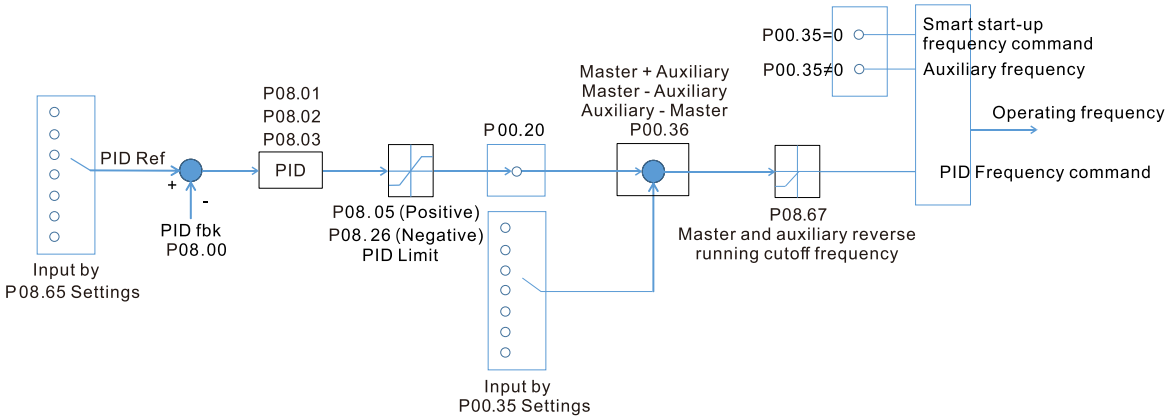
		Type	Hex Addr	Dec Addr
P08.65	**PID Target Value Source**	♦R/W	0841	42114
Range/Units (Format: 16-bit binary)		Default		
0: Frequency command (P00.20, P00.30)		0		
1: P08.66 setting				
2: RS-485 communication input				
3: External analog input (refer to P03.00, P03.01)				
6: Communication card				
7: Digital keypad VR/Potentiometer dial (GS20 only)				

P08.65 selects the target value source for the PID controller.

- *When P08.65=0, the maximum operating frequency P01.00 is 60Hz, the error is 100%, and P08.01=1.00, then the output frequency is "1" times the P01.00 maximum operating frequency. Therefore, the output frequency = 60 * 100% * 1=60Hz.*
  *Calculation formula: Output frequency=Fmax (P01.00) * error% ((PID reference value (P00.20 / P00.30) – PID feedback (P08.00)) * P08.01.*
- *When P08.65≠0, the internal calculation of the proportional gain reduces by 100 times, that is, when P01.00 Fmax=60Hz, error=100%, P08.01=1.00, then the output frequency is "0.01" times the P01.00 Fmax. Therefore, the output frequency=60 * 100% * 0.01=0.6 Hz.*
  *Calculation formula: Output frequency=Fmax (P01.00) * error% ((PID reference value (P08.66) – PID feedback value (P08.00)) * P08.01 * 0.01.*
- *When P08.65=0, the PID controller architecture shows as the diagram below:*



- *When P08.65≠0, the PID controller architecture shows as the diagram below:*



- *When P08.65 is not set to 0, P00.20 is automatically set to 9.*
- *When P08.65 is set to 1, set the PID command through P08.66; when P08.65 is not set to 1, P08.66 displays the PID command.*
- *When P08.65 is set to 2, 4, and 6, the corresponding communication address is C2003H.*

		Type	Hex Addr	Dec Addr
P08.66	**PID Target Value Setting**	♦R/W	0842	42115
Range/Units (Format: 16-bit signed)		Default		
-100.00–100.00%		50.00		

The target value setting of the PID controller (P08.66) is a relative value.

		Type	Hex Addr	Dec Addr
P08.67	**Master and Auxiliary Reverse Running Cutoff Frequency**	♦R/W	0843	42116
Range/Units (Format: 16-bit unsigned)		Default		
0.0–100.0%		10.0		

100% corresponds to P01.00 the maximum operation frequency

In some cases, it is only possible for the PID to control the set point and the feedback to the same status when the PID output frequency is negative (the motor runs in reverse). However, an excessively high reverse frequency is not allowed in some cases, and P08.67 is used to determine the upper limit of the reverse frequency

		Type	Hex Addr	Dec Addr
P08.68	**PID Deviation Limit**	♦R/W	0844	42117
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00%		0.00		

When P08.68 is not set to 0, the PID deviation limit function is enabled.

When PID deviation ≤ PID deviation limit, PID stops adjusting, which means the PID output frequency maintains the value at last status. This function is effective for some closed-loop control applications.

		Type	Hex Addr	Dec Addr
P08.69	**Integral Separation Level**	♦R/W	0845	42118
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00%		0.00		

P08.69 reduces overshoot when overshoot occurs in the PID feedback at start-up.

- *When P08.69 is not set to 0, the integral separation function is enabled.*
- *The benchmark for the integral separation level is the PID error%.*
- *The integral separation function activates only once at start-up.*

When PID deviation ≥ P08.69, the integral effect is cancelled to avoid the increasing system overshoot due to the integral effect. When PID deviation is smaller than P08.69, the integral effect is activated to eliminate the steady-state error.

		Type	Hex Addr	Dec Addr
P08.70	**Smart Start-up Level**	R/W	0846	42119
Range/Units (Format: 16-bit unsigned)		Default		
0.00–100.00%		5.00		

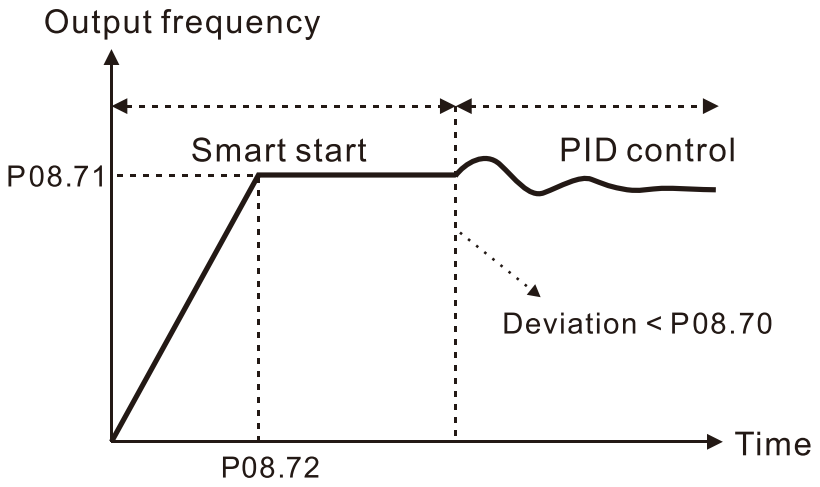
		Type	Hex Addr	Dec Addr
P08.71	**Smart Start-up Frequency Command**	♦R/W	0847	42120
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		0.00		

P08.72	Smart Start-up Acceleration Time	Type	Hex Addr	Dec Addr
		♦R/W	0848	42121
Range/Units (Format: 16-bit unsigned)		Default		
		3.00		

When P08.71 is not set to 0, the smart start-up function is enabled.

- *The benchmark for the smart start-up level is the percentage of PID deviation.*
- *Use the smart start-up function to reduce overshoot when overshoot occurs in the PID feedback at start-up. The smart start-up activates only once at start-up.*

When the smart start-up function is enabled, it starts with the P08.71 frequency and P08.72 acceleration time (P08.72 acceleration time is the time that it accelerates to P08.71). When the PID deviation is smaller than P08.70, it switches to the normal PID control (the smart start-up frequency is filled into the PID integral when switching to PID control to avoid discontinuous frequency).



P08.75	PID2 Parameter Switch Condition	Type	Hex Addr	Dec Addr
		♦R/W	084B	42124
Range/Units (Format: 16-bit binary)		Default		
0: No switching (refer to P08.01–P08.03) 1: Auto-switch based on the output frequency 2: Auto-switch based on the deviation		0		

P08.76	PID2 Parameter Switch Deviation 1	Type	Hex Addr	Dec Addr
		♦R/W	084C	42125
Range/Units (Format: 16-bit unsigned)		Default		
0.00–P08.77%		10.00		

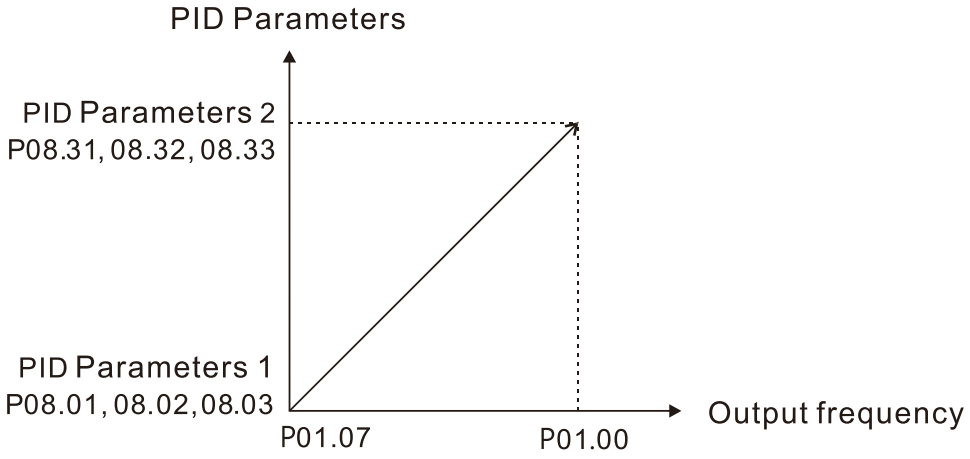
P08.77	PID2 Parameter Switch Deviation 2	Type	Hex Addr	Dec Addr
		♦R/W	084D	42126
Range/Units (Format: 16-bit unsigned)		Default		
P08.76–100.00%		40.00		

A set of PID parameters cannot meet the requirements of the entire running process in some applications. Use P08.75 to switch to the second set of PID parameters P08.31–P08.33. The setting method for P08.31–P08.33 is the same as that for P08.01–P08.03.

The two sets of PID parameters switch automatically according to the frequency and deviation.

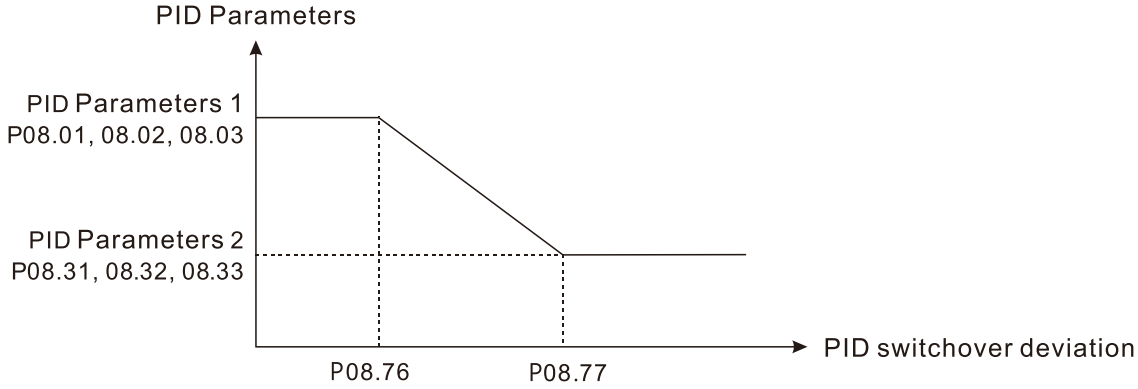
Switch according to the output frequency:

When the output frequency is between P01.07 and P01.00, the PID parameter is the linear interpolation value between the two PID parameter groups.



Switch according to the deviation:

- *When the deviation absolute value between the set point and feedback is smaller than P08.76 (PID2 Parameter Switch Deviation 1), the first group PID parameters are used.*
- *When the deviation absolute value between the set point and feedback is larger than P08.77 (PID2 Parameter Switch Deviation 2), the second group PID parameters are used.*
- *When the deviation absolute value between the set point and feedback is between P08.76 and P08.77, the PID parameter is the linear interpolation value between the two PID parameter groups.*



		Type	Hex Addr	Dec Addr
P08.78	***Allowed Reverse Running Time after Start-up***	♦R/W	084E	42127
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–6553.5 sec.		0.0		

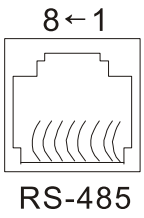
When P08.78 is not set to 0, the allowed reverse running time after start-up is enabled.

When it is set to 1 second, the PID control is not allowed to change the running direction within 0–1 seconds of starting time (P08.21=0), and is allowed to change after 1 second of starting time (P08.21=1).

Group P09.xx Details – Communication Parameters

When connecting the drive to an RS-485 network, the diagram on the right shows the built-in RS-485 communication port pin definitions.

To connect your drive to a PC USB port with GSoft2 software, utilize the GS20 type 2 serial port connection only. This port does not require configuration of the COM1 parameters.



Modbus RS-485
Pin 1, 2, 6: Reserved
Pin 3, 7: SGND
Pin 4: SG-
Pin 5: SG+
Pin 8: +10VS

		Type	Hex Addr	Dec Addr
P09.00	**COM1 Communication Address**	♦R/W	0900	42305
Range/Units (Format: 16-bit unsigned)		*Default*		
1–254		1		

P09.00 sets the communication address for the drive if the AC motor drive is controlled through RS-485 serial communication. The communication address for each AC drive must be unique.

		Type	Hex Addr	Dec Addr
P09.01	**COM1 Transmission Speed**	♦R/W	0901	42306
Range/Units (Format: 16-bit unsigned)		*Default*		
4.8–115.2 Kbps		9.6		

P09.01 sets the transmission speed of the RS-485 port of the drive.

Options are 4.8 Kbps, 9.6 Kbps, 19.2 Kbps, 38.4 Kbps, 57.6 Kbps, or 115.2 Kbps; otherwise, the transmission speed is set to the default 9.6 Kbps.

For optional GS4-KPD remote keypad, value must be set to 19.2.

		Type	Hex Addr	Dec Addr
P09.02	**COM1 Transmission Fault Treatment**	♦R/W	0902	42307
Range/Units (Format: 16-bit binary)		*Default*		
0: Warn and continue operation		3		
1: Fault and ramp to stop				
2: Fault and coast to stop				
3: No warning, no fault, and continue operation				

P09.02 determines the treatment when an error is detected that the host controller does not continuously transmit data to the AC motor drive during Modbus communication. The detection time is based on the P09.03 setting.

When a transmission error occurs (for example, the error code CE10 displays), the error remains even if the transmission status returns to normal, and is not cleared automatically. In this case, set a reset command (Reset) to clear the error.

		Type	Hex Addr	Dec Addr
P09.03	**COM1 Time-out Detection**	♦R/W	0903	42308
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–100.0 sec.		0.0		

P09.03 sets the communication time-out value.

		Type	Hex Addr	Dec Addr
P09.04	**COM1 Communication Protocol**	♦R/W	0904	42309
Range/Units (Format: 16-bit binary)		*Default*		
1: 7, N, 2 (ASCII) 2: 7, E, 1 (ASCII) 3: 7, O, 1 (ASCII) 4: 7, E, 2 (ASCII) 5: 7, O, 2 (ASCII) 6: 8, N, 1 (ASCII) 7: 8, N, 2 (ASCII) 8: 8, E, 1 (ASCII) 9: 8, O, 1 (ASCII) 10: 8, E, 2 (ASCII) 11: 8, O, 2 (ASCII) 12: 8, N, 1 (RTU) 13: 8, N, 2 (RTU) 14: 8, E, 1 (RTU) 15: 8, O, 1 (RTU) 16: 8, E, 2 (RTU) 17: 8, O, 2 (RTU)		15		

Control by RS-485 Network

When using the RS-485 serial communication interface, you must specify each drive's communication address in P09.00. The RS-485 network master then implements control using the drives' individual addresses.

Modbus ASCII (American Standard Code for Information Interchange): Each byte of data is the combination of two ASCII characters. For example, one byte of data: 64 Hex, shown as '64' in ASCII, consists of '6' (36Hex) and '4' (34Hex).

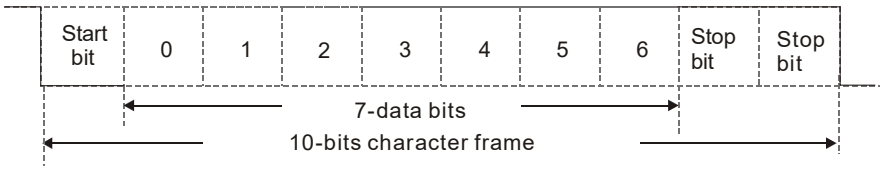
1) Code Description
The communication protocol is in hexadecimal, ASCII: "0" … "9", "A" … "F", every hexadecimal value represents an ASCII code. The following table shows some examples.

Character	***'0'***	***'1'***	***'2'***	***'3'***	***'4'***	***'5'***	***'6'***	***'7'***
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H

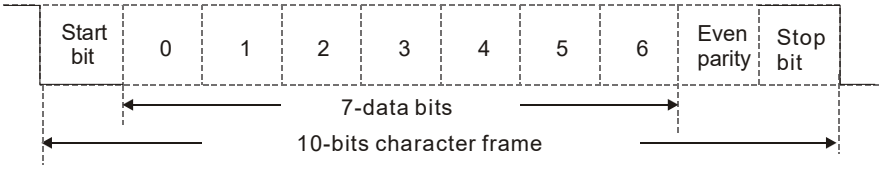
Character	***'8'***	***'9'***	***'A'***	***'B'***	***'C'***	***'D'***	***'E'***	***'F'***
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

2) Data Format
10-bit character frame (For ASCII):

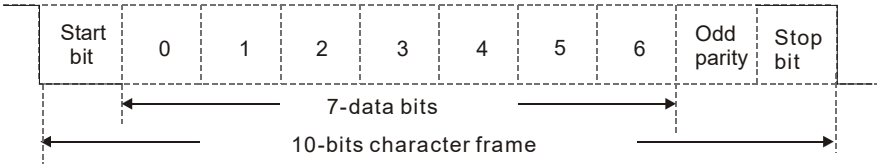
a) (7, N, 2)



b) (7, E, 1)

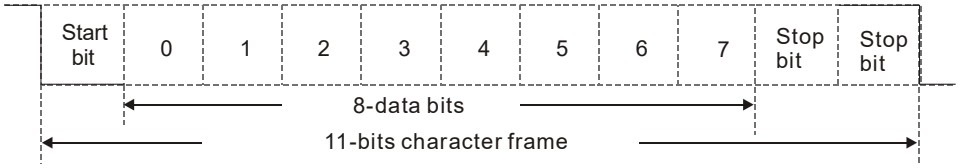


c) (7, O, 1)

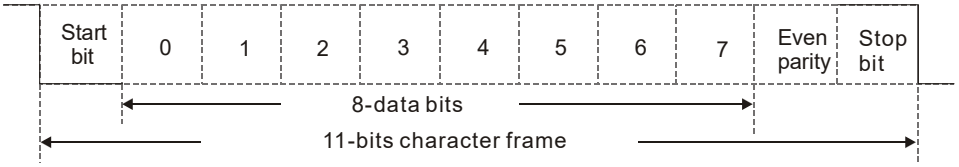


11-bit character frame (For RTU):

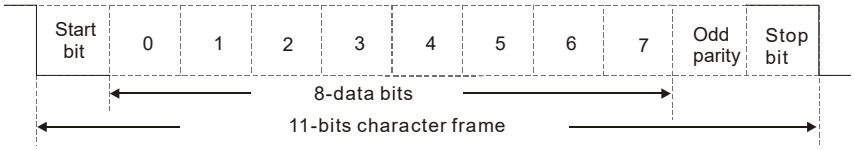
a) (8, N, 2)



b) (8, E, 1)



c) (8, O, 1)



3) Communication Protocol

a) Communication Data Frame

ASCII mode:

STX	Start character = ' : ' (3AH)
Address High	Communication address: one 8-bit address consists of 2 ASCII codes
Address Low	
Function High	Command code: one 8-bit command consists of 2 ASCII codes
Function Low	
DATA (n-1)	Contents of data: n x 8-bit data consists of 2n ASCII codes n ≤ 16, maximum of 32 ASCII codes (20 sets of data)
.....	
DATA 0	
LRC Check High	LRC checksum: one 8-bit checksum consists of 2 ASCII codes
LRC Check Low	
END High	End characters: END High = CR (0DH), END Low = LF (0AH)
END Low	

RTU mode:

START	Defined by a silent interval of larger than/equal to 10ms
Address	Communication address: 8-bit binary address
Function	Command code: 8-bit binary command
DATA (n-1)	Contents of data: n × 8-bit data, n ≤ 16
.....	
DATA 0	
CRC Check Low	CRC checksum: one 16-bit CRC checksum consists of 2 8-bit binary characters
CRC Check High	
END	Defined by a silent interval of larger than/equal to 10ms

b) Communication Address (Address)

- *00H: Broadcast to all AC motor drives*
- *01H: AC motor drive at address 01*
- *0FH: AC motor drive at address 15*
- *10H: AC motor drive at address 16*

  :
- *FEH: AC motor drive at address 254*

c) Function (Function code) and DATA (Data characters)

i) 03H: Read data from a register

Example: Reading two continuous data from register address 2102H. AMD address is 01H.

ASCII Mode:

Command Message	
STX	':'
Address	'0'
	'1'
Function	'0'
	'3'
Starting register	'2'
	'1'
	'0'
	'2'
Number of register (count by word)	'0'
	'0'
	'0'
	'2'
LRC Check	'D'
	'7'
END	CR
	LF

Response Message	
STX	':'
Address	'0'
	'1'
Function	'0'
	'3'
Number of register (count by byte)	'0'
	'4'
Content of starting register 2102H	'1'
	'7'
	'7'
	'0'
Content of register 2103H	'0'
	'0'
	'0'
	'0'
LRC Check	'7'
	'1'
END	CR
	LF

RTU Mode:

Command Message	
Address	01H
Function	03H
Starting data register	21H
	02H
Number of register (count by world)	00H
	02H
CRC Check Low	6FH
CRC Check High	F7H

Response Message	
Address	01H
Function	03H
Number of register (count by byte)	04H
Content of register address 2102H	17H
	70H
Content of register address 2103H	00H
	00H
CRC Check Low	FEH
CRC Check High	5CH

ii) 06H: Single write, write single data to a register
Example: Writing data 6000 (1770H) to register 0100H. AMD address is 01H.
ASCII Mode:

Command Message	
STX	':'
Address	'0'
	'1'
Function	'0'
	'6'
Target register	'0'
	'1'
	'0'
	'0'
Register content	'1'
	'7'
	'7'
	'0'
LRC Check	'7'
	'1'
END	CR
	LF

Response Message	
STX	':'
Address	'0'
	'1'
Function	'0'
	'6'
Target register	'0'
	'1'
	'0'
	'0'
Register content	'1'
	'7'
	'7'
	'0'
LRC Check	'7'
	'1'
END	CR
	LF

RTU Mode:

Command Message	
Address	01H
Function	06H
Target register	01H
	00H
Register content	17H
	70H
CRC Check Low CRC Check High	86H 22H

Response Message	
Address	01H
Function	06H
Target register	01H
	00H
Register content	17H
	70H
CRC Check Low CRC Check High	86H 22H

iii) 10H: Write multiple registers (can write at most 20 sets of data simultaneously).
Example: Set the multi-step speed of an AC motor drive (address is 01H):
P04.00 = 50.00 (1388H), P04.01 = 40.00 (0FA0H)
ASCII Mode:

Command Message	
STX	':'
ADR 1 ADR 0	'0'
	'1'
CMD 1	'1'
CMD 0	'0'
Target register	'0'
	'5'
	'0'
	'0'
Number of register (count by word)	'0'
	'0'
	'0'
	'2'
Number of register (count by Byte)	'0'
	'4'
The first data content	'1'
	'3'
	'8'
	'8'
The second data content	'0'
	'F'
	'A'
	'0'
LRC Check	'9'
	'A'
END	CR
	LF

Response Message	
STX	':'
ADR 1 ADR 0	'0'
	'1'
CMD 1	'1'
CMD 0	'0'
Target register	'0'
	'5'
	'0'
	'0'
Number of register (count by word)	'0'
	'0'
	'0'
	'2'
LRC Check	'E'
	'8'
END	CR
	LF

RTU Mode:

Command Message	
ADR	01H
CMD	10H
Target register	05H
	00H
Number of register (count by word)	00H
	02H
Quantity of data (byte)	04
The first data content	13H
	88H
The second data content	0FH
	A0H
CRC Check Low	'9'
CRC Check High	'A'

Response Message	
ADR	01H
CMD 1	10H
Target register	05H
	00H
Number of register (count by word)	00H
	02H
CRC Check Low	41H
CRC Check High	04H

d) Checksum

i) ASCII mode (LRC Check):
LRC (Longitudinal Redundancy Check) is calculated by summing up the values of the bytes from ADR1 to the last data character then calculating the hexadecimal representation of the 2's-complement negation of the sum.
For example, as shown in the above Section 3.3.(1),
01H + 03H + 21H + 02H + 00H + 02H = 29H, the 2's-complement negation of 29H is D7H.

ii) RTU mode (CRC Check):
CRC (Cyclical Redundancy Check) is calculated by the following steps:

- ***Step 1:*** *Load a 16-bit register (called CRC register) with FFFFH.*
- ***Step 2:*** *Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, and put the result in the CRC register.*
- ***Step 3:*** *Examine the LSB of CRC register.*
- ***Step 4:*** *If the LSB of CRC register is 0, shift the CRC register one bit to the right, fill MSB with zero, then repeat step 3. If the LSB of CRC register is 1, shift the CRC register one bit to the right, fill MSB with zero, Exclusive OR the CRC register with the polynomial value A001H, then repeat step 3.*
- ***Step 5:*** *Repeat step 3 and 4 until you perform eight shifts. This processes a complete 8-bit byte.*
- **Step 6:** Repeat step 2 through 5 for the next 8-bit byte of the command message. Continue doing this until all bytes are processed. The final contents of the CRC register are the CRC value. When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, that is, the lower order byte is transmitted first.

The following is an example of CRC generation using C language.

- *The function takes two arguments:*
  Unsigned char data ← a pointer to the message buffer*
  Unsigned char length ← the quantity of bytes in the message buffer
- *The function returns the CRC value as a type of unsigned integer.*

```
Unsigned int crc_chk(unsigned char* data, unsigned char length)
{
  int j;
  unsigned int reg_crc=0Xffff;
  while(length--){
        reg_crc ^= *data++;
        for(j=0;j<8;j++){
              if(reg_crc & 0x01){  /* LSB(b0)=1 */
                    reg_crc=(reg_crc>>1) ^ 0Xa001;
              }else{
                    reg_crc=reg_crc >>1;
              }
        }
  }
  return reg_crc;             // return register CRC
}
```

4) Address list

Content	Function		Hex	Dec	Octal
AC motor drive parameters	GG is the parameter group, nn is the parameter number; for example, the address of P04.10 is 040AH.		GGnn (ex. 040A)	xxxxx (41035)	yyyyy (2012)
Command write only	bit 1–0	00B: No function	2000	48193	20000
		01B: Stop			
		10B: Run			
		11B: JOG + RUN			
	bit 3–2	Reserved			
	bit 5–4	00B: No function			
		01B: FWD			
		10B: REV			
		11B: Change direction			
	bit 7–6	00B: 1st accel. / decel.			
		01B: 2nd accel. / decel.			
		10B: 3rd accel. / decel.			
		11B: 4th accel. / decel.			
	bit 11–8	000B: Master speed			
		0001B: 1st step speed frequency			
		0010B: 2nd step speed frequency			
		0011B: 3rd step speed frequency			
		0100B: 4th step speed frequency			
		0101B: 5th step speed frequency			
		0110B: 6th step speed frequency			
		0111B: 7th step speed frequency			
		1000B: 8th step speed frequency			
		1001B: 9th step speed frequency			
		1010B: 10th step speed frequency			
		1011B: 11th step speed frequency			
		1100B: 12th step speed frequency			
		1101B: 13th step speed frequency			
		1110B: 14th step speed frequency			
		1111B: 15th step speed frequency			
	bit 12	1: Enable bit 06–11 function			
	bit 14–13	00B: No function			
		01B: No function			
		10B: No function			
		11B: No function			
	bit 15	Reserved			
	Frequency command (XXX.XX Hz)		2001	48194	20001
	bit 0	1: E.F. (External Fault) ON	2002	48195	20002
	bit 1	1: Reset command			
	bit 2	1: B.B. ON			
	bit 4–3	Reserved			
	bit 5	1: Enable fire mode			
	bit 15–6	Reserved			
Status monitor read only	High byte: Warning code / Low Byte: Fault code		2100	48449	20400

Content	Function		Hex	Dec	Octal
Status monitor read only (continued)	bit 1–0	AC motor drive operation status 00B: The drive stops 01B: The drive is decelerating 10B: The drive is in standby status 11B: The drive is operating	2101	48450	20401
	bit 2	1: JOG command			
	bit 4–3	Operation direction 00B: FWD running 01B: From REV running to FWD running 10B: From FWD running to REV running 11B: REV running			
	bit 8	1: Master frequency controlled by the communication interface			
	bit 9	1: Master frequency controlled by the analog / external terminal signal			
	bit 10	1: Operation command controlled by the communication interface			
	bit 11	1: Parameter locked			
	bit 12	1: Enable to copy parameters from keypad			
	bit 15–13	Reserved			
	Frequency command (XXX.XX Hz)		2102	48451	20402
	Output frequency (XXX.XX Hz)		2103	48452	20403
	Display the drive's output current (XX.XX A). When the current is higher than 655.35, it automatically shifts one decimal place as (XXX.X A). Refer to the high byte of 211F for information on the decimal places.		2104	48453	20404
	DC bus voltage (XXX.X V)		2105	48454	20405
	Output voltage (XXX.X V)		2106	48455	20406
	Current step for the multi-step speed operation		2107	48456	20407
	Reserved		2108	48457	20410
	Digital Input Counter value		2109	48458	20411
	Output power factor angle (XXX.X)		210A	48459	20412
	Output torque (XXX.X %)		210B	48460	20413
	Actual motor speed (XXXXX rpm)		210C	48461	20414
	Reserved		210D	48462	20415
	Reserved		210E	48463	20416
	Power output (X.XXX kW)		210F	48464	20417
	Inidicates one or decimal points for value in 210F.		2114	48469	20424
	Multi-function display (P00.04)		2116	48471	20426
	Maximum Operation Frequency (P01.00) or Maximum User-defined Value (P00.26) When P00.26 is 0, this value is equal to P01.00 setting When P00.26 is not 0, and the command source is keypad, this value = P00.24 * P00.26 / P01.00. When P00.26 is not 0, and the command source is 485, this value = P09.10 * P00.26 / P01.00.		211B	48476	20433
	High byte: the decimal place of current value (display)		211F	48480	20437
	Display the drive's output current (XX.XX A). When the current is higher than 655.35, it automatically shifts one decimal place as (XXX.X A). Refer to the high byte of 211F for information on the decimal places.		2200	48705	21000
	Counter value		2201	48706	21001
	Actual output frequency (XXXXX Hz)		2202	48707	21002

Content	Function	Hex	Dec	Octal
Status monitor read only (continued)	DC bus voltage (XXX.X V)	2203	48708	21003
	Output voltage (XXX.X V)	2204	48709	21004
	Power factor angle (XXX.X)	2205	48710	21005
	Display the output power of U, V, W (XXXX.X kW)	2206	48711	21006
	Display the motor speed estimated by the drive or encoder feedback (XXXXX rpm)	2207	48712	21007
	Display the positive / negative output torque estimated by the drive (+0.0: positive torque; -0.0: negative torque) (XXX.X%)	2208	48713	21010
	Reserved	2209	48714	21011
	Display the PID feedback value after enabling PID function (XXX.XX%)	220A	48715	21012
	Display the AI1 analog input terminal signal, 0–10 V corresponds to 0.00–100.00% (see Explanation 1 in Pr.00-04)	220B	48716	21013
	Display the AI2 analog input terminal signal, 4–20 mA / 0–10 V corresponds to 0.00–100.00% (2.) (see Explanation 2 in P00.04)	220C	48717	21014
	Reserved	220D	48718	21015
	IGBT temperature of the power module (XXX.X °C)	220E	48719	21016
	Reserved	220F	48720	21017
	The digital input status (ON / OFF), refer to P02.12 (see Explanation 2 in P00.04)	2210	48721	21020
	The digital output status (ON / OFF), refer to P02.18 (see Explanation 3 in P00.04)	2211	48722	21021
	Current step for the multi-step speed operation	2212	48723	21022
	The corresponding CPU digital input pin status (d.) (see Explanation 3 in P00.04)	2213	48724	21023
	The corresponding CPU digital output pin status (O.) (see Explanation 4 in P00.04)	2214	48725	21024
	Reserved	2215	48726	21025
	Pulse input frequency (XXX.XX Hz)	2216	48727	21026
	Reserved	2217	48728	21027
	Reserved	2218	48729	21030
	Counter value of overload (XXX.XX %)	2219	48730	21031
	GFF (XXX.XX %)	221A	48731	21032
	DC bus voltage ripples (XXX.X V)	221B	48732	21033
	PLC register D1043 data	221C	48733	21034
	Magnetic field area of the synchronous motor	221D	48734	21035
	User page displays the value in physical measure	221E	48735	21036
	Output value of P00.05 (XXX.XX Hz)	221F	48736	21037
	Reserved	2220	48737	21040
	Reserved	2221	48738	21041
	Reserved	2222	48739	21042
	Control mode of the drive 0: speed mode 1: torque mode	2223	48740	21043
	Carrier frequency of the drive (XX kHZ)	2224	48741	21044
	Reserved	2225	48742	21045

Content	Function		Hex	Dec	Octal
Status monitor read only (continued)	Drive status		2226	48743	21046
	bit 1–0	00b: No direction			
		01b: Forward			
		10b: Reverse			
	bit 3–2	01b: Drive ready			
		10b: Error			
	bit 4	0b: Motor drive does not output			
		1b: Motor drive outputs			
	bit 5	0b: No warning			
		1b: Warning			
	Drive's estimated output torque (positive or negative direction) (XXXX N•m)		2227	48744	21047
	Reserved		2228	48745	21050
	KWH display (XXXX.X)		2229	48746	21051
	Reserved		222A	48747	21052
	Reserved		222B	48748	21053
	Reserved		222C	48749	21054
	Reserved		222D	48750	21055
	PID target value (XXX.XX %)		222E	48751	21056
	PID offset (XXX.XX %)		222F	48752	21057
	PID output frequency (XXX.XX Hz)		2230	48753	21060
	Reserved		2231	48754	21061
	Display the auxiliary frequency		2232	48755	21062
	Display the master frequency		2233	48756	21063
	Display the frequency after adding and subtracting of the master and auxiliary frequencies.		2234	48757	21064

5) Exception response:
When the drive is using the communication connection, if an error occurs, the drive responds to the error code and sets the highest bit (bit 7) of the command code to 1 (function code AND 80H) then responds to the control system to signal that an error occurred.
If the keypad displays "CE-XX" as a warning message, "XX" is the error code at that time. Refer to the table of error codes for communication error for reference.
Example:

ASCII Mode	
STX	':'
Address	'0'
	'1'
Function	'8'
	'6'
Exception code	'0'
	'2'
LRC Check	'7'
	'7'
END	CR
	LF

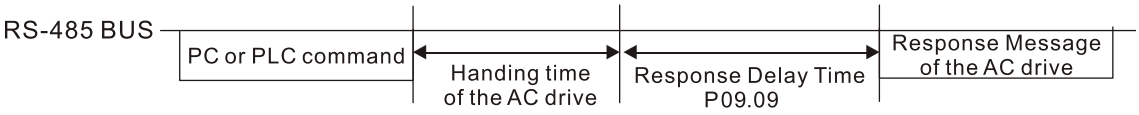
RTU Mode	
Address	01H
Function	86H
Exception code	02H
CRC Check Low	C3H
CRC Check High	A1H

The following table describes the exception code.

Exception Code	Description
1	Function code is not supported or unrecognized.
2	Address is not supported or unrecognized.
3	Data is not correct or unrecognized.
4	Failure to execute this function code

	Type	Hex Addr	Dec Addr
P09.09 **Communication Response Delay Time**	♦R/W	0909	42314
Range/Units (Format: 16-bit unsigned)	*Default*		
0.0–200.0 ms	2.0		

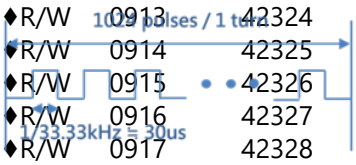
If the host controller does not finish the transmitting/receiving process, you can use this parameter to set the response delay time after the AC motor drive receives communication command as shown in the following picture.



	Type	Hex Addr	Dec Addr
P09.10 **Communication Main Frequency**	R/W	090A	42315
Range/Units (Format: 16-bit unsigned)	*Default*		
0.00–599.00 Hz	60.00		

When you set P00.20 to 1 (RS-485 communication input), the AC motor drive saves the last Frequency command into P09.10 when there is abnormal power off or momentary power loss. When power is restored, the AC motor drive operates with the frequency in P09.10 if there is no new Frequency command input. When a Frequency command of 485 changes (the Frequency command source must be set as Modbus), this parameter also changes.

		Type	Hex Addr	Dec Addr
P09.11	Block Transfer 1	♦R/W	090B	42316
P09.12	Block Transfer 2	♦R/W	090C	42317
P09.13	Block Transfer 3	♦R/W	090D	42318
P09.14	Block Transfer 4	♦R/W	090E	42319
P09.15	Block Transfer 5	♦R/W	090F	42320
P09.16	Block Transfer 6	♦R/W	0910	42321
P09.17	Block Transfer 7	♦R/W	0911	42322
P09.18	Block Transfer 8	♦R/W	0912	42323
P09.19	Block Transfer 9	♦R/W	0913	42324
P09.20	Block Transfer 10	♦R/W	0914	42325
P09.21	Block Transfer 11	♦R/W	0915	42326
P09.22	Block Transfer 12	♦R/W	0916	42327
P09.23	Block Transfer 13	♦R/W	0917	42328
P09.24	Block Transfer 14	♦R/W	0918	42329
P09.25	Block Transfer 15	♦R/W	0919	42330
P09.26	Block Transfer 16	♦R/W	091A	42331



Range/Units (Format: 16-bit unsigned)	Default
0–65535	0

This is a group of block transfer parameters that is available for communications use in the drive (P09.11–P09.26). Using communication code 03H, you can store the parameters (P09.11–P09.26) that you want to read.

		Type	Hex Addr	Dec Addr
P09.30	Communication Decoding Method	R/W	091E	42335

Range/Units (Format: 16-bit binary)	Default
0: Decoding method 1 1: Decoding method 2	0

Source of Operation Control	Decoding Method 1	Decoding Method 2
Digital Keypad	Digital keypad controls the drive action regardless of decoding method 1 or 2.	
External Terminal	External terminal controls the drive action regardless of decoding method 1 or 2.	
RS-485	Refer to address: 2000h–20FFh	Refer to address: 2000h–20FFh
Communication Card	Refer to address: 2000h–20FFh	Not supported - for future use
PLC	PLC command controls the drive action regardless of decoding method 1 or 2.	

Use Decoding Method 1. Decoding Method 2 is not supported at this time.

		Type	Hex Addr	Dec Addr
P09.33	PLC Command Force to 0	♦R/W	0921	42338

Range/Units (Format: 16-bit unsigned)	Default
0–65535	0

P09.33 defines whether the Frequency command or the Speed command must be cleared to zero or not before the PLC starts the next scan.

bit	Description
bit 0	Before PLC scan, set the PLC target frequency = 0
bit 1	Before PLC scan, set the PLC target torque = 0
bit 2	Before PLC scan, set the speed limit of torque mode = 0

		Type	Hex Addr	Dec Addr
P09.35	**PLC Address**	R/W	0923	42340
Range/Units (Format: 16-bit unsigned)		Default		
1–254		2		

The PLC address is required for modbus communications to the PLC. Ensure this address remains different from P09.00, or any other nodes on the modbus network. See Chapter 5 for more information.

		Type	Hex Addr	Dec Addr
P09.60	**Communication Card Identification**	Read	093C	42365
Range/Units (Format: 16-bit binary)		Default		
0: No communication card 4: Modbus-TCP Slave 5: EtherNet/IP Slave 10: Backup Power Supply		0		

If P09.74 = 2, GS20A-CM-ENETIP comm card will identify as 4: Modbus TCP slave.

If P09.74 ≠ 2, GS20A-CM-ENETIP comm card will identify as 5:EtherNet/IP slave.

		Type	Hex Addr	Dec Addr
P09.61	**Firmware Version of Communication Card**	Read (Hex)	093D	42366
P09.62	**Product Code**	Read	093E	42367
P09.63	**Error code**	Read	093F	42368
Range/Units (Format: 16-bit unsigned)		Default		
Read only. P09.61 is displayed in Hex format.		0		

		Type	Hex Addr	Dec Addr
P09.74	**Set Comm Master Protocol (for GS20A-CM-ENETIP)**	♦R/W	094A	42379
Range/Units (Format: 16-bit binary)		Default		
0: Ethernet IP and MODBUS TCP both on 1: EtherNet/IP 2: Modbus TCP		1		

The GS20A-CM-ENETIP card is configurable to use Ethernet/IP and/or Modbus TCP communications. P09.74 defines the master protocol of the communication card and allows the user to define proper actions in the event of communication timeouts.

If P09.74 = 1: EtherNet/IP, in a timeout situation (defined by P09.93 – P09.95), only the EtherNet/IP connection (Implicit OR Explicit) will trigger the timeout, not Modbus TCP.

A 'timeout situation' is defined by 5 different possibilities:

1) A TCP RST or FIN message from the Master in EtherNet/IP Explicit (no EtherNet/IP Implicit).
2) A Forward Close message in EtherNet/IP Implicit.
3) No data message received in the time duration specified in Pr09-95 on EtherNet/IP Explicit.
4) No data message received in the time duration specified in RPI timeout EtherNet/IP Implicit.
5) Physical connection loss (no link available on Ethernet interface).

If P09.74 = 2: Modbus TCP, in a timeout situation (defined by P09.93 – P09.95), only the Modbus TCP connection will trigger the timeout, not EtherNet/IP Explicit (Implicit won't be allowed in this case).

A 'timeout situation' is defined by 3 different possibilities:

1) A TCP RST or FIN message from the Master in Modbus TCP
2) No data message received in the time duration specified in Pr09-95 on Modbus TCP
3) Physical connection loss (no Link Good on Ethernet interface).

If P09.74 = 0: Ethernet/IP and Modbus TCP both on, a loss in either will cause a timeout.

		Type	Hex Addr	Dec Addr
P09.75	**Communication Card IP Configuration (for GS20A-CM-ENETIP)**	♦R/W	094B	42380
	Range/Units (Format: 16-bit binary)	*Default*		
	0: Static IP 1: Dynamic IP (DHCP)	0		

When P09.75=0: Set the IP address manually.

When P09.75=1: IP address is dynamically set by the host controller.

		Type	Hex Addr	Dec Addr
P09.76	**Communication Card IP Address 1 (for GS20A-CM-ENETIP)**	♦R/W	094C	42381
P09.77	**Communication Card IP Address 2 (for GS20A-CM-ENETIP)**	♦R/W	094D	42382
P09.78	**Communication Card IP Address 3 (for GS20A-CM-ENETIP)**	♦R/W	094E	42383
P09.79	**Communication Card IP Address 4 (for GS20A-CM-ENETIP)**	♦R/W	094F	42384
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–255	0		

Use P09.76–P09.79 with a communication card.

		Type	Hex Addr	Dec Addr
P09.80	**Communication Card Address Mask 1 (for GS20A-CM-ENETIP)**	♦R/W	0950	42385
P09.81	**Communication Card Address Mask 2 (for GS20A-CM-ENETIP)**	♦R/W	0951	42386
P09.82	**Communication Card Address Mask 3 (for GS20A-CM-ENETIP)**	♦R/W	0952	42387
P09.83	**Communication Card Address Mask 4 (for GS20A-CM-ENETIP)**	♦R/W	0953	42388
P09.84	**Communication Card Gateway Address 1 (for GS20A-CM-ENETIP)**	♦R/W	0954	42389
P09.85	**Communication Card Gateway Address 2 (for GS20A-CM-ENETIP)**	♦R/W	0955	42390
P09.86	**Communication Card Gateway Address 3 (for GS20A-CM-ENETIP)**	♦R/W	0956	42391
P09.87	**Communication Card Gateway Address 4 (for GS20A-CM-ENETIP)**	♦R/W	0957	42392
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–255	0		

		Type	Hex Addr	Dec Addr
P09.88	**Communication Card Password (Low Word)(for GS20A-CM-ENETIP)**	♦R/W	0958	42393
P09.89	**Communication Card Password (High Word)(for GS20A-CM-ENETIP)**	♦R/W	0959	42394
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0–99	0		

		Type	Hex Addr	Dec Addr
P09.90	**Reset Communication Card (for GS20A-CM-ENETIP)**	♦R/W	095A	42395
	Range/Units (Format: 16-bit binary)	*Default*		
	0: Disable 1: Reset to defaults	0		

		Type	Hex Addr	Dec Addr
P09.91	**Additional Settings for the Communication Card (for GS20A-CM-ENETIP)**	♦R/W	095B	42396

Range/Units (Format: 16-bit binary) — *Default*: 0

bit 0: Enable IP filter
bit 1: Enable Internet parameters (1 bit)
When the IP address is set, this bit is enabled. After updating the parameters for the communication card, this bit changes to disabled.
bit 2: Enable login password (1 bit)
When you enter the login password, this bit is enabled. After updating the communication card parameters, this bit changes to disabled.

		Type	Hex Addr	Dec Addr
P09.92	**Communication Card Status (for GS20A-CM-ENETIP)**	R/W	095C	42397

Range/Units (Format: 16-bit binary) — *Default*: 0

bit 0: Enable password
When the communication card is set with a password, this bit is enabled. When the password is cleared, this bit is disabled.

		Type	Hex Addr	Dec Addr
P9.93	**ENETIP Communication Card Fault Select (for GS20A-CM-ENETIP)**	♦ R/W	095D	42398

Range/Units (Format: 16-bit binary) — *Default*: 3

0: Warn & Continue Operation
1: Warn & Ramp to Stop
2: Warn & Coast to Stop
3: No Warning & Continue Operation

This parameter is used to detect an Ethernet communication error and take appropriate action.

Related Parameters:

P09.74, P09.94, P09.95

		Type	Hex Addr	Dec Addr
P9.94	**ENETIP Communication Card Time Out Detection (for GS20A-CM-ENETIP)**	♦ R/W	095E	42399

Range/Units (Format: 16-bit binary) — *Default*: 0

0: Disable
1: Enable

This parameter Enables or Disables time-out detection for Ethernet communications.

Related Parameters:

P09.74, P09.93, P09.95

		Type	Hex Addr	Dec Addr
P9.95	***ENETIP Communication Card Time Out Duration (for GS20A-CM-ENETIP)***	♦ R/W	095F	42400
Range/Units (Format: 16-bit unsigned)		*Default*		
0.1 to 100.0 seconds		0.5		

When parameter P9.94 is set to 1, the communications Time Out Detection is Enabled. If a delay in communications for more than the Time Out Duration (P9.95) is detected, the action selected by the Transmission Fault Treatment (P9.93) will be used.

Related Parameters:

P09.74, P09.93, P09.94

Group P10.xx Details – Speed Feedback Control Parameters

In this parameter group the following abbreviations are used:

- *ASR - Adjust Speed Regulator*
- *AMR - Active Magnetic Regulator*
- *PG - Pulse Generator*

Parameters P10.00 - P10.21 are used for setting up a pulse generator signal into the GS20(X) drive.

The DI7 mulitfunction input will accept a pulse generator signal with a maximum frequency of 33kHz. This signal can be configured as an encoder feedback device from a motor (PG) or as a speed command signal to the drive (PG2) from another device.

DI7 (PG) uses pulse time to calculate the motor frequency. The Encoder PPR (pulse per revolution) and Motor RPM will affect the operating frequency range. Normal encoder PPR values are 512, 1024, 2048, etc. To calculate the operating frequency of an application, use this formula:

(Max Motor RPM x Encoder PPR) / 60 seconds = Pulses/Sec

Choose an encoder PPR value that will generate less than 33,000 pulses/sec for use with the DI7 input.

NOTE: For GS20, VF+PG is only single-phase input and will not know if it's REV or FWD.

The following table summarizes the parameter configuration for the PG and PG2 application. See the detailed parameter descriptions for more information.

Parameter	***Pulse Generator (PG)*** (Use for Motor Encoder Feedback)	***Pulse Generator 2 (PG2)*** (Use for Pulse Input Frequency Reference)	***Description***
	Parameter Setting		
P00.04	--	22	View Input Frequency value on keypad display (optional)
P00.11	1	--	Speed Control Mode (IMVFPG mode only)
P00.20	--	4	Auto Mode Only
P00.30	--	4	Manual Mode Only
P02.07	0	0	DI7 input config
P03.20	--	19	Analog Output to send PG2 signal to another device (optional)
P10.00	5	5	Selects Pulse Input for use
P10.01	PPR	PPR	Defines Pulses per revolution of device
P10.02	5	0	Encoder input type (PG only)
P10.04	1-65535	--	Electrical Gearing Load Side A1 (PG)
P10.05	1-65535	--	Electrical Gearing Motor Side B1 (PG)
P10.06	1-65535	--	Electrical Gearing Load Side A2 (PG)
P10.07	1-65535	--	Electrical Gearing Motor Side B2 (PG)
P10.10	0-120%	--	Encoder Stall Level (PG)
P10.11	0-2.0 sec	--	Encoder Stall Time (PG)
P10.12	0, 1, or 2	--	Encoder Stall Action (PG)
P10.13	0-50%	--	Encoder Slip Range (PG)
P10.14	0-10 sec	--	Encoder Slip Detection Time (PG)
P10.15	0, 1, or 2	--	Encoder Stall and Slip Error Action (PG)
P10.16	0	5	Set PG2 Pulse Input Type
P10.17	--	1-65535	PG2 Electrical Gear A
P10.18	--	1-65535	PG2 Electrical Gear B
P10.21	--	1-65535 sec	PG2 Low Pass Filter Time

		Type	Hex Addr	Dec Addr
P10.00	**Encoder Type Selection**	R/W	0A00	42561
Range/Units (Format: 16-bit binary)		Default		
0: Disabled 5: Pulse input (DI7)		0		

When you use DI7 single-phase pulse input (PG2), you must use it with P10.00=5 and P00.20=4, P02.07=0, and P10.16=5.

When you use DI7 single-phase pulse input as speed feedback (PG), you must use it with P02.07=0, P10.00=5, and P10.02=5. The drive calculates the DI7 single-phase pulse input speed when the control mode is IMVFPG.

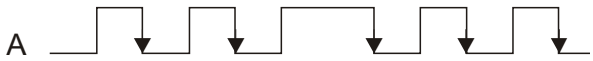
The GS20(X) does not support the full position control pulse command input function.

		Type	Hex Addr	Dec Addr
P10.01	**Encoder Pulses per Revolution**	R/W	0A01	42562
Range/Units (Format: 16-bit unsigned)		Default		
1–20000		600		

P10.01 sets the encoder pulses per revolution (PPR). It is a feedback control signal source when using PG (pulse generator) for DI7. The encoder sets the number of pulses for the motor rotating through one rotation. The A/B phase cycle generates the pulse number.

- *This setting is also the encoder resolution. The speed control is more accurate with higher resolution.*
- *If you set this parameter incorrectly, it may cause motor stall, drive over-current, or a magnetic pole origin detection error for the PM motor in closed-loop control. When using the PM motor, you must perform the magnetic pole origin detection (P05.00 = 13) again if you modify the content of this parameter.*

		Type	Hex Addr	Dec Addr
P10.02	**Encoder Input Type Setting (PG)**	R/W	0A02	42563
Range/Units (Format: 16-bit binary)		Default		
0: Disable 5: Single-phase input (DI7)		0		

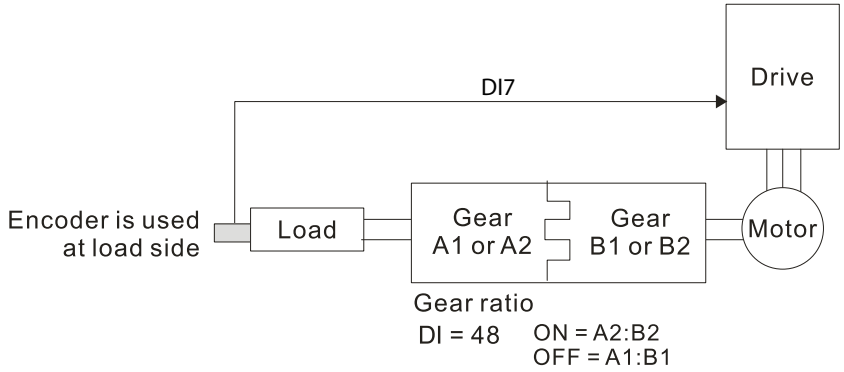


P10.02 sets the DI7 Pulse input as an encoder feedback device from the motor (PG).

To use this parameter, P10.00=5 and P10.16=0 are required.

		Type	Hex Addr	Dec Addr
P10.04	**Electrical Gear at Load Side A1**	♦R/W	0A04	42565
P10.05	**Electrical Gear at Motor Side B1**	♦R/W	0A05	42566
P10.06	**Electrical Gear at Load Side A2**	♦R/W	0A06	42567
P10.07	**Electrical Gear at Motor Side B2**	♦R/W	0A07	42568
Range/Units (Format: 16-bit unsigned)		Default		
1–65535		100		

Use P10.04–P10.07 with the multi-function input terminal setting 48 to switch to P10.04– P10.05 or P10.06–P10.07, as shown in the diagram below.



		Type	Hex Addr	Dec Addr
P10.10	**Encoder Stall Level**	♦R/W	0A0A	42571
Range/Units (Format: 16-bit unsigned)		*Default*		
0–120% (0: Disable)		115		

P10.10 determines the maximum encoder feedback signal allowed before a fault occurs; the maximum operation frequency P01.00 = 100%.

		Type	Hex Addr	Dec Addr
P10.11	**Detection Time of Encoder Stall**	♦R/W	0A0B	42572
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–2.0 sec.		0.1		

		Type	Hex Addr	Dec Addr
P10.12	**Encoder Stall Action**	♦R/W	0A0C	42573
Range/Units (Format: 16-bit binary)		*Default*		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop		2		

When the drive output frequency exceeds the encoder stall level (P10.10), the drive starts to count the time. When the error time exceeds the encoder stall detection time (P10.11), the drive implements the encoder stall action.

		Type	Hex Addr	Dec Addr
P10.13	**Encoder Slip Range**	♦R/W	0A0D	42574
Range/Units (Format: 16-bit unsigned)		*Default*		
0–50% (0: Disable)		50		

		Type	Hex Addr	Dec Addr
P10.14	**Detection Time of Encoder Slip**	♦R/W	0A0E	42575
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–10.0 sec.		0.5		

		Type	Hex Addr	Dec Addr
P10.15	**Encoder Stall and Slip Error Action**	♦R/W	0A0F	42576
Range/Units (Format: 16-bit binary)		*Default*		
0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop		2		

P10.15 acts on the settings for P10.13–P10.14:

When the value of (rotation speed – motor frequency) exceeds the P10.13 setting, and the detection time exceeds P10.14; the drive starts to count the time. If the detection time exceeds P10.14, the encoder feedback signal error occurs.

		Type	Hex Addr	Dec Addr
P10.16	**Pulse Input Type Setting (PG2)**	♦R/W	0A10	42577
Range/Units (Format: 16-bit binary)		*Default*		
0: Disabled 5: Single-phase input (DI7)		0		

P10.16 sets the DI7 Pulse input as a pulse generator input for frequency reference (PG2).

When P10.16=5, you cannot set P10.02 to 5: Single-phase input (DI7) for closed-loop control.

The setting steps when using the DI7 single-phase pulse input as the frequency command:

1) Set P00.20=4: Pulse input without direction command
2) Set P02.07=0
3) Set P10.00=5: Pulse input (DI7)
4) Set P10.01 to motor pulses per revolution (PPR)
5) Set P10.16=5: Single-phase input (DI7)
6) Set P00.04=22 (Pulse input frequency) to verify if the pulse input frequency is correct.

		Type	Hex Addr	Dec Addr
P10.17	**PG2 Electrical Gear A**	♦R/W	0A11	42578
P10.18	**PG2 Electrical Gear B**	♦R/W	0A12	42579
Range/Units (Format: 16-bit unsigned)		*Default*		
1–65535		100		

Rotation speed = pulse frequency / encoder pulses (P10.01) * electrical gear A / electrical gear B.

		Type	Hex Addr	Dec Addr
P10.21	**PG2 Pulse Input Speed Command Low Pass Filter Time**	♦R/W	0A15	42582
Range/Units (Format: 16-bit binary)		*Default*		
0.000–65.535 sec.		0.100		

When you set P00.20 to 4, the system treats the pulse command as a Frequency command. Use this parameter to suppress the speed command jump.

Parameters P10.24 - P10.53 are for configuring the speed and torque control loop characteristics. These parameters are only applicable to certain speed control modes (P00.11). See function block diagrams under P00.11 on page 4–59 for a visual representation of how the parameters interact.

		Type	Hex Addr	Dec Addr
P10.24	**FOC Function Control**	♦R/W	0A18	42585
Range/Units (Format: 16-bit unsigned)		*Default*		
0–65535		0		

FOC (Field Oriented Control) is the highest accuracy speed control mode of the drive, set by P00.11=5: IMFOC sensorless mode. This parameter configures the optional settings of FOC.

bit	Description
0	ASR controller under torque control. 0: use PI as ASR; 1: use P as ASR
1–10	N/A
11	Activates the DC brake when executing the zero torque command. 0: ON; 1: OFF
12	FOC sensorless mode with crossing zero means the speed goes from negative to positive or positive to negative (forward to reverse direction or reverse to forward direction). 0: determined by the stator frequency; 1: determined by the speed command
13	N/A
14	N/A
15	Direction control in open-loop torque 0: Switch ON direction control; 1: Switch OFF direction control

Only bit = 0 is used for closed-loop; other bits are used for open-loop.

Set the bits as needed in binary format. Then convert to decimal for parameter entry on drive keypad, or Hex for parameter entry on optional GS4-KPD.

This parameter is only active when P00.11=5: IMFOC sensorless mode. See function block diagrams under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P10.25	**FOC Bandwidth for Speed Observer**	♦R/W	0A19	42586
Range/Units (Format: 16-bit unsigned)		*Default*		
20.0–100.0 Hz		40.0		

Setting the speed observer to a higher bandwidth could shorten the speed response time but creates greater noise interference during the speed observation.

This parameter is only active when P00.11=5: IMFOC Sensorless mode. See Function diagram under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P10.26	**FOC Minimum Stator Frequency**	♦R/W	0A1A	42587
Range/Units (Format: 16-bit unsigned)		*Default*		
0.0–10.0% fN		2.0		

P10.26 sets the stator frequency lower limit in operation status. This setting ensures the stability and accuracy of observer and avoids interferences from voltage, current and motor parameters. fN is the motor rated frequency.

This parameter is only active when P00.11=5: IMFOC Sensorless mode. See Function diagram under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P10.27	**FOC Low Pass Filter Time Constant**	♦R/W	0A1B	42588
Range/Units (Format: 16-bit unsigned)		Default		
1–1000 ms		50		

P10.27 sets the low pass filter time constant of a flux observer at start-up. If you cannot activate the motor during high speed operation, lower the setting for this parameter.

		Type	Hex Addr	Dec Addr
P10.28	**FOC Gain for Excitation Current Rise Time**	♦R/W	0A1C	42589
Range/Units (Format: 16-bit unsigned)		Default		
33–100% Tr		100		

P10.28 sets the drive's excitation current rise time when it activates in open-loop torque mode. When the drive's activation time is too long in torque mode, adjust this parameter to a shorter time value. Tr is the rotor time constant.

		Type	Hex Addr	Dec Addr
P10.29	**Upper Limit of Frequency Deviation**	♦R/W	0A1D	42590
Range/Units (Format: 16-bit unsigned)		Default		
0.00–200.00 Hz		20.00		

P10.29 limits the maximum frequency deviation.

This parameter is only applicable when P00.11=IMVFPG, using input DI7 as the PG (encoder).

If you set this parameter too high, an abnormal feedback malfunction occurs.

If the application needs a higher setting for P10.29, note that a higher setting results in larger motor slip, which causes a PG Error (PGF3, PGF4). In this case, you can set P10.10 and P10.13 to 0 to disable PGF3 and PGF4 detection, but you must make sure the DI7 wiring and application are correct; otherwise, it may lose the instant PG protection. Setting P10.29 too high is not commonly done.

		Type	Hex Addr	Dec Addr
P10.31	**I/F Mode, Current Command**	♦R/W	0A1F	42592
Range/Units (Format: 16-bit unsigned)		Default		
0–150% rated current of the motor		40		

P10.31 is only applicable to PM motors with P00.11= 2: PMSVC. See Function diagram under P00.11 on page 4–59.

P10.31 sets the current command for the drive in the low speed area (low speed area: Frequency command < P10.39). When the motor stalls on heavy duty start-up or forward/reverse with load, increase the parameter value. If the inrush current is too high and causes oc stall, then decrease the parameter value.

		Type	Hex Addr	Dec Addr
P10.32	**PM Sensorless Speed Estimator Bandwidth**	♦R/W	0A20	42593
Range/Units (Format: 16-bit unsigned)		Default		
0.00–600.00 Hz		5.00		

P10.32 is only applicable to PM motors with P00.11= 2: PMSVC. See Function diagram under P00.11 on page 4–59.

P10.32 sets the speed estimator bandwidth. Adjust the parameter to influence the stability and the accuracy of the motor speed.

If there is low frequency vibration (the waveform is similar to a sine wave) during the process, then increase the bandwidth. If there is high frequency vibration (the waveform shows extreme vibration and is like a spur), then decrease the bandwidth.

		Type	Hex Addr	Dec Addr
P10.34	**PM Sensorless Speed Estimator Low-pass Filter Gain**	♦R/W	0A22	42595
Range/Units (Format: 16-bit unsigned)		Default		
0.00–655.35		1.00		

P10.34 is only applicable to PM motors with P00.11= 2: PMSVC. See Function diagram under P00.11 on page 4–59.

P10.34 influences the response speed of the speed estimator.

If there is low frequency vibration (the waveform is similar to a sine wave) during the process, then increase the gain. If there is high frequency vibration (the waveform shows extreme vibration and is like a spur), then decrease the gain.

		Type	Hex Addr	Dec Addr
P10.35	**AMR (Kp) Gain**	♦R/W	0A23	42596
Range/Units (Format: 16-bit unsigned)		Default		
0.00–3.00		1.00		

		Type	Hex Addr	Dec Addr
P10.36	**AMR (Ki) Gain**	♦R/W	0A24	42597
Range/Units (Format: 16-bit unsigned)		Default		
0.00–3.00		0.20		

The AMR parameters P10.35 and P10.36 are only active when P00.11= 5: IMFOC Sensorless mode. See Function diagram under P00.11 on page 4–59.

Active Magnetic Regulator (AMR) Kp/Ki, affects the response of magnetic regulation in the low magnetic area.

If entering the low magnetic area and the input voltage (or DC BUS) plummets (e.g. an unstable power net causes instant insufficient voltage, or a sudden load that makes DC BUS drop), which causes the ACR diverge and oc, then increase the gain. If the Id value of a spur creates large noise in high-frequency output current, decrease the gain to reduce noise. Decreasing the gain will slow down the response.

		Type	Hex Addr	Dec Addr
P10.39	**Frequency Point to Switch from I/F Mode to PM Sensorless Mode**	♦R/W	0A27	42600
Range/Units (Format: 16-bit unsigned)		Default		
0.00–599.00 Hz		20.00		

P10.39 sets the frequency for the switch point from low frequency to high frequency. This parameter is only applicable to PM motors with P00.11=2: PMSVC.

Due to the weak back-EMF in the low frequency area, PM sensorless mode cannot estimate the accurate speed and position of the rotor. Thus, using I/F mode control is more suitable. In the medium-to-high frequency area, PM sensorless can accurately estimate the back-EMF, stabilizes and controls the motor with lower current.

If the switch point is too low and PM sensorless mode operates at a too low frequency, the motor does not generate enough back-EMF to let the speed estimator measure the right position and speed of the rotor, and causes stall and oc when running at the switch point frequency.

If the switch point is too high, the drive easily runs in the frequency area of the I/F mode for a long time, which generates a larger current and will not save energy. (If the current for P10.31 is too high, the high switch point makes the drive continue to output with the setting value for P10.31.)

		Type	Hex Addr	Dec Addr
P10.42	**Initial Angle Detection Pulse Value**	♦R/W	0A2A	42603
Range/Units (Format: 16-bit unsigned)		Default		
0.0–3.0		1.0		

P10.42 is only applicable to SPM motors with P00.11=2:PMSVC. See Function diagram under P00.11 on page 4–59.

P10.42 is only active when P10.53=3:Pulse Injection.

The angle detection is fixed to 3: Use the pulse injection method to start. The parameter influences the value of the pulse during the angle detection. The larger the pulse, the higher the accuracy of rotor's position. A larger pulse might cause oc.

Increase the parameter when the running direction and the command are opposite during start-up. If oc occurs at start-up, then decrease the parameter.

Refer to Adjustment & Application for detailed motor adjustment procedure.

		Type	Hex Addr	Dec Addr
P10.49	**Zero Voltage Time during Start-up**	♦R/W	0A31	42610
Range/Units (Format: 16-bit unsigned)		Default		
0.000–60.000 sec.		0.000		

P10.49 is valid only when the setting of P07.12 (Speed Tracking during Start-up) = 0.

When the motor is in static state at start-up, this increases the accuracy when estimating angles. In order to put the motor in static state, set the drive three-phase output to the motor to 0V. The P10.49 setting time is the length of time for three-phase output at 0 V.

It is possible that even when you apply this parameter, the motor cannot go in to the static state because of inertia or some external force. If the motor does not go into a complete static state in 0.2 seconds, increase this setting value appropriately.

If P10.49 is set too high, the start-up time is longer. If it is too low, then the braking performance is weak.

		Type	Hex Addr	Dec Addr
P10.51	**Injection Frequency**	♦R/W	0A33	42612
Range/Units (Format: 16-bit unsigned)		Default		
0–1200 Hz		500		

P10.51 is a high frequency injection command in PM SVC control mode, and usually you do not need to adjust it. But if a motor's rated frequency (for example, 400Hz) is too close to the frequency setting for this parameter (that is, the default of 500Hz), it affects the accuracy of the angle detection. Refer to the setting for P01.01 before you adjust this parameter.

- *If the setting value for P00.17 is lower than P10.51*10, then increase the frequency of the carrier frequency.*
- *P10.51 is valid only when P10.53 = 2.*

		Type	Hex Addr	Dec Addr
P10.52	**Injection Magnitude**	♦R/W	0A34	42613
Range/Units (Format: 16-bit unsigned)		Default		
120V / 230V series: 100.0 V 460V series: 200.0 V 575V series: 200.0 V Note: The setting range varies depending on the voltage.		15.0 / 30.0 / 37.5		

P10.52 is the magnitude command for the high frequency injection signal in PM SVC control mode.

Increasing the parameter can increase the accuracy of the angle estimation, but the electromagnetic noise might be louder if the setting value is too high.

- *The system uses this parameter when the motor's parameter is "Auto". This parameter influences the angle estimation accuracy.*
- *When the ratio of the salient pole (Lq / Ld) is lower, increase P10.52 to make the angle detection accurate.*
- *P10.52 is valid only when P10.53 = 2.*

		Type	Hex Addr	Dec Addr
P10.53	***Angle Detection Method***	♦R/W	0A35	42614
Range/Units (Format: 16-bit binary)		*Default*		
0: Disabled 1: Force attracting the rotor to zero degrees 2: High frequency injection 3: Pulse injection		0		

Set P10.53 = 2 for IPM; set to 3 for SPM. If these settings cause problems, then set the parameter to 1.

Group P11.xx Details – Advanced Parameters

In this parameter group the following abbreviations are used:

- *ASR - Adjustable Speed Regulation. ASR parameters are for tuning the zero, low and high speed ranges of the drive when in IMFOC sensorless vector speed control mode (P00.11=5) or IMVFPG (P00.11=1) speed control mode.*

Parameters P11.00 – P11.16 are used to configure the Adjust Speed Regulator.

Parameters P11.17 – P11.38 are used to configure Torque control parameters.

		Type	Hex Addr	Dec Addr
P11.00	**Adjust Speed Regulator (ASR) System Control**	R/W	0B00	42817
Range/Units (Format: 16-bit binary)		Default		
bit 0: Auto-tuning for ASR bit 3: Dead time compensation closed bit 7: Save or do not save the frequency		0		

When P11.00 Bit 0=0, parameters P11.06 – P11.11 are enabled (applicable to P00.11 = 1: IMVFPG or 5: IMFOC sensorless modes).

When P11.00 Bit 0=1, Auto-tuning mode enables parameters 11.03 – 11.05. P11.12 – ASR Speed feed forward and P11.13- PDFF Gain are also enabled (applicable to P00.11 = 5: IMFOC sensorless only).

When P11.00 bit 7 = 0: Save the frequency before power is OFF. When power is ON again, the saved frequency is displayed.

When P11.00 bit 7 = 1: The frequency is not saved when power is cycled OFF. When power is cycled ON again, 0.00 Hz is the displayed frequency.

See Function diagram under P00.11 on page 4–59.

		Type	Hex Addr	Dec Addr
P11.01	**ASR Per-Unit of System Inertia**	R/W	0B01	42818
Range/Units (Format: 16-bit unsigned)		Default		
1–65535 (256 = 1 PU)		256		

To get the system inertia per unit from P11.01, you need to set P11.00 to bit1 = 1 and execute continuous forward / reverse running. See Adjustments and Applications section.

When P11.01 = 256, it is 1PU. So if you use a 2HP motor, the 2HP motor inertia is 0.00043 kg-cm2 according to the table below. If P11.01 = 10000 after tuning, the system inertia is (10000 / 256) x 0.00043 kg-cm^2.

Perform the operation test with load based on the inertia after tuning. Run the motor in acceleration, deceleration, and steady speed and observe the values. If values between speed feedback and speed command are close, steady-state error is small and overshoot is less, then this inertia is a better one.

If the Iq current command from ASR has a high-frequency glitch, then decrease the setting. If the response time of sudden loading is too slow, then increase the setting.

When using torque mode as the control mode, perform the tuning with speed mode first to see if the tuned inertia can work normally. After verifying with speed mode, change the control mode to torque mode.

The following table shows the base value for the induction motor system inertia (Unit: kg-m^2)

Power	Setting
1 HP	0.00023
2 HP	0.00043
3 HP	0.00083
5 HP	0.00148
7.5 HP	0.0026

Power	Setting
10 HP	0.00358
15 HP	0.00743
20 HP	0.00953
25 HP	0.01428
30 HP	0.01765

		Type	Hex Addr	Dec Addr
P11.02	**ASR1 / ASR2 Switch Frequency**	♦R/W	0B02	42819
Range/Units (Format: 16-bit unsigned)		*Default*		
5.00–599.00 Hz		7.00		

P11.02 sets the low-speed and high-speed ASR switching point in the FOC area. Provides flexibility to meet two needs: in the high-speed region of the estimator switch point it has a high response, and in the low-speed region of the estimator switch point it has a lower response. The recommended switching point is higher than P10.39.

A low setting does not cover P10.39. If the setting is too high, high-speed range is too narrow.

		Type	Hex Addr	Dec Addr
P11.03	**ASR1 Low-speed Bandwidth**	♦R/W	0B03	42820
P11.04	**ASR2 High-speed Bandwidth**	♦R/W	0B04	42821
P11.05	**Zero-speed Bandwidth**	♦R/W	0B05	42822
Range/Units (Format: 16-bit unsigned)		*Default*		
1–40 Hz		10		

After estimating the inertia and setting P11.00 bit 0 = 1 (auto-tuning), you can adjust P11.03, P11.04 and P11.05 separately by speed response. The larger the setting value, the faster the response. P11.02 is the switch frequency between the low-speed/high-speed bandwidth.

		Type	Hex Addr	Dec Addr
P11.06	**ASR 1 Gain**	♦R/W	0B06	42823
P11.08	**ASR2 Gain**	♦R/W	0B08	42825
P11.10	**ASR Gain of Zero Speed**	♦R/W	0B0A	42827
Range/Units (Format: 16-bit unsigned)		*Default*		
0–40 Hz		10		

Enabled when P11.00 Bit 0 = 0.

		Type	Hex Addr	Dec Addr
P11.07	**ASR 1 Integral Time**	♦R/W	0B07	42824
P11.09	**ASR2 Integral Time**	♦R/W	0B09	42826
P11.11	**ASR Integral Time of Zero Speed**	♦R/W	0B0B	42828
Range/Units (Format: 16-bit unsigned)		*Default*		
0.000–10.000 sec.		0.100		

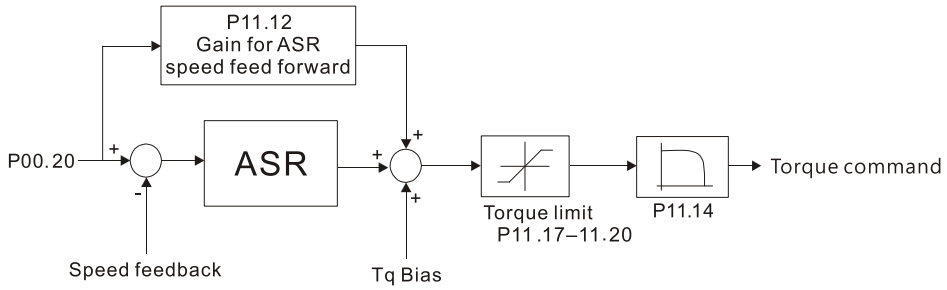
Enabled when P11.00 Bit 0 = 0.

		Type	Hex Addr	Dec Addr
P11.12	**Gain for ASR Speed Feed Forward**	♦R/W	0B0C	42829
Range/Units (Format: 16-bit unsigned)		Default		
0–200%		0		

This function enables when P11.00 bit 0 = 1.

Increase the setting for P11.12 to reduce the command tracking difference and improve the speed response. Use this function for speed tracking applications.

Set P11.01 correctly to improve the speed response.



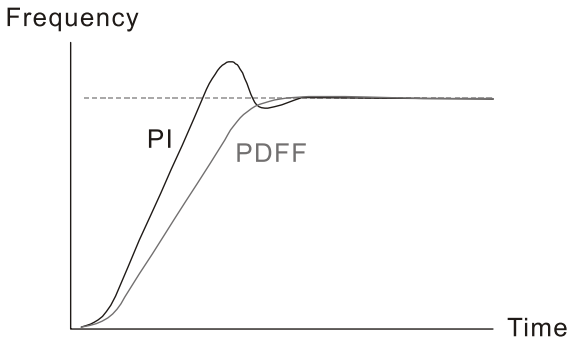
		Type	Hex Addr	Dec Addr
P11.13	**PDFF Gain Value**	♦R/W	0B0D	42830
Range/Units (Format: 16-bit unsigned)		Default		
0–200%		30		

P11.13 is invalid when P05.24 = 1. This parameter is valid only when P11.00 bit0 = 1.

After you estimate and set P11.00 bit0=1 (auto-tuning), use P11.13 to reduce overshoot. However, a shift of the curve may occur earlier. In this case, you can set P11.13=0 first, and then increase the setting value to "a condition with best acceleration and without overshoot" when the acceleration time meets your application but overshoot occurs.

- *Increasing P11.13 improves the overshoot of speed tracking, but an excessive value may reduce the transient response.*
- *Increasing P11.13 enhances the system stiffness in high-speed steady state and reduces the speed transient fluctuation at a sudden loading.*

Set P11.01 system inertia correctly to improve speed response.



		Type	Hex Addr	Dec Addr
P11.14	**ASR Output Low Pass Filter Time**	♦R/W	0B0E	42831
Range/Units (Format: 16-bit unsigned)		Default		
0.000–0.350 sec.		0.008		

P11.14 sets the ASR command filter time.

		Type	Hex Addr	Dec Addr
P11.15	**Notch Filter Depth**	♦R/W	0B0F	42832
Range/Units (Format: 16-bit unsigned)		Default		
0–20 db		0		

		Type	Hex Addr	Dec Addr
P11.16	**Notch Filter Frequency**	♦R/W	0B10	42833
Range/Units (Format: 16-bit unsigned)		Default		
0.00–200.00 Hz		0.00		

P11.16 sets the resonance frequency of the mechanical system. Adjust it to a smaller value to suppress the mechanical system resonance.

- *A larger value improves resonance suppression function.*
- *The notch filter frequency is the mechanical frequency resonance.*

		Type	Hex Addr	Dec Addr
P11.17	**Forward Motor Torque Limit**	♦R/W	0B11	42834
P11.18	**Forward Regenerative Torque Limit**	♦R/W	0B12	42835
P11.19	**Reverse Motor Torque Limit**	♦R/W	0B13	42836
P11.20	**Reverse Regenerative Torque Limit**	♦R/W	0B14	42837
Range/Units (Format: 16-bit unsigned)		Default		
0–500%		500		

FOC Sensorless mode:

The motor rated current = 100%. The settings for P11.17–P11.20 compare with the P03.00=7, 8, 9, 10. The minimum value of the comparison result is the torque limit. The diagram below illustrates the torque limit.

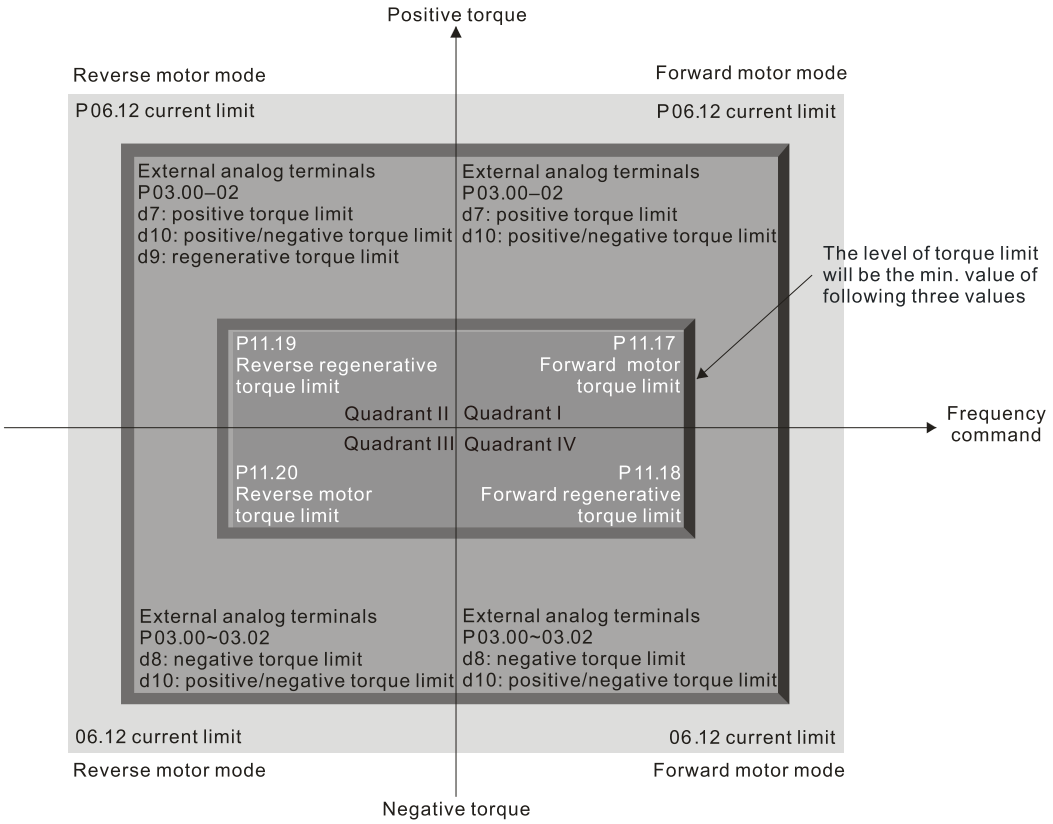
TQC sensorless mode:

The function of P11.17–P11.20 is the same as FOC; however, in this case, the torque limit and the torque command executes the output torque limit at the same time. Therefore, the minimum value between P11.17–P11.20 and P06.12 becomes the current output torque limit.

Calculation equation for the motor rated torque:

Motor rated torque: $T(N.M) = \frac{P(W)}{\omega(rad/s)}$

P (W) value = P05.02, ω (rad / s) value = P05.03; $\frac{P5.03 \times 2\pi}{60} = rad/s$



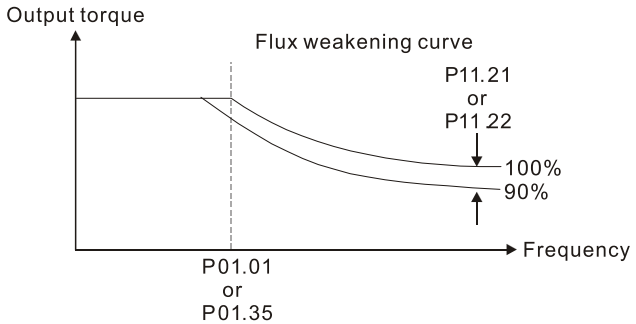
Note: P11.21-P11.38 are for configuring Torque control mode (IM TQC Sensorless, P00.10=2). See Function block diagram under P00.11 on page 4-59 and Adjustments and Applications section.

		Type	Hex Addr	Dec Addr
P11.21	**Flux Weakening Curve for Motor 1 Gain Value**	♦R/W	0B15	42838
P11.22	**Flux Weakening Curve for Motor 2 Gain Value**	♦R/W	0B16	42839
Range/Units (Format: 16-bit unsigned)		Default		
0–200%		90		

P11.21 and P11.22 adjust the output voltage for the flux weakening curve.

For the spindle application, use this adjustment method:

1) Run the motor to the highest frequency.
2) Observe the output voltage.
3) Adjust P11.21 (motor 1) or P11.22 (motor 2) setting to make the output voltage reach the motor rated voltage.
4) The larger the setting value, the greater the output voltage.



P11.23	Flux Weakening Area Speed Response	Type	Hex Addr	Dec Addr
		♦R/W	0B17	42840
Range/Units (Format: 16-bit unsigned)		Default		
0–150%		65		

P11.23 controls the speed in the flux weakening area. The larger the value, the faster the acceleration/deceleration. In normal condition, you do not need to adjust this parameter.

P11.27	Maximum Torque Command	Type	Hex Addr	Dec Addr
		♦R/W	0B1B	42844
Range/Units (Format: 16-bit unsigned)		Default		
0–500%		100		

P11.27 determines the upper limit of the torque command (motor rated torque is 100%).

Calculation equation for the motor rated torque:

Motor rated torque: $T(N.M) = \frac{P(W)}{\omega(rad/s)}$

Where:

P (W) value = P05.02

ω (rad / s) value = $\frac{P5.03 \times 2\pi}{60} = rad/s$

P11.28	Torque Offset Source	Type	Hex Addr	Dec Addr
		♦R/W	0B1C	42845
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Analog signal input 2: RS-485 communication (Pr.11-29) 3: Controlled through external terminals (by Pr.11-30–Pr.11-32)		0		

P11.28 specifies the torque offset source.

When set to 3, the torque offset sources are P11.30, P11.31 or P11.32 according to the multi-function input terminal settings 31, 32 or 33.

Normally open (N.O.) contact: ON = contact closed, OFF = contact open

P11.32	P11.31	P11.30	Torque Offset
MI = 33 (Low)	MI = 32 (Mid)	MI = 31 (High)	
OFF	OFF	OFF	None
OFF	OFF	ON	P11.30
OFF	ON	OFF	P11.31
OFF	ON	ON	P11.30 + P11.31
ON	OFF	OFF	P11.32
ON	OFF	ON	P11.30 + P11.32
ON	ON	OFF	P11.31 + P11.32
ON	ON	ON	P11.30 + P11.31 + P11.32

		Type	Hex Addr	Dec Addr
P11.29	**Torque Offset Setting**	♦R/W	0B1D	42846
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0 %		0.0		

P11.29 determines the torque offset command. The motor rated torque is 100%.

The calculation equation for the motor rated torque:

Motor rated torque: $T(N.M) = \frac{P(W)}{\omega(rad/s)}$

P (W) value = P05.02, ω (rad / s) value = P05.03; $\frac{P5.03 \times 2\pi}{60} = rad/s$

		Type	Hex Addr	Dec Addr
P11.30	**High Torque Offset**	♦R/W	0B1E	42847
P11.31	**Middle Torque Offset**	♦R/W	0B1F	42848
P11.32	**Low Torque Offset**	♦R/W	0B20	42849
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0 %		High: 30.0 Middle: 20.0 Low: 10.0		

When P11.28 is set to 3, the torque offset sources are P11.30, P11.31 or P11.32 according to the multi-function input terminals settings 31, 32 or 33. The motor rated torque is 100%.

The calculation equation for the motor rated torque:

Motor rated torque: $T(N.M) = \frac{P(W)}{\omega(rad/s)}$

P (W) value = P05.02, ω (rad / s) value = P05.03; $\frac{P5.03 \times 2\pi}{60} = rad/s$

		Type	Hex Addr	Dec Addr
P11.33	**Torque Command Source**	♦R/W	0B21	42850
Range/Units (Format: 16-bit unsigned)		Default		
0: Digital keypad 1: RS-485 communication (P11.34) 2: Analog signal input (P03.00) 5: Communication Card		0		

When P11.33 is set to 0 or 1, you can set the torque command in P11.34.

When P11.33 is set to 2 or 5, P11.34 only displays the torque command.

		Type	Hex Addr	Dec Addr
P11.34	**Torque Command**	♦R/W	0B22	42851
Range/Units (Format: 16-bit signed)		Default		
-100.0–100.0%		0.0		

This parameter sets the torque command. When P11.27 is 250% and P11.34 is 100%, the actual torque command = 250 × 100% = 250% of the motor rated torque.

The drive saves the settings before power is OFF.

		Type	Hex Addr	Dec Addr
P11.35	**Torque Command Filter Time**	♦R/W	0B23	42852
Range/Units (Format: 16-bit unsigned)		Default		
0.000–1.000 sec.		0.000		

When the P11.35 setting is too long, the control is stable but the control response is delayed. When the setting is too short, the response is quick but the control may be unstable. Adjust the setting according to your control and response situation.

		Type	Hex Addr	Dec Addr
P11.36	**Speed Limit Selection**	R/W	0B24	42853
Range/Units (Format: 16-bit binary)		Default		
0: Set by P11.37 (Forward Speed Limit) and P11.38 (Reverse Speed Limit) 1: Set by P00.20 (Master Frequency Command (AUTO, REMOTE) Source) and P11.37, P11.38 2: Set by P00.20 (Master Frequency Command (AUTO, REMOTE) Source)		0		

Speed limit function: when you use torque control mode, if the torque command is greater than the load, the motor accelerates until the motor speed equals the speed limit. At this time, it switches to speed control mode to stop acceleration.

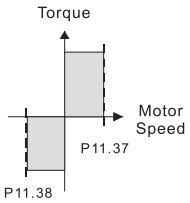
When P11.36 = 1:

- *When the torque command is positive, the forward speed limit is P00.20 and the reverse speed limit is P11.38. When the torque command is negative, the forward speed limit is P11.37 and the reverse speed limit is P00.20.*
- *Example:*
  In an unwinding application, if the torque command direction is different from the motor operating direction, the load drives the motor. In this case, the speed limit must be P11.37 or P11.38. Only in normal applications where the motor drives the load and the torque command is in the same direction as the speed limit can you set the speed limit according to P00.20.

In torque control mode, the F page of keypad displays the present speed limit value. For details on the keypad display, refer to the LED Function Description in Section 7-14 Digital Keypad (optional).

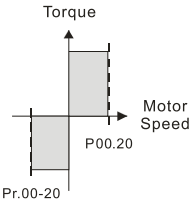
P11.36=0

Forward/reverse running speed are limited by P11.37 and P11.38



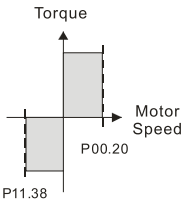
P11.36=2

Forward/reverse running speed are limited by P00.20



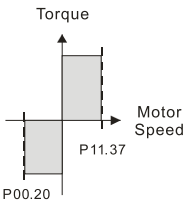
P11.36=1

When torque is positive, forward running speed is limited by P00.20; reverse running speed is limited by P11.38



P11.36=1

When torque is negative, forward running speed is limited by P11.37; reverse running speed is limited by P00.20



		Type	Hex Addr	Dec Addr
P11.37	**Forward Speed Limit (Torque Mode)**	♦R/W	0B25	42854
P11.38	**Reverse Speed Limit (Torque Mode)**	♦R/W	0B26	42855
Range/Units (Format: 16-bit unsigned)		*Default*		
0–120%		10		

P11.37 and P11.38 limit the speed for forward and reverse running in torque mode (P01.00 Maximum Operation Frequency = 100%).

		Type	Hex Addr	Dec Addr
P11.41	**PWM Mode Selection**	R/W	0B29	42858
Range/Units (Format: 16-bit binary)		*Default*		
0: Two-phase modulation mode 2: Space vector modulation mode		2		

Two-phase modulation mode: effectively reduces the drive power component losses and provides better performance in long wiring applications.

Space vector modulation mode: effectively reduces the power loss and electromagnetic noise of the motor.

		Type	Hex Addr	Dec Addr
P11.42	**System Control Flag**	R/W	0B2A	42859
Range/Units (Format: 16-bit unsigned)		*Default*		
0000–FFFFh		0000		

bit No.	Function	Description
0	Reserved	
1	FWD / REV action control	0: FWD / REV cannot be controlled by Pr.02-12 bit 0 & 1. 1: FWD / REV can be controlled by Pr.02-12 bit 0 & 1.

Group P13.xx Details – Macro / User Defined Parameters

		Type	Hex Addr	Dec Addr
P13.00	**Industry-specific Parameter Application**	R/W	0D0D	43329
	Range/Units (Format: 16-bit binary)	Default		
	00: Disabled	00		
	01: User-defined parameter			
	02: Compressor			
	03: Fan			
	04: Pump			
	05: Conveyor			
	06: Machine tool			
	07: Packing			
	08: Textiles			
	10: Logistics			
	11: Tension PID			
	12: Tension PID + master / auxiliary frequency			

NOTE: : After you select the macro, some of the default values adjust automatically according to the application selection. If P13.00 is set to a macro selection, the drive must be set back to defaults (P00.02 =10) to revert all parameters to the original parameter settings.

P13.00=02: Compressor

The following table lists the relevant compressor setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF control mode)
P00.16	Load selection	0 (Normal load)
P00.17	Carrier frequency	Default setting
P00.20	Master frequency command source (AUTO, REMOTE)	2 (External analog input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P00.22	Stop method	0 (Ramp to stop)
P0023	Motor direction control	1 (Disable reverse)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.11	Output frequency lower limit	20 (Hz)
P01.12	Acceleration time 1	20 (sec.)
P01.13	Deceleration time 1	20 (sec.)
P03.00	Analog input selection (AI1)	0 (No function)
P03.01	Analog input selection (AI2)	1 (Frequency command)
P05.01	Full-load current for induction motor 1 (A)	Default setting
P05.03	Rated speed for induction motor 1 (rpm)	Default setting

P05.04	Number of poles for induction motor 1	Default setting

P13.00=03: Fan

The following table lists the relevant fan setting application parameters.

Parameter	*Parameter Name*	*Settings*
P00.11	Speed control mode	0 (IMVF)
P00.16	Load selection	0 (Normal load)
P00.17	Carrier frequency	Default setting
P00.20	Master frequency command source (AUTO, REMOTE)	2 (External analog input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P00.22	Stop method	1 (Coast to stop)
P00.23	Motor direction control	1 (Disable reverse)
P00.30	Master frequency command source (HAND, LOCAL)	0 (Digital keypad)
P00.31	Operation command source (HAND, LOCAL)	0 (Digital keypad)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.10	Output frequency upper limit	50 (Hz)
P01.11	Output frequency lower limit	35 (Hz)
P01.12	Acceleration time 1	15 (sec.)
P01.13	Deceleration time 1	15 (sec.)
P01.43	V/F curve selection	2 (V/F curve to the power of 2)
P02.05	Multi-function input command 5 (DI5)	16 (Rotating speed command from AI2)
P02.16	Multi-function output 2 (DO1)	11 (Malfunction indication)
P02.17	Multi-function output 3 (DO2)	1 (Indication during RUN)
P03.00	Analog input selection (AI1)	1 (Frequency command)
P03.01	Analog input selection (AI2)	1 (Frequency command)
P03.28	AI1 terminal input selection	0 (0–10 V)
P03.29	AI2 terminal input selection	1 (0–10 V)
P03.31	AO1 output selection	0 (0–10 V)
P03.50	Analog input curve selection	1 (three-point curve of AI1)
P07.06	Restart after momentary power loss	2 (Speed tracking by the minimum output freqeuncy)
P07.11	Number of times of restart after fault	5 (times)
P07.33	Auto-restart interval of fault	60 (sec.)

P13.00=04: Pump

The following table lists the relevant pump setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF)
P00.16	Load selection	0 (Normal load)
P00.20	Master frequency command source (AUTO, REMOTE)	2 (External analog input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P00.23	Motor direction control	1 (Disable reverse)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.10	Output frequency upper limit	50 (Hz)
P01.11	Output frequency lower limit	35 (Hz)
P01.12	Acceleration time 1	15 (sec.)
P01.13	Deceleration time 1	15 (sec.)
P01.43	V/F curve selection	2 (V/F curve to the power of 2)
P07.06	Restart after momentary power loss	2 (Speed tracking by the minimum output frequency)
P07.11	Number of times of restart after fault	5 (times)
P07.33	Auto-restart interval of fault	60 (sec.)

P13.00=05: Conveyor

The following table lists the relevant conveyor setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF)
P00.16	Load selection	0 (Normal load)
P00.20	Master frequency command source (AUTO, REMOTE)	2 (External analog input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting

Parameter	Parameter Name	Settings
P01.12	Acceleration time 1	10 (sec.)
P01.13	Deceleration time 1	10 (sec.)

P13.00=06: Machine Tool

The following table lists the relevant machine tool setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF)
P00.17	Carrier frequency	Default setting
P00.20	Master frequency command source (AUTO, REMOTE)	2 (External analog input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	0
P01.04	Mid-point voltage 1 of motor 1	0
P01.05	Mid-point frequency 2 of motor 1	0
P01.06	Mid-point voltage 2 of motor 1	0
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.12	Acceleration time 1	5 (sec.)
P01.13	Deceleration time 1	5 (sec.)
P01.24	S-curve for acceleration begin time 1	0
P01.25	S-curve for acceleration arrival time 2	0
P01.26	S-curve for deceleration begin time 1	0
P01.27	S-curve for deceleration arrival time 2	0
P02.03	Multi-function input command 3 (DI3)	1 (Multi-step speed command 1)
P02.04	Multi-function input command 4 (DI4)	2 (Multi-step speed command 2)
P02.13	Multi-function output 1 (R1)	11 (Malfunction indication)
P02.16	Multi-function output 2 (DO1)	1 (Indication during RUN)
P02.17	Multi-function output 3 (DO2)	2 (Operation speed reached)
P03.00	Analog input selection (AI1)	1 (Frequency command)
P06.01	Over-voltage stall prevention	0 (Disabled)
P06.03	Over-current stall prevention during acceleration	0 (Disabled)
P06.04	Over-current stall prevention during operation	0 (Disabled)
P06.05	Acceleration / deceleration time selection for stall prevention at constant speed	0 (By current acceleration / deceleration time)
P07.01	DC brake current level	20 (%)
P07.03	DC brake time at STOP	0.3 (sec.)
P07.04	DC brake frequency at STOP	0 (Hz)
P07.23	Automatic voltage regulation (AVR) function	1 (Disable AVR)

P13.00=07: Packing

The following table lists the relevant compressor setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF)
P00.20	Master frequency command source (AUTO, REMOTE)	0 (Digital keypad)
P00.21	Operation command source (AUTO, REMOTE)	2 (RS-485 communication input)
P02.00	Two-wire / three-wire operation control	1 (two-wire mode 1, power on for operation control (M1: FWD / STOP, M2: REV / STOP))
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.12	Acceleration time 1	10 (sec.)
P01.13	Deceleration time 1	10 (sec.)
P01.24	S-curve for acceleration begin time 1	Default setting
P01.25	S-curve for acceleration arrival time 2	Default setting
P01.26	S-curve for deceleration begin time 1	Default setting
P01.27	S-curve for deceleration arrival time 2	Default setting
P03.00	Analog input selection (AI1)	1 (Frequency command)
P03.28	AI1 terminal input selection	Default setting

P13.00=08: Textiles

The following table lists the relevant textile setting application parameters.

Parameter	Parameter Name	Settings
P00.11	Speed control mode	0 (IMVF)
P00.20	Master frequency command source (AUTO, REMOTE)	1 (RS-485 communication input)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	Default setting
P01.03	Mid-point frequency 1 of motor 1	Default setting
P01.04	Mid-point voltage 1 of motor 1	Default setting
P01.05	Mid-point frequency 2 of motor 1	Default setting
P01.06	Mid-point voltage 2 of motor 1	Default setting
P01.07	Minimum output frequency of motor 1	Default setting
P01.08	Minimum output voltage of motor 1	Default setting
P01.12	Acceleration time 1	10 (sec.)
P01.13	Deceleration time 1	10 (sec.)
P01.24	S-curve for acceleration begin time 1	0.2 (sec.)
P01.25	S-curve for acceleration arrival time 2	0.2 (sec.)

Parameter	Parameter Name	Settings
P01.26	S-curve for deceleration begin time 1	0.2 (sec.)
P01.27	S-curve for deceleration arrival time 2	0.2 (sec.)
P06.03	Over-current stall prevention during acceleration	180 (%)
P06.04	Over-current stall prevention during operation	180 (%)
P06.07	Over-torque detection level (motor 1)	200 (%)
P07.19	Fan cooling control	2 (Fan is ON when the AC motor drive runs; fan is OFF when the AC motor drive stops)

P13.00=10: Logistics

The following table lists the relevant logistics setting application parameters.

Parameter	Parameter Name	Settings
P00.20	Master frequency command source (AUTO, REMOTE)	7 (Digital keypad VR/potentiometer dial)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.01	Output frequency of motor 1 (Base frequency / Motor's rated frequency)	Default setting
P01.02	Output voltage of motor 1 (Base voltage / Motor's rated voltage)	400.0
P01.04	Mid-point voltage 1 of motor 1	20.0
P01.06	Mid-point voltage 2 of motor 1	20.0
P01.08	Minimum output voltage of motor 1	20.0
P01.03	Mid-point frequency 1 of motor 1	1.50
P01.07	Minimum output frequency of motor 1	1.50
P01.12	Acceleration time 1	3 (sec.)
P01.13	Deceleration time 1	3 (sec.)
P01.24	S-curve for acceleration begin time 1	0.00
P01.25	S-curve for acceleration arrival time 2	0.00
P01.26	S-curve for deceleration begin time 1	0.00
P01.27	S-curve for deceleration arrival time 2	0.00
P06.03	Over-current stall prevention during acceleration	200
P06.04	Over-current stall prevention during operation	200
P06.05	Acceleration / deceleration time selection for stall prevention at constant speed	2: By the second acceleration / deceleration time
P07.23	Automatic voltage regulation (AVR) function	1: Disable AVR
P07.26	Torque compensation gain	0

P13.00=11: PID

The following table lists the relevant PID setting application parameters.

Parameter	Parameter Name	Settings
P00.20	Master frequency command source (AUTO, REMOTE)	9 (PID controller)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.12	Acceleration time 1	3 (sec.)
P01.13	Deceleration time 1	3 (sec.)
P03.00	Analog input selection (AI1)	5 (PID feedback signal)
P03.50	Analog input curve selection	1: Three-point curve of AI1
P03.63	AVI voltage lowest point	0.00
P03.65	AVI voltage mid-point	9.99
P03.66	AVI proportional mid-point	100%
P08.00	Terminal selection of PID feedback	1: Negative PID feedback: by analog input (P03.00, P03.01)
P08.01	Proportional gain (P)	10
P08.02	Integral time (I)	1
P08.20	PID mode selection	1: Parallel connection
P08.21	Enable PID to change the operation direction	0: Operation direction cannot be changed
P08.65	PID target value source	1: P08.66 setting
P08.66	PID target value setting	50%

P13.00=12: Tension PID + Master/Aux Frequency

The following table lists the relevant tension PID setting application parameters.

Parameter	Parameter Name	Settings
P00.20	Master frequency command source (AUTO, REMOTE)	9 (PID controller)
P00.21	Operation command source (AUTO, REMOTE)	1 (External terminals)
P01.00	Maximum operation frequency	Default setting
P01.12	Acceleration time 1	3 (sec.)
P01.13	Deceleration time 1	3 (sec.)
P00.35	Auxiliary frequency source	3: Analog input
P03.00	Analog input selection (AI1)	5 (PID feedback signal)
P03.01	Analog input selection (AI2)	12: Auxiliary frequency input
P03.10	Reverse setting when analog signal input is negative frequency	0: Negative frequency input is not allowed. The digital keypad or external terminal controls the forward and reverse direction.
P03.12	Analog input gain (AI2)	100.0%
P03.29	AI2 terminal input selection	1: 0–10 V
P03.50	Analog input curve selection	1: Three-point curve of AI1
P03.63	AI1 voltage lowest point	0.00
P03.65	AI1 voltage mid-point	9.99
P03.66	AI1 proportional mid-point	100%
P08.00	Terminal selection of PID feedback	1: Negative PID feedback: by analog input (P03.00, P03.01)
P08.01	Proportional gain (P)	10
P08.02	Integral time (I)	1
P08.20	PID mode selection	1: Parallel connection

Parameter	Parameter Name	Settings
P08.21	Enable PID to change the operation direction	0: Operation direction cannot be changed
P08.65	PID target value source	1: P08.66 setting
P08.66	PID target value setting	50%
P08.67	Master and auxiliary reverse running cutoff frequency	10%

P13.00=1, User-defined Parameters

Parameters 13.01 through 13.50 are blank for your use. You can record any user defined parameter settings here if you wish.

	Type	Hex Addr	Dec Addr
P13.01	♦R/W	0D01	43330
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.02	♦R/W	0D02	43331
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.03	♦R/W	0D03	43332
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.04	♦R/W	0D04	43333
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.05	♦R/W	0D05	43334
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.06	♦R/W	0D06	43335
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.07	♦R/W	0D07	43336
Range/Units (Format: 16-bit unsigned)	*Default*		

		Type	Hex Addr	Dec Addr
P13.08		♦R/W	0D08	43337
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.09		♦R/W	0D09	43338
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.10		♦R/W	0D0A	43339
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.11		♦R/W	0D0B	43340
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.12		♦R/W	0D0C	43341
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.13		♦R/W	0D0D	43342
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.14		♦R/W	0D0E	43343
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.15		♦R/W	0D0F	43344
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.16		♦R/W	0D10	43345
	Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.17	♦R/W	0D11	43346
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.18	♦R/W	0D12	43347
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.19	♦R/W	0D13	43348
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.20	♦R/W	0D14	43349
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.21	♦R/W	0D15	43350
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.22	♦R/W	0D16	43351
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.23	♦R/W	0D17	43352
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.24	♦R/W	0D18	43353
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.25	♦R/W	0D19	43354
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.26	♦R/W	0D1A	43355
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.27	♦R/W	0D1B	43356
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.28	♦R/W	0D1C	43357
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.29	♦R/W	0D1D	43358
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.30	♦R/W	0D1E	43359
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.31	♦R/W	0D1F	43360
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.32	♦R/W	0D20	43361
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.33	♦R/W	0D21	43362
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.34	♦R/W	0D22	43363
Range/Units (Format: 16-bit unsigned)	Default		

	Type	Hex Addr	Dec Addr
P13.35	♦R/W	0D23	43364
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.36	♦R/W	0D24	43365
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.37	♦R/W	0D25	43366
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.38	♦R/W	0D26	43367
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.39	♦R/W	0D27	43368
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.40	♦R/W	0D28	43369
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.41	♦R/W	0D29	43370
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.42	♦R/W	0D2A	43371
Range/Units (Format: 16-bit unsigned)	*Default*		

	Type	Hex Addr	Dec Addr
P13.43	♦R/W	0D2B	43372
Range/Units (Format: 16-bit unsigned)	*Default*		

		Type	Hex Addr	Dec Addr
P13.44		♦R/W	0D2C	43373
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.45		♦R/W	0D2D	43374
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.46		♦R/W	0D2E	43375
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.47		♦R/W	0D2F	43376
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.48		♦R/W	0D30	43377
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.49		♦R/W	0D31	43378
	Range/Units (Format: 16-bit unsigned)	Default		

		Type	Hex Addr	Dec Addr
P13.50		♦R/W	0D32	43379
	Range/Units (Format: 16-bit unsigned)	Default		

Group P14.xx Details – Protection Parameters (2)

		Type	Hex Addr	Dec Addr
P14.50	**Output Frequency at Malfunction 2**	Read	0E32	43635
P14.54	**Output Frequency at Malfunction 3**	Read	0E36	43639
P14.58	**Output Frequency at Malfunction 4**	Read	0E3A	43643
P14.62	**Output Frequency at Malfunction 5**	Read	0E3E	43647
P15.66	**Output Frequency at Malfunction 6**	Read	0E42	43651
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–599.00 Hz	0		

When an error occurs, you can check the output frequency for the malfunction. If the error happens again, this parameter overwrites the previous record.

		Type	Hex Addr	Dec Addr
P14.51	**DC bus Voltage at Malfunction 2**	Read	0E33	43636
P14.55	**DC bus Voltage at Malfunction 3**	Read	0E37	43640
P14.59	**DC bus Voltage at Malfunction 4**	Read	0E3B	43644
P14.63	**DC bus Voltage at Malfunction 5**	Read	0E3F	43648
P14.67	**DC bus Voltage at Malfunction 6**	Read	0E43	43652
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.0–6553.5 V	0		

When an error occurs, you can check the DC bus voltage for the malfunction. If the error happens again, this parameter overwrites the previous record.

		Type	Hex Addr	Dec Addr
P14.52	**Output Current at Malfunction 2**	Read	0E34	43637
P14.56	**Output Current at Malfunction 3**	Read	0E38	43641
P14.60	**Output Current at Malfunction 4**	Read	0E3C	43645
P14.64	**Output Current at Malfunction 5**	Read	0E40	43649
P14.68	**Output Current at Malfunction 6**	Read	0E44	43653
	Range/Units (Format: 16-bit unsigned)	*Default*		
	0.00–655.35 Amps	0		

When an error occurs, you can check the output current for the malfunction. If the error happens again, this parameter overwrites the previous record.

		Type	Hex Addr	Dec Addr
P14.53	**IGBT Temperature at Malfunction 2**	Read	0E35	43638
P14.57	**IGBT Temperature at Malfunction 3**	Read	0E39	43642
P14.61	**IGBT Temperature at Malfunction 4**	Read	0E3D	43646
P14.65	**IGBT Temperature at Malfunction 5**	Read	0E41	43650
P14.69	**IGBT Temperature at Malfunction 6**	Read	0E45	43654
	Range/Units (Format: 16-bit signed)	*Default*		
	-3276.7–3276.7 °C	0		

When an error occurs, you can check the IGBT temperature for the malfunction. If the error happens again, this parameter overwrites the previous record.

		Type	Hex Addr	Dec Addr
P14.70	***Fault Record 7***	Read	0E46	43655
P14.71	***Fault Record 8***	Read	0E47	43656
P14.72	***Fault Record 9***	Read	0E48	43657
P14.73	***Fault Record 10***	Read	0E49	43658

Range/Units (Format: 16-bit unsigned) — *Default*: 0

Settings
0: No fault record
1: Over-current during acceleration (ocA)
2: Over-current during deceleration (ocd)
3: Over-current during steady operation (ocn)
4: Ground fault (GFF)
6: Over-current at STOP (ocS)
7: Over-voltage during acceleration (ovA)
8: Over-voltage during deceleration (ovd)
9: Over-voltage during constant speed (ovn)
10: Over-voltage at stop (ovS)
11: Low-voltage during acceleration (LvA)
12: Low-voltage during deceleration (Lvd)
13: Low-voltage during constant speed (Lvn)
14: Low-voltage at stop (LvS)
15: Phase loss protection (orP)
16: IGBT overheating (oH1)
18: IGBT temperature detection failure (tH1o)
21: Over load (oL)
22: Electronics thermal relay 1 protection (EoL1)
23: Electronics thermal relay 2 protection (EoL2)
24: Motor PTC overheating (oH3)
26: Over-torque 1 (ot1)
27: Over-torque 2 (ot2)
28: Under current (uC)
31: EEPROM read error (cF2)
33: U-phase error (cd1)
34: V-phase error (cd2)
35: W-phase error (cd3)
36: cc (current clamp) hardware error (Hd0)
37: oc (over-current) hardware error (Hd1)
40: Auto-tuning error (AUE)
41: PID loss AI2 (AFE)
43: PG feedback loss (PGF2)
44: PG feedback stall (PGF3)
45: PG slip error (PGF4)
48: AI2 loss (ACE)
49: External fault (EF)
50: Emergency stop (EF1)
51: External Base Block (bb)
52: Password is locked (Pcod)
54: Illegal command (CE1)
55: Illegal data address (CE2)
56: Illegal data value (CE3)
57: Data is written to read-only address (CE4)
58: Modbus transmission time-out (CE10)
61: Y-connection / Δ-connection switch error (ydc)

62: Deceleration energy backup error (dEb)
63: Over slip error (oSL)
72: STO Loss (STL1)
76: STO (STo)
77: STO Loss 2 (STL2)
78: STO Loss 3 (STL3)
79: U-phase over-current before run (Aoc)
80: V-phase over-current before run (boc)
81: W-phase over-current before run (coc)
82: Output phase loss U phase (oPL1)
83: Output phase loss V phase (oPL2)
84: Output phase loss W phase (oPL3)
87: Low frequency overload protection (oL3)
89: Rotor position detection error (roPd)
97: Ethercat Card Timeout (CD10)
111: InrCOM time-out error (ictE)
121: Internal communication error (CP20)
123: Internal communication error (CP22)
124: Internal communication error (CP30)
126: Internal communication error (CP32)
127: Internal communication error (CP33)
128: Over-torque 3 (ot3)
129: Over-torque 4 (ot4)
134: Internal communication error (EoL3)
135: Internal communication error (EoL4)
140: Oc hardware error (Hd6)
141: GFF occurs before run (b4GFF)
142: Auto-tune error 1 (DC test stage) (AuE1)
143: Auto-tune error 2 (High frequency test stage) (AuE2)
144: Auto-tune error 3 (Rotary test stage) (AuE3)
149: Auto-tune error 5 (Rotor resistance measure test stage)

The parameters record when the fault occurs and forces a stop.

- *When low-voltage at stop fault (LvS) occurs, the fault is not recorded. When low-voltage during operation faults (LvA, Lvd, Lvn) occur, the faults are recorded.*
- *When the dEb function is valid and enabled, the drive executes dEb and records fault code 62 to P06.17–P06.22 and P14.70–P14.73 simultaneously.*

		Type	Hex Addr	Dec Addr
P14.74	***Over-torque Detection Selection (Motor 3)***	♦R/W	0E4A	43659
P14.77	***Over-torque Detection Selection (Motor 4)***	♦R/W	0E4D	43662
Range/Units (Format: 16-bit binary)		*Default*		
0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN		0		

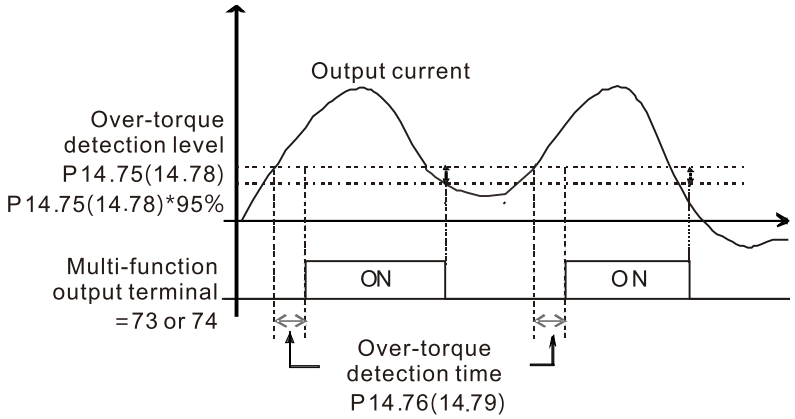
When you set P14.74 and P14.77 to 1 or 3, a warning message displays but there is no error record.
When you set P14.74 and P14.77 to 2 or 4, an error message displays and there is an error record.

		Type	Hex Addr	Dec Addr
P14.75	**Over-torque Detection Level (Motor 3)**	♦R/W	0E4B	43660
P14.78	**Over-torque Detection Level (Motor 4)**	♦R/W	0E4E	43663
Range/Units (Format: 16-bit unsigned)		*Default*		
10–250% (100% corresponds to the rated current of the drive)		120		

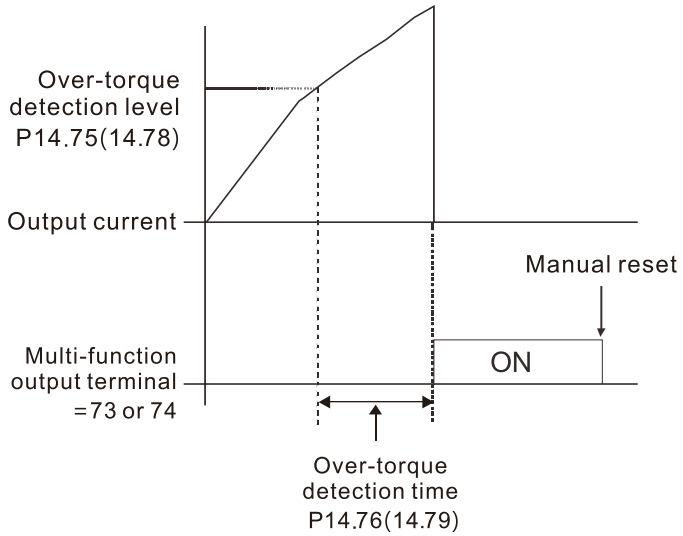
		Type	Hex Addr	Dec Addr
P14.76	**Over-torque Detection Time (Motor 3)**	♦R/W	0E4C	43661
P14.79	**Over-torque Detection Time (Motor 4)**	♦R/W	0E4F	43664
Range/Units (Format: 16-bit unsigned)		*Default*		
0.1–60.0 sec.		0.1		

When the output current exceeds the over-torque detection level (P14.75 or P14.78) and also exceeds the over-torque detection time (P14.76 or P14.79), the over-torque detection follows the setting of P14.74 or P14.77.

When you set P14.74 or P14.77 to 1 or 3, an ot3/ot4 warning displays while the drive keeps running after over-torque detection. The warning remains on until the output current is smaller than 5% of the over-torque detection level.



When you set P14.74 or P14.77 to 2 or 4, an ot3/ot4 warning displays and the drive stops running after over-torque detection. The drive does not run until you manually reset it.



		Type	Hex Addr	Dec Addr
P14.80	**Electronic Thermal Relay Selection 3 (Motor 3)**	♦R/W	0E50	43665
P14.82	**Electronic Thermal Relay Selection 4 (Motor 4)**	♦R/W	0E52	43667

Range/Units (Format: 16-bit binary)	Default
0: Inverter motor (with external forced cooling) 1: Standard motor (motor with the fan on the shaft) 2: Disable	2

These parameters prevent self-cooled motors from overheating under low speed. Use an electronic thermal relay to limit the drive's output power.

- *Setting the parameter to 0 is suitable for an inverter motor (motor fan using an independent power supply). For this kind of motor, there is no significant correlation between cooling capacity and motor speed. Therefore, the action of electronic thermal relays remains stable in low speed to ensure the load capability of the motor in low speed.*
- *Setting the parameter to 1 is suitable for standard motor (motor fan is fixed on the rotor shaft). For this kind of motor, the cooling capacity is lower in low speed; therefore, the action of an electronic thermal relay reduces the action time to ensure the life of motor.*

When the power is cycled frequently, if the power is switched OFF, the electronic thermal relay protection is reset; therefore, even setting the parameter to 0 or 1 may not protect the motor well. If there are several motors connected to one drive, install an electronic thermal relay in each motor.

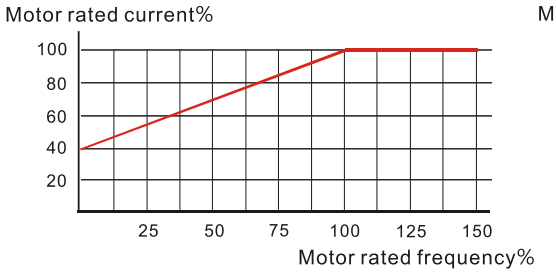
		Type	Hex Addr	Dec Addr
P14.81	**Electronic Thermal Relay Action Time 3 (Motor 3)**	♦R/W	0E51	43666
P14.83	**Electronic Thermal Relay Action Time 4 (Motor 4)**	♦R/W	0E53	43668

Range/Units (Format: 16-bit unsigned)	Default
30.0–600.0 sec.	60.0

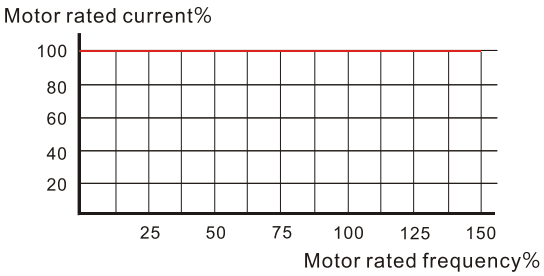
The electronic thermal relay amperage threshold is based on 150% of the parameter value in "Full Load Current for Induction Motor X" (P05.64 for motor 1, P05.70 for motor 2)

Set Parameter P14.81 or P14.83 for the amount of time the motor exceeds this threshold. Proper setup will prevent motor damage due to overheating. When it reaches the setting, the drive displays "EoL3 / EoL4", and the motor coasts to stop.

Use this parameter to set the action time of the electronic thermal relay. It works based on the I2t characteristic curve of electronic thermal relay, the output frequency and current of the drive, and the operation time to prevent the motor from overheating.



Motor cooling curve with shaft-fixed fan



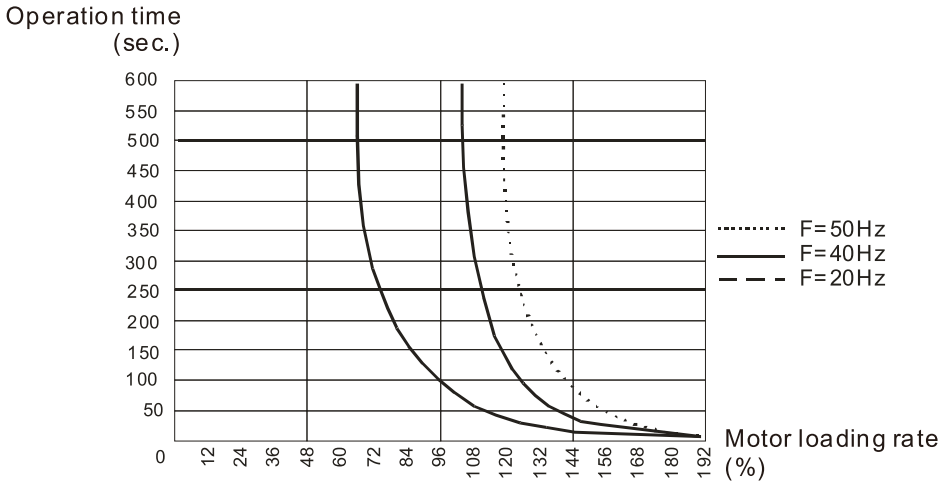
Motor cooling curve with independent fan

The action of the electronic thermal relay depends on the settings for P14.80 and P14.82:

1) P14.80 or P14.82 is set to 0 (using inverter motor):
When the output current of the drive is higher than 150% of the motor rated current (refer to the motor rated current % corresponded to the motor rated frequency in the motor cooling curve with independent fan), the drive starts to count the time. The electronic thermal relay acts when the accumulated time exceeds P14.81 or P14.83.

2) P14.80 or P14.82 is set to 1 (using standard motor):
When the output current of the drive is higher than 150% of the motor rated current (refer to the motor rated current % corresponded to the motor rated frequency in the motor cooling curve with shaft-fixed fan), the drive starts to count the time. The electronic thermal relay acts when the accumulated time exceeds P14.81 or P14.83.

The actual electronic thermal relay action time adjusts according to the drive output current (shown as the motor loading rate %). The action time is short when the current is high, and the action time is long when the current is low. Refer to the following diagram.



Adjustments and Applications

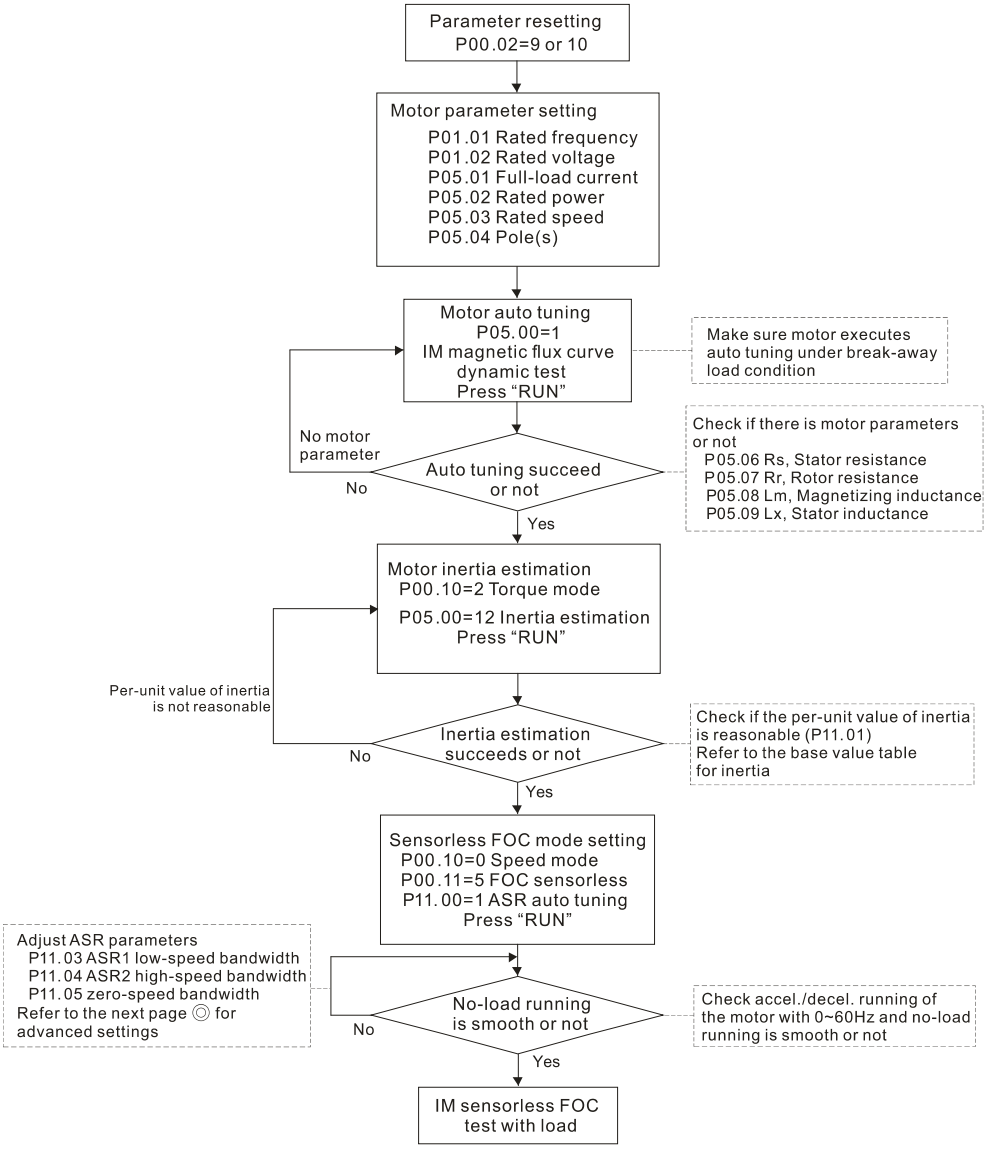
This section provides step-by-step information on how to optimize the advanced speed and torque control modes of the GS20(X) drive. These setup guides are not used for the basic speed control modes of V/F and IMVFPG (P00.11=0 or 1). These procedures are not required for advanced speed control, but will ensure your drive and motor perform at the highest level.

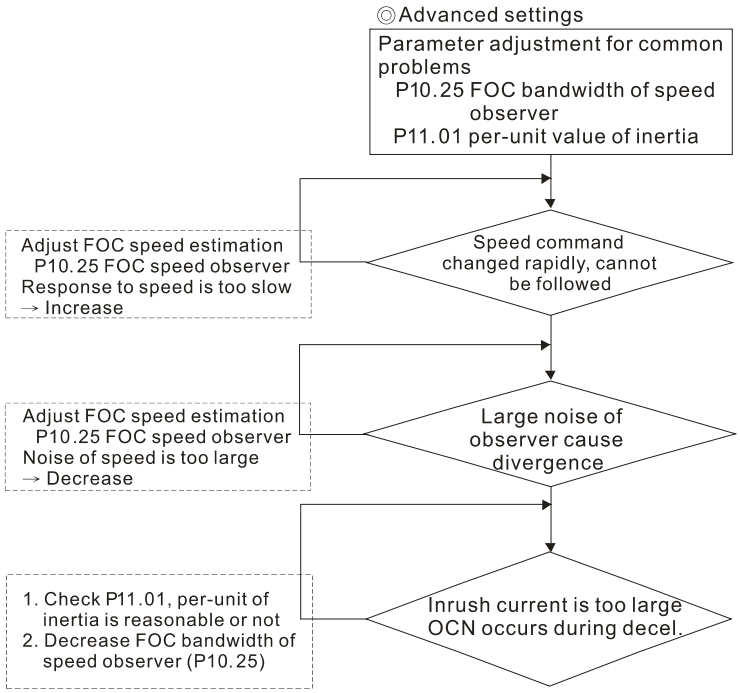
The following three procedures can be found in this section:

1) FOC sensorless vector mode with standard induction motor (IM) adjustment procedure.
2) TQC sensorless vector mode standard induction motor (IM) adjustment procedure.
3) PMSVC mode with permanent magnet motor (PM) adjustment procedure.

FOC sensorless vector mode with standard induction motor (IM) adjustment procedure

Flow Chart





FOC control diagram

Please see the function block diagrams under P00.11 on page 4–59.

Adjustment Procedure

1) Parameter reset to default, P00.02=10 or 9
   (To avoid other parameters that are not related affecting the motor control)
2) Set up the following motor parameters according to the nameplate on the motor:
   - *P01.01, Output Frequency of Motor 1*
   - *P01.02, Output Voltage of Motor 1*
   - *P05.01, Full-load Current for Indunction Motor 1*
   - *P05.02, Rated Power for Induction Motor 1*
   - *P05.03, Rated Speed for Induction Motor 1*
   - *P05.04, Number of Poles for Induction Motor 1*
3) Press RUN to start auto-tuning of IM magnetic flux curve dynamic test for P05.00=1 or 6 (motor is running). Make sure the motor executes auto-tuning under break-away load condition. Check if there are motor parameters after auto-tuning.
   - *P05.06, Stator Resistance (Rs) for Induction Motor 1*
   - *P05.07, Rotor Resistance (Rr) for Induction Motor 1*
   - *P05.08, Magnetizing Inductance (Lm) for Induction Motor 1*
   - *P05.09, Stator Inductance (Lx) for Induction Motor 1*
4) Execute estimation of the motor inertia (optional). Press “RUN” to start the estimation after finishing the settings for the parameters mentioned below.
   - *P00.10=2: Torque mode*
   - *P05.00=12: FOC sensorless inertia estimation (motor is running)*

   After inertia estimation is finished, check if the estimated value for P11.01 is reasonable, refer to the base value table below (unit = kg•cm2):

Power	Setting
1HP	2.3
2HP	4.3
3HP	8.3
5HP	14.8
7.5HP	26.0
10HP	35.8
12HP	54.8
15HP	74.3
20HP	95.3

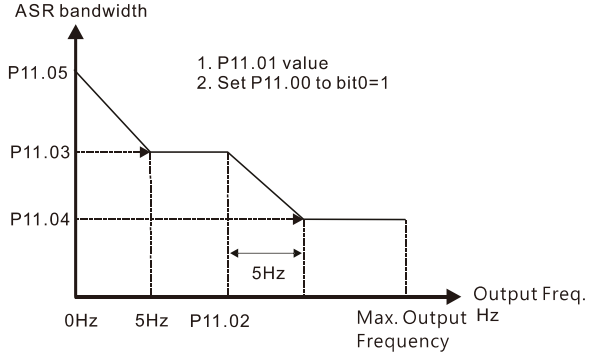
Power	Setting
25HP	142.8
30HP	176.5
40HP	202.5
50HP	355.5
60HP	410.8
75HP	494.8
100HP	1056.5
125HP	1275.3
150HP	1900.0

Power	Setting
175HP	2150.0
250HP	2800.0
300HP	3550.0
375HP	5139.0
425HP	5981.0
475HP	7053.0
600HP	9643.0
650HP	10734.0
750HP	13000.0

5) Execute IM sensorless FOC mode and set up the following parameters:
   - *P00.10=0, set as speed mode*
   - *P00.11=5, set as FOC sensorless mode*
   - *P11.00 bit0=1, use ASR gain auto-tuning*

   Press RUN and start the test with no load. Accelerate the motor to the rated speed, then decelerate to stop and check if the motor runs smoothly.
   a) If the motor runs smoothly, then the setting for IM Sensorless FOC is complete.
   b) If the motor does not run smoothly, or fails to start at low frequency, refer to the following steps for adjustment.
6) Select auto-tuning gain (P11.00 bit0=1) and adjust ASR parameters according to the speed response.
   - *P11.00 bit0=1, use auto-tuning for ASR.*
   - *P11.03, ASR1 low-speed bandwidth. When the acceleration of low-speed cannot follow the acceleration command, increase the low-speed bandwidth.*
   - *P11.04, ASR2 high-speed bandwidth. When the acceleration in high speed causes vibration or cannot follow the acceleration command, increase high-speed bandwidth.*
   - *P11.05, Zero-speed bandwidth. If the response of start-up is slow or incapable, increase zero-speed bandwidth.*

   The bigger the setting value for ASR bandwidth, the faster the response.
   The low speed bandwidth cannot be set too high, or the observer will diverge.



ASR adjustment- auto gain

7) Adjust the setting of FOC speed observer and per-unit value of inertia (common problems).
   a) P10.25: Set up FOC bandwidth of speed observer
      - *Situation 1: Speed command changes rapidly, but speed response cannot follow. Speed response is too slow, increase the setting value.*
      - *Situation 2: The noise of the observer is too large, and causes the operation to diverge. Speed noise is too large, decrease the setting value.*
   b) P11.01: Set up per unit of system inertia

- *Situation 1: The inrush current is too high at startup and causes an oc error.*
- *Situation 2: An ocn error occurs during RUN or STOP and the motor runs randomly.*
  - *Check P11.01 and determine whether the JM per-unit of system inertia is too large.*
  - *Decrease P10.25 FOC bandwidth for speed observer, or P11.05 zero-speed bandwidth.*

TQC SENSORLESS VECTOR MODE STANDARD INDUCTION MOTOR (IM) ADJUSTMENT PROCEDURE

Adjustment Procedure

1) Set P00.02=9 (50Hz) or 10 (60Hz) to go back to factory setting.
2) Set the following parameters based on the nameplate values of the IM motor you are using:
   - *P01.00, Induction Motor Max Frequency (Hz)*
   - *P01.01, Induction Motor Rated Frequency (Hz)*
   - *P01.02, Induction Motor Rated Voltage (V)*
   - *P05.01, Induction Motor Rated Current (A)*
   - *P05.02, Induction Motor Rated Power (kW)*
   - *P05.03, Induction Motor Rated Speed (RPM)*
   - *P05.04, Induction Motor Pole Numbers*
3) Set P05.00=1, named IM flux curve dynamic tuning and press the RUN key to get parameters P05.05 to P05.09 and weak flux parameters for sensorless.
   Please note that the motor will run in P05.00=1: Auto-tuning method.
4) Check the following parameters after IM flux curve dynamic tuning:
   - *P05.05, IM No-load Current*
   - *P05.06, IM Stator Resistance*
   - *P05.07, IM Rotor Resistance*
   - *P05.08, IM Lm*
   - *P05.09, IM Lx*
5) Set P05.00=12 to begin IM motor inertia auto-tuning.
   - *Set P00.10=2, Torque mode*
   - *Set P05.00=12, press RUN key to operate inertia estimation*
   - *Repeat to set P05.00=12 for operating inertia estimation until P11.01 is stable.*
6) Enable automatic ASR bandwidth adjustment.
   - *Set P11.00=1 to enable automatic ASR bandwidth adjustment. This allows P11.03 to P11.05 to make real ASR PI changes automatically based on the situation. This is more flexible for practical commissioning.*
   - *If P11.00=0, ASR bandwidth is not automatically adjusted and only P11.06 to P11.11 will be enabled. The ASR bandwidth will not adjust while running.*
7) The following additional parameters may help fine tune the performance of your motor – adjust as needed:
   - *P10.24, bit0, ASR control at TQC sensorless*
   - *P10.24, bit11, DC brake when executing zero torque command*
   - *P10.24, bit15, Direction limitation at TQC sensorless*
   - *P10.25, FOC bandwidth of speed observer (Hz). Setting this value higher can decrease the speed response time, but will creat emore noise interference.*
   - *P10.26, FOC minimum stator frequency. Set the minimum stator frequency in case the frequency command or limitation is too low.*
   - *P10.27, FOC low-pass filter time constance (ms). If the motor can't be activated during high-speed operation, decrease the value of P10.27.*
   - *P10.28, FOC gain of excitation current rise time (ms). If the drive's action time is too long in torque mode, decrease the value of P10.28.*
   - *P11.33, Source of torque command.*
   - *P11.34, Torque command.*
   - *P11.36, Speed limit selection.*

TQC Sensorless Mode FAQ

1) Q: Can we use GS20 TQC sensorless mode to work smoothly in any situation?

A: It is dependent on load. GS20 TQC sensorless works smoothly at 3Hz and 10% torque, the minimum requirements. However, with a light load the GS20 can work smoothly even below 3Hz.

2) Q: What is the essence of the P10.26 function?

   A: P10.26 is for minimum stator frequency. So if P10.26=10 and P01.00=50Hz, the minimum stator frequency is P01.00 x P10.26 / 100 = 5Hz. When your frequency limitation is less than 5Hz, the output frequency will be at least 5Hz. Do not set P10.26 too high or too low as drive internal calculations have one stable range for successful operation. Typically it's best to use the default settings for P10.26 through P10.28.

3) Q: Why does the motor run when the speed limit is zero and the torque command is not zero?

   A: GS20 TQC sensorless can't calculate accurately when the motor is working at very low speed. If the speed lmit is zero, the motor will still run at about 3Hz due to internal drive calculations. Set P01.34=1 to use DC brake mode and the motor will be held when the speed limit is zero and torque command is not zero. However, the motor will run if the speed limit is above 3Hz to ensure smooth operation.

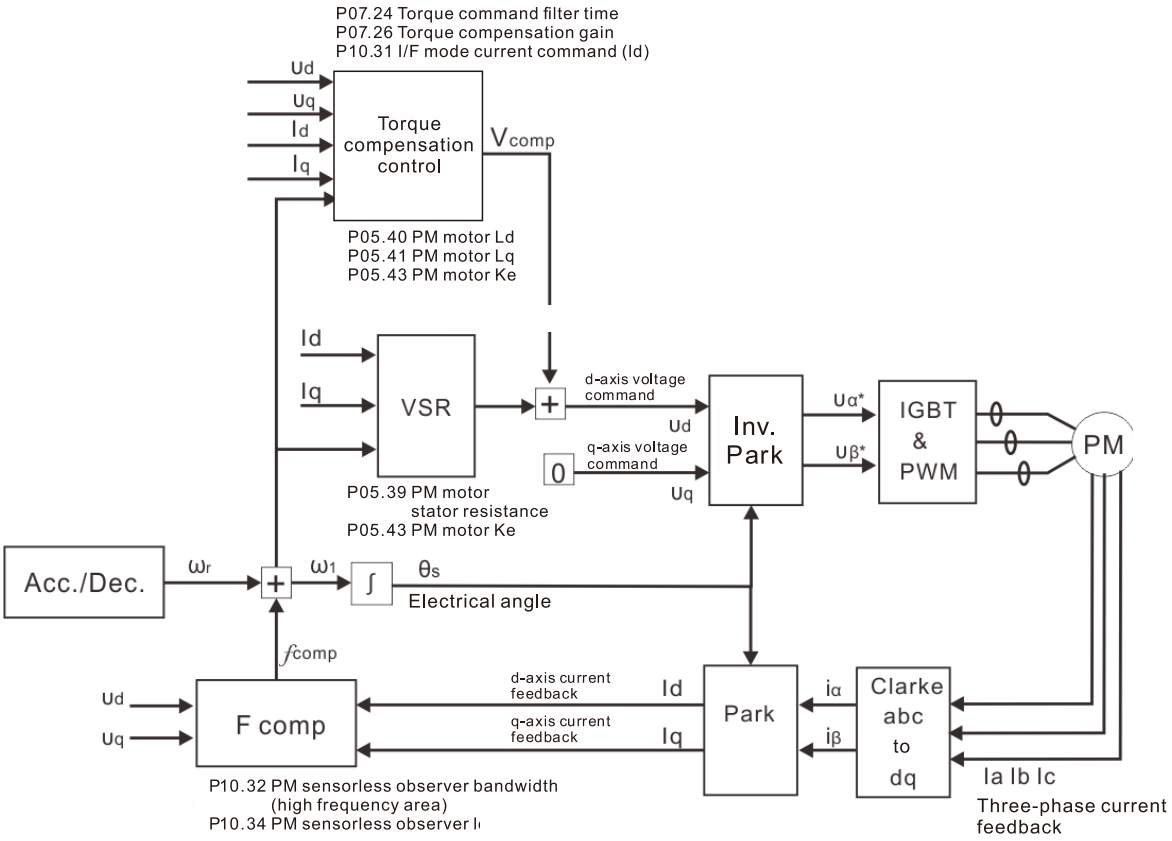
4) Q: How do I use the DC brake function when the torque command is zero?

   A: When the torque command is zero, the motor should not output torque. However, in some special applications, even if the torque command is zero the motor needs to output zero speed torque to avoid load falling. In these instances, we can set bit11 of P10.24=0 (default) to enable the DC brake when the torque command is zero, but DC brake torque size is fixed by firmware and can't be adjusted. If bit11 of P10.24=1, no DC output will occur when torque command is zero and the GS20 will output one frequency based on P10.26.

PMSVC mode with permanent magnet motor (PM) adjustment procedure

When P00.11 Speed Control Mode = 2 SVC (P05.33 = 1 or 2)

PMSVC control diagram



NOTE: In the diagram, "PM motor" means "permanent magnet synchronous AC motor".

NOTE: Once PMSVC adjustment procedure is complete, cycle power to the GS20(X) drive.

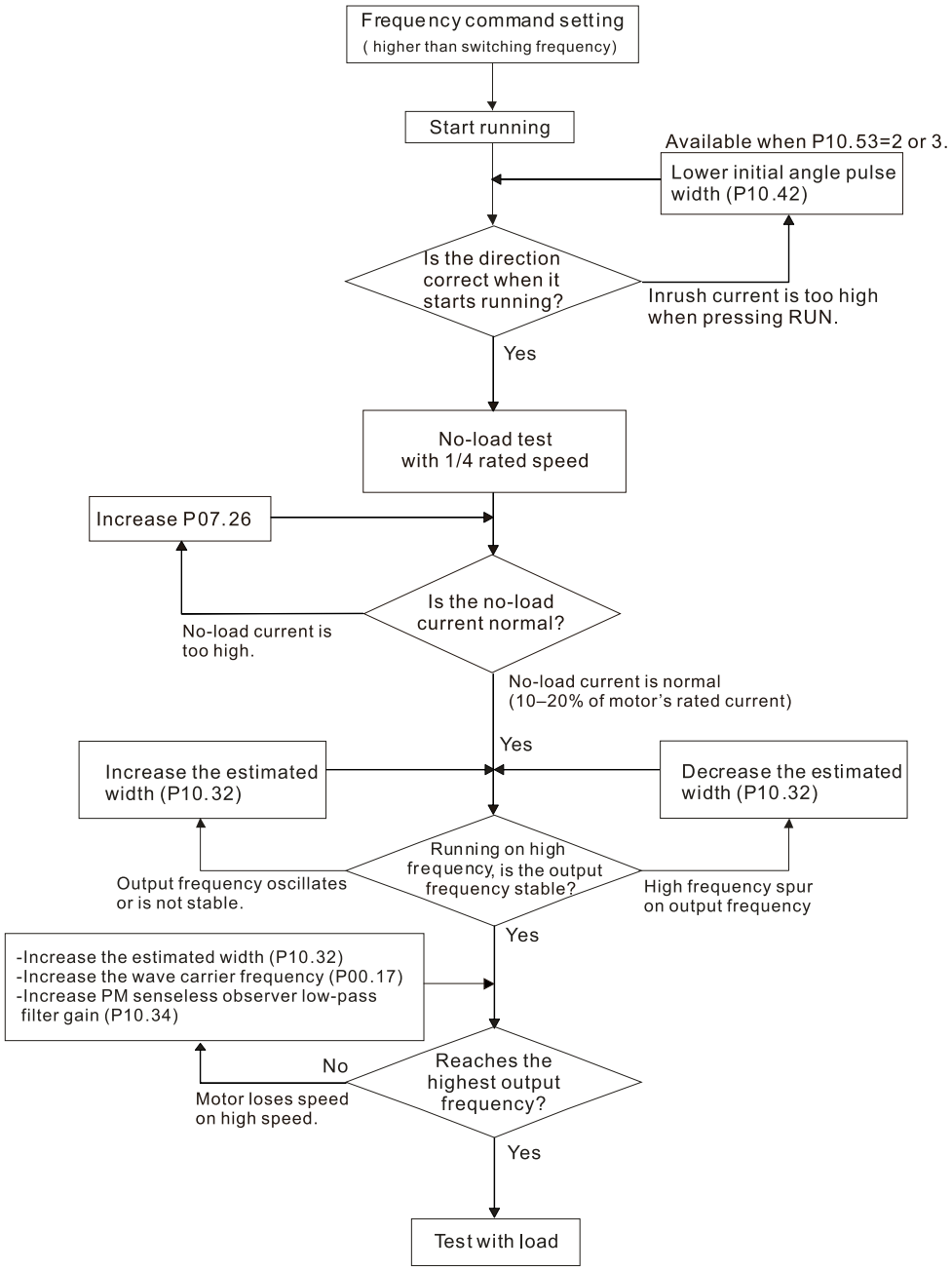
Adjustment procedure

1) Select PM synchronous AC motor control.
   P05.33 Induction Motor (IM) or Permanent Magnet (PM) Synchronous AC Motor Selection =1 (SPM) or 2 (IPM)
2) Set up motor parameters according to the motor's nameplate
   - *P01.01: Rated frequency*
   - *P01.02: Rated voltage*
   - *P05.34: Rated current*
   - *P05.35: Rated Power*
   - *P05.36: Rated speed*
   - *P05.37: Number of poles for the motor*
3) Execute PM synchronous AC motor auto-tuning (static)
   a) Set P05.00 Motor Parameter Auto-tuning =13 (High frequency stall test for PM synchronous AC motor) and press RUN.

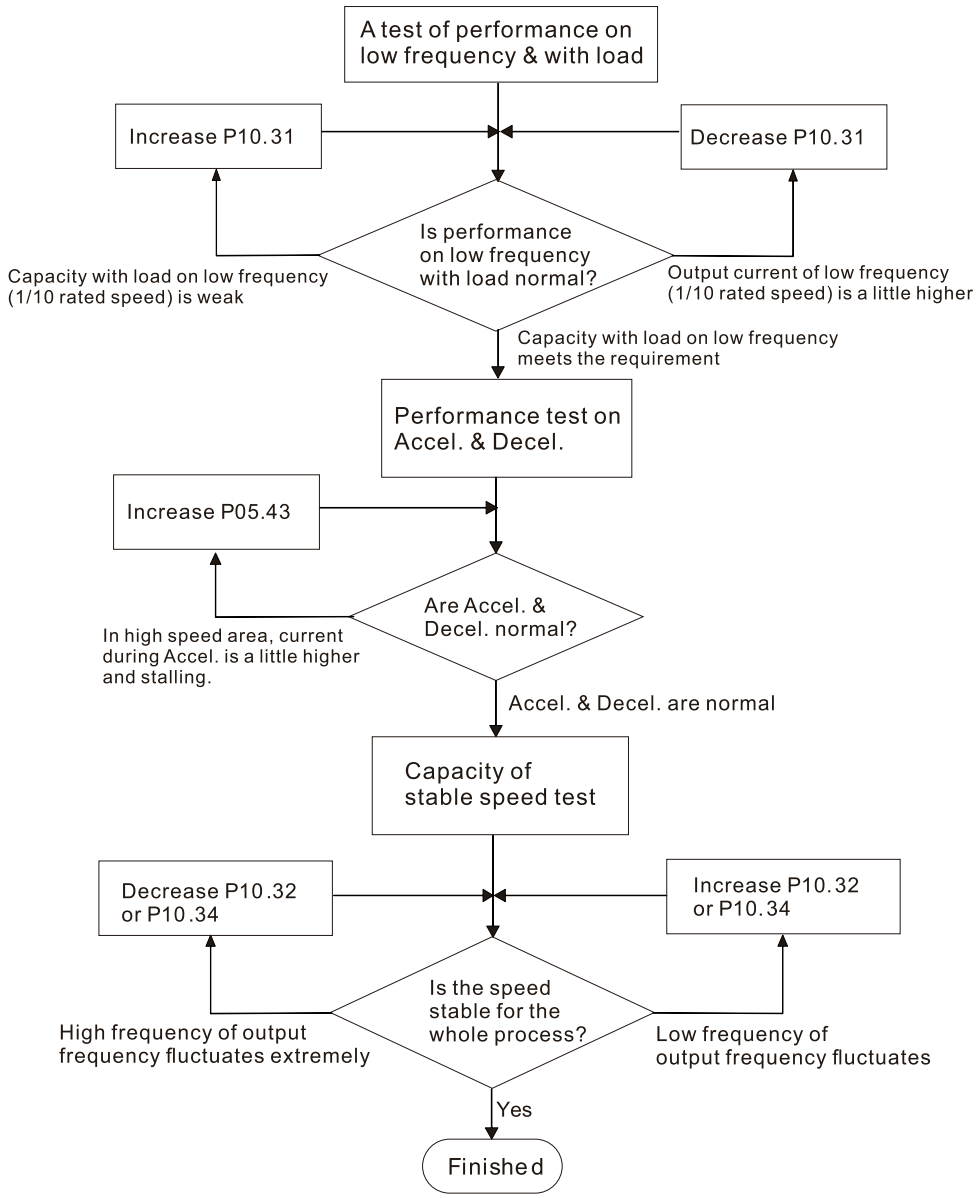
b) When you finish tuning, the following parameters are available:
   - *P05.39: Stator resistance*
   - *P05.40: Permanent magnet synchronous AC motor Ld*
   - *P05.41: Permanent magnet synchronous AC motor lq*
   - *P05.43: (V / 1000 rpm), the Ke parameter of PM synchronous AC motor (you can calculate this automatically according to power, current, and speed of the motor).*

4) Set the speed control mode: P00.10 Control Mode = 0, P00.11 Speed Control Mode = 2 SVC.
5) Cycle the power after you finish tuning.
6) The ratio of the PMSVC control mode is 1:20.
7) When the PMSVC control mode is under 1/20th of the rated speed, the load bearing capacity is 100% of the motor rated torque.
8) PMSVC control mode is not applicable to zero speed control.
9) The start-up load and the load bearing capacity of the forward/reverse running in PMSVC control mode equal to 100% of the motor rated torque.

10) Adjustment flow chart when starting WITHOUT load:



11) Adjustment flow chart when starting WITH load:

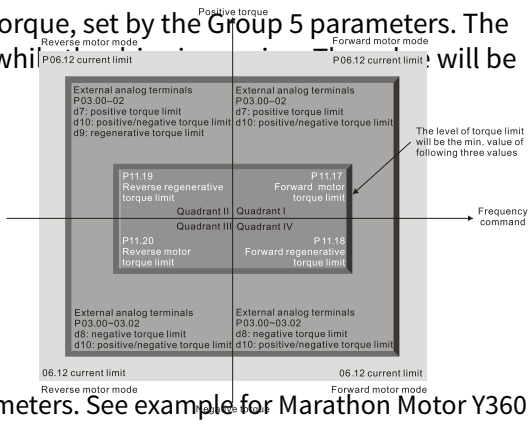


12) Set up the related parameters for speed estimators
    - *P10.31, I/F Mode, Current Command*
    - *P10.32, PM FOC Sensorless Speed Estimator Bandwidth*
    - *P10.34, PM Sensorless Speed Estimator Low-pass Filter Gain*
    - *P10.39, Frequency Point to Switch from I/F Mode to PM Sensorless Mode*
    - *P10.42, Initial Angle Detection Pulse Value*
    - *P10.49, Zero Voltage Time during Start-up*
    - *P10.51, Injection Frequency*
    - *P10.52, Injection Magnitude*
    - *P10.53, Angle Detection Method*
    - *P07.26, Torque Compensation Gain*
13) After PMSVC setup is complete, cycle power to the GS20(X) drive.

Torque Calculation and Torque Parameter Setup Reference

Drive Motor Torque Calculation

Torque reference scaling is based on the motor rated torque, set by the Group 5 parameters. The Torque calculated value can be viewed in P00.04 = 39 whi[illegible] will be similar to the rated nameplate motor torque.



See an example for Motor Y360 below:

Calculation equation for the motor rated torque:

Motor rated torque: $T(N.M) = \frac{P(W)}{\omega(rad/s)}$

Where:

P (W) value = P05.02

ω (rad / s) value = $\frac{P5.03 \times 2\pi}{60} = rad/s$

1) Set the motor nameplate data in the Group 5 parameters. See example for Marathon Motor Y360 below:

MOTOR NAMEPLATE DATA

Motor	Torque	Current	Power	Speed
Part No	N-m	Amps	kW	RPM
Y360	1.5	1.8	0.37	1725

SET MOTOR PARAMETERS

Parameter	Description	Parameter Value
P05.01	IM1, FLA	1.8
P05.02	IM1 Power (kW)	0.37
P05.03	IM1 Speed (rpm)	1725

$$T\ (N{\cdot}m) = \frac{P5.02 \times 1000}{\left(\frac{P5.03 \times 2 \times 3.14}{60}\right)} = \frac{0.37 \times 1000}{\left(\frac{1725 \times 2 \times 3.14}{60}\right)} = 2.0$$

2) Set P11.27, Max Torque Command, to scale the upper limit of the torque command. The value can be 0–500%.
   - P11.27 = 100% . . . this corresponds to the 2 N·m result from the step above.

GS20 Drive - Torque Limit in Speed Mode Detailed Explanation

Torque limit is controlled in 2 ways:

1) Parameter control: P11.17–P11.20

P11.17	Forward Motor Torque Limit
P11.18	Forward Regenerative Torque Limit
P11.19	Reverse Motor Torque Limit
P11.20	Reverse Regenerative Torque Limit

Range/Units (Format: 16-bit unsigned)

0–500%

2) Analog input control: P03.00 or P03.01 = 7, 8, 9, or 10

P03.00	Analog input selection (AI1)	0: No function 1: Frequency command 2: Torque command (torque limit under speed mode) 3: Torque compensation command 4: PID target value 5: PID feedback signal 6: Thermistor (PTC) input value
P03.01	Analog input selection (AI2)	7: Positive torque limit 8: Negative torque limit 9: Regenerative torque limit 10: Positive / negative torque limit 11: PT100 thermistor input value 12: Auxiliary frequency input 13: PID compensation value

These settings are based on MOTOR RATED TORQUE = 100%. The settings for P11.17–P11.20 compare with the P03.00 = 7, 8, 9, 10 in the torque limit block. The minimum value of the comparison result is the torque limit.

NOTE: The total drive current limit is governed by P06.12. This parameter is to protect the drive (0 -250% of Drive Rated Current). If either P11.17-20 or Analog input torque limit exceeds P06.12, the speed of the drive will be reduced until the current is under this limit.

P06.12 is the only current/torque limit available for V/F, VFPG, IMSVC or PMSVC modes (P00.11 = 0, 1,2).

P06.12	Current limit	0–250% (100% corresponds to the rated current of the drive)

Speed Mode with Torque Limits via Analog Input

While in Speed mode and controlling torque limits via an analog input, use the following parameter configuration.

NOTE: Only P00.11=5 IMFOC speed mode can be used with torque limits.

Set parameters as follows:

1) Set Control Modes:

Parameter	Parameter Description	Parameter Value
P00.10	Control Method	0 (Speed)
P00.11	Speed (Velocity) Control Mode	5 (IMFOC)

2) Set up motor values for calculation of proper torque:

Parameter	Parameter Description	Parameter Value
P05.01	Induction Motor 1, Full-load amps	10-120% drive current
P05.02	Induction Motor 1, Rated power (kW)	Set based on motor. This is used to calculate Torque Cmd value
P05.03	Induction Motor 1, Rated speed (rpm)	Set based on motor. This is used to calculate Torque Cmd value

3) Tune Motor

Parameter	Parameter Description	Parameter Value
P05.00	1	Press Run and allow Auto-Tune

4) Set up User display to monitor the torque of the drive. This is optional but will help you see what the drive is doing to limit the torque.

Parameter	Parameter Description	Parameter Value
P00.04	User Display	8 = % Torque or 39 = Torque Netwon - Meters

5) Set up Analog Input command signal.

Parameter	Parameter Description	Parameter Value
P03.00 or P03.01	Analog input selection	**7–10 - Torque limits** When using this selection, the corresponding value for 0–10 V / 4–20 mA is 0 – maximum output torque (P11.27).

6) Set up the maximum torque value for the torque command.

Parameter	Parameter Description	Parameter Value
P11.27	Maximum Torque Command	0-500% (of Motor Rated Torque)

7) Set up the torque limits for the torque command.

Parameter	Parameter Description	Parameter Value
P11.17	Forward motor torque limit	500%
P11.18	Forward regenerative torque limit	500%
P11.19	Reverse motor torque limit	500%
P11.20	Reverse regenerative torque limit	500%

8) Ensure the drive current limit will not interfere with torque command limits

Parameter	Parameter Description	Parameter Value
P06.12	Current limit	0-250% drive current. Ensure this value is set above the motor torque requirements or it will prevent full torque to the motor

GS20 Drive Quick Reference- Alternating between Torque and Speed Mode

The drive allows alternating between Torque and Speed mode via a digital input. ***A multifunction input must be set to 26 for the use of P03.00 / P03.01 = 2*** as the torque limit function.

Set parameters according to the steps below to use analog input control of torque and frequency while in this mode.

1) Set Control Modes:

Parameter	Parameter Description	Parameter Value
P00.10	Control Method	0 (Speed) or 2 (Torque)
P00.11	Speed (Velocity) Control Mode	5 (IMFOC)

2) Set up motor values for calculation of proper torque:

Parameter	Parameter Description	Parameter Value
P05.01	Induction Motor 1, Full-load amps	10-120% drive current
P05.02	Induction Motor 1, Rated power (kW)	Set based on motor. This is used to calculate Torque Cmd value
P05.03	Induction Motor 1, Rated speed (rpm)	Set based on motor. This is used to calculate Torque Cmd value

3) Tune Motor

Parameter	Parameter Description	Parameter Value
P05.00	1	Press Run and allow Auto-Tune

4) Set up User display to monitor the torque of the drive. This is optional but will help you see what the drive is doing to limit the torque.

Parameter	Parameter Description	Parameter Value
P00.04	User Display	8 = % Torque or 39 = Torque Netwon - Meters

5) Set up one digital input selection of control mode.

Parameter	Parameter Description	Parameter Value
P02.01–P02.07	Digital input config	26 (DIx=1 TQC Torque mode, DIx=0 IMFOC Speed Mode) **NOTE:** If P00.10 = 0....when Speed mode is enabled (Dix=0), the torque limit will be held at the last value used while in torque mode. If P00.10=2, when Speed mode is enabled (Dix=0), the torque limit follows the value of the configured analog input in real time.

6) Set up Analog Input command signal.

Parameter	Parameter Description	Parameter Value
P03.00 or P03.01	Analog input selection	**2 - Torque command (torque limit under speed mode)** When using this selection, the corresponding value for 0–10 V / 4–20 mA is 0–maximum output torque (P11.27). When DIx=1: AI functions as Torque Commmand. When DIx=0: AI functions as Torque Limit. Speed command is determined by P00.20.

7) Set up the Analog input as the torque command source.

Parameter	Parameter Description	Parameter Value
P11.33	Torque command source	2 – Analog Signal Input

8) Set up the maximum torque value for the torque command.

Parameter	Parameter Description	Parameter Value
P11.27	Maximum Torque Command	0-500% (of Motor Rated Torque)

9) Set up the torque limits for the torque command.

Parameter	*Parameter Description*	*Parameter Value*
P11.17	Forward motor torque limit	500%
P11.18	Forward regenerative torque limit	500%
P11.19	Reverse motor torque limit	500%
P11.20	Reverse regenerative torque limit	500%

10) Ensure the drive current limit will not interfere with torque command limits

Parameter	*Parameter Description*	*Parameter Value*
P06.12	Current limit	0-250% drive current. Ensure this value is set above the motor torque requirements or it will prevent full torque to the motor

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Serial Communications

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Communications Parameters Summary

A summary of the GS20(X) AC drives Communications Parameters is listed below. Refer to "Parameters" Chapter 4 for a complete listing of all GS20(X) AC drives parameters, including details and Modbus addresses.

For GS20A-CM-ENETIP communication card parameters and information, please see Appendix B.

Summary – Serial Communication Parameters

GS20(X) Parameters Summary – Communication Parameters (P09.xx)							
Parameter		**Range**	**Run[1] Read/ Write**	**Modbus Address**		**Settings**	
				Hex	**Dec**	**Default[2]**	**User**
1) ♦ in the Run-Read/Write column indicates that the parameter can be set during RUN mode. R/W indicates "Read/write." Read indicates "Read-only."							
2) Parameters can be restored to their default values using P00.02.							
P09.00	Communication address	1–254	♦R/W	0900	42305	1	
P09.01	COM1 transmission speed	4.8–115.2 Kbps	♦R/W	0901	42306	9.6	
P09.02	COM1 transmission fault treatment	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning, no fault, and continue operation	♦R/W	0902	42307	3	
P09.03	COM1 time-out detection	0.0–100.0 sec.	♦R/W	0903	42308	0.0	
P09.04	COM1 communication protocol	1: 7, N, 2 (ASCII) 2: 7, E, 1 (ASCII) 3: 7, O, 1 (ASCII) 4: 7, E, 2 (ASCII) 5: 7, O, 2 (ASCII) 6: 8, N, 1 (ASCII) 7: 8, N, 2 (ASCII) 8: 8, E, 1 (ASCII) 9: 8, O, 1 (ASCII) 10: 8, E, 2 (ASCII) 11: 8, O, 2 (ASCII) 12: 8, N, 1 (RTU) 13: 8, N, 2 (RTU) 14: 8, E, 1 (RTU) 15: 8, O, 1 (RTU) 16: 8, E, 2 (RTU) 17: 8, O, 2 (RTU)	♦R/W	0904	42309	15	
P09.09	Communication response delay time	0.0–200.0 ms	♦R/W	0909	42314	2.0	
P09.10	Communication main frequency	0.00–599.00 Hz	R/W	090A	42315	60.00	
P09.11	Block transfer 1	0–65535	♦R/W	090B	42316	0	
P09.12	Block transfer 2	0–65535	♦R/W	090C	42317	0	
P09.13	Block transfer 3	0–65535	♦R/W	090D	42318	0	
P09.14	Block transfer 4	0–65535	♦R/W	090E	42319	0	
P09.15	Block transfer 5	0–65535	♦R/W	090F	42320	0	
P09.16	Block transfer 6	0–65535	♦R/W	0910	42321	0	
P09.17	Block transfer 7	0–65535	♦R/W	0911	42322	0	
P09.18	Block transfer 8	0–65535	♦R/W	0912	42323	0	
P09.19	Block transfer 9	0–65535	♦R/W	0913	42324	0	
P09.20	Block transfer 10	0–65535	♦R/W	0914	42325	0	
P09.21	Block transfer 11	0–65535	♦R/W	0915	42326	0	

GS20(X) Parameters Summary - Serial Communication Parameters (P09.xx) - (continued)							
Parameter		Range	Run[1] Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default[2]	User
P09.22	Block transfer 12	0–65535	♦R/W	0916	42327	0	
P09.23	Block transfer 13	0–65535	♦R/W	0917	42328	0	
P09.24	Block transfer 14	0–65535	♦R/W	0918	42329	0	
P09.25	Block transfer 15	0–65535	♦R/W	0919	42330	0	
P09.26	Block transfer 16	0–65535	♦R/W	091A	42331	0	
P09.30	Communication decoding method	0: Decoding method 1 1: Decoding method 2	R/W	091E	42335	1	
P09.33	PLC command force to 0	0–65535	♦R/W	0921	42338	0	
P09.35	PLC address	1–254	R/W	0923	42340	2	
P09.60	Communication card identification	0: No communication card 4: Modbus-TCP slave 5: EtherNet/IP slave 10: Backup power supply	Read	093C	42365	0	
P09.61	Firmware version of communication card	Read only	Read	093D	42366	0	
P09.62	Product code	Read only	Read	093E	42367	0	
P09.63	Error code	Read only	Read	093F	42368	0	
P09.74	Set Comm Master Protocol	0: Ethernet IP and Modbus TCP both 1: Ethernet IP 2: Modbus TCP	♦R/W	094A	42379	1	
P09.75	Communication card IP configuration (Ethernet)	0: Static IP 1: Dynamic IP (DHCP)	♦R/W	094B	42380	0	
P09.76	Communication card IP address 1 (Ethernet)	0–255	♦R/W	094C	42381	0	
P09.77	Communication card IP address 2 (Ethernet)	0–255	♦R/W	094D	42382	0	
P09.78	Communication card IP address 3 (Ethernet)	0–255	♦R/W	094E	42383	0	
P09.79	Communication card IP address 4 (Ethernet)	0–255	♦R/W	094F	42384	0	
P09.80	Communication card address mask 1 (Ethernet)	0–255	♦R/W	0950	42385	0	
P09.81	Communication card address mask 2 (Ethernet)	0–255	♦R/W	0951	42386	0	
P09.82	Communication card address mask 3 (Ethernet)	0–255	♦R/W	0952	42387	0	
P09.83	Communication card address mask 4 (Ethernet)	0–255	♦R/W	0953	42388	0	
P09.84	Communication card gateway address 1 (Ethernet)	0–255	♦R/W	0954	42389	0	
P09.85	Communication card gateway address 2 (Ethernet)	0–255	♦R/W	0955	42390	0	
P09.86	Communication card gateway address 3 (Ethernet)	0–255	♦R/W	0956	42391	0	
P09.87	Communication card gateway address 4 (Ethernet)	0–255	♦R/W	0957	42392	0	

GS20(X) Parameters Summary - Serial Communication Parameters (P09.xx) - (continued)							
Parameter		Range	Run[1] Read/ Write	Modbus Address		Settings	
				Hex	Dec	Default[2]	User
P09.88	Communication card password (low word) (Ethernet)	0–99	♦R/W	0958	42393	0	
P09.89	Communication card password (high word) (Ethernet)	0–99	♦R/W	0959	42394	0	
P09.90	Reset communication card (Ethernet)	0: Disable 1: Reset to defaults	♦R/W	095A	42395	0	
P09.91	Additional settings for the communication card (Ethernet)	bit 0: Enable IP filter bit 1: Enable internet parameters (1 bit) When the IP address is set, this bit is enabled. After updating the parameters for the communication card, this bit changes to disabled. bit 2: Enable login password (1 bit) When you enter the login password, this bit is enabled. After updating the communication card parameters, this bit changes to disabled.	♦R/W	095B	42396	0	
P09.92	Communication card status (Ethernet)	bit 0: Enable password When the communication card is set with a password, this bit is enabled. When the password is cleared, this bit is disabled.	R/W	095C	42397	0	
P09.93	ENETIP Comm Card Fault Select	0: Warn & Continue Operation 1: Warn & Ramp to Stop 2: Warn & Coast to Stop 3: No Warning & Continue Operation	♦R/W	095D	42398	3	
P09.94	ENETIP Comm Card Time Out Detection	0: Disable 1: Enable	♦R/W	095E	42399	1	
P09.95	ENETIP Comm Card Time Out Duration	0.1 to 100.0 seconds	♦R/W	095F	42400	3.0	

Block Transfer Explanation

Block Transfer allows Parameters from many different Parameter Groups to be consolidated into one (or fewer) Modbus communication messages. This can greatly simplify PLC programming and reduce network traffic.

The Block Transfer parameters are P09.11 through P09.26. To use these parameters, enter the value of another parameter you wish to read or write through the keypad or GSoft2 configuration software. The parameter values must be converted by adding the upper byte value to the lower byte value, convert the sum to hex, then convert the hex to decimal.

Example:

Parameter P02.22. 0200 + 16 (hex of 22) = 0x0216 = result is 534. 534 is what would be entered in the Block Transfer parameter to read or write parameter P02.22.

Examples of Block Transfer are below:

1) Block transfer 1 (P09.11) = 0000 (AC Motor drive identity code). A Modbus read of P09.11 results in a value of 104. In this case, the drive is model # GS21-11P0 and corresponds to the value 104 in Parameter P00.00.
2) Block transfer 2 (P09.12) = 0006 (Firmware version). A Modbus read of P09.12 results in a value of 100. This is the firmware version of the GS20 drive.
3) Block transfer 3 (P09.13) = 8448 (decimal value of 0x2100 Status Monitor 1). A Modbus read of P09.13 returns the current status of Status Monitor 1.

4) Block transfer 4 (P09.14) = 8449 (decimal value of 0x2101 Status Monitor 2). A Modbus read of P09.14 returns the current status of Status Monitor 2.
5) Block transfer 5 (P09.15) = 8451 (decimal value of 0x2103 Output Frequency). A Modbus read of P09.15 returns the current running frequency of the GS20.
6) Block transfer 6 (P09.16) = 0268 (Acceleration time 1 is parameter P01.12. 12 = 0x0c. 0100 + 0c = 0x010C = 0268 decimal). A Modbus write to P09.16 will set the Acceleration time 1 value.
7) Block transfer 7 (P09.17) = 0269 (Deceleration time 1 is parameter P01.13. 13 = 0x0d. 0100 + 0d = 0x010d = 0269 decimal). A Modbus write to P09.17 will set the Deceleration time 1 value.
8) Block transfer 8 (P09.18) = 8192 (Control Word 1 (Run, Stop, etc…) is 0x2000 = 8192). A Modbus write to P09.18 will control the Run/Stop of the drive along with other items.
9) Block transfer 9 (P09.19) = 8193 (Control Word 2 (Frequency Command) is 0x2001 = 8193). A Modbus write to P09.19 will control the commanded Frequency of the drive.

Accessing all of the registers above would typically take about 6 Modbus messages but by blocking them together in the Block Transfer parameters, we can access everything with 1 read and 1 write.

Serial Modbus Status Addresses

The *DURAPULSE* GS20(X) AC drive has status memory addresses that are used to monitor the AC drive.

Status Addresses (Read Only)

GS20(X) Addresses						
Description		**Range**		**Modbus Address**		
				Hex	**Dec**	**Octal**
Status Monitor 1 Read Only	Error Codes	0: No Error 1: Overcurrent during Accel (ocA) 2: Overcurrent during Decel (ocd) 3: Overcurrent during normal speed (ocn) 4: Ground Fault (GFF) 5: IGBT short circuit (occ) 6: Overcurrent during Stop (ocS) 7: Overvoltage during Accel (ovA) 8: Overvoltage during Decel (ovd) 9: Overvoltage during normal speed (ovn) 10: Overvoltage during Stop (ovS) 11: Low voltage during Accel (LvA) 12: Low voltage during Decel (Lvd) 13: Low voltage during normal speed (Lvn) 14: Low voltage during Stop (LvS) 15: Input phase loss (OrP) 16: IGBT Overheat 1 (oH1) 17: Cap Overheat 2 (oH2) 18: Thermistor 1 open (tH1o) 19: Thermistor 2 open (tH2o) 20: Power Reset Off (PWR) 21: Overload (oL) (150% 1Min, Inverter) 22: Motor1 Thermal Overload (EoL1) 23: Motor2 Thermal Overload (EoL2) 24: Motor Overheat-PTC (oH3) 25: reserved 26: Over Torque 1 (ot1) 27: Over Torque 2 (ot2) 28: Under current (uc) 29: reserved 30: EEPROM write error (cF1) 31: EEPROM read error (cF2) 32: reserved 33: U phase current sensor detection error (cd1) 34: V phase current sensor detection error (cd2) 35: W phase current sensor detection error (cd3) 36: CC Hardware Logic error 0 (Hd0) 37: OC Hardware Logic error 1 (Hd1) 38: OV Hardware Logic error 2 (Hd2) 39: OCC Hardware Logic error 3 (Hd3)	40: Motor auto tune error (AuE) 41: PID Feedback loss (AFE) 42~47: reserved 48: Analog input signal loss (ACE) 49: External Fault (EF) 50: Emergency Stop (EF1) 51: Base Block (bb) 52: Password Error (Pcod) 53: Software Code lock (ccod) 54: PC Command error (CE1) 55: PC Address error (CE2) 56: PC Data error (CE3) 57: PC Slave error (CE4) 58: PC Communication Time Out (CE10) 59: PC Keypad Time out (CP10) 60: Braking Transistor Fault (bf) 61: Y-Delta connection Error (ydc) 62: Decel Energy Backup Error (dEb) 63: Over Slip Error (oSL) 64: Electromagnet switch error (ryF) 65~71: reserved 72: STO Loss1 (STL1) STO1~SCM1 internal hardware detect error 73: ES1 Emergency Stop (S1) 74: In Fire Mode (Fire) 75: reserved 76: Safety Torque Off function active (STO) 77: STO Loss2 (STL2) STO2~SCM2 internal hardware detect error 78: STO Loss3 (STL3) – STO1~SCM1 and STO2~SCM2 internal hardware detect errors 79: U Phase Short (Uoc) 80: V Phase Short (Voc) 81: W Phase Short (Woc) 82: U Phase Loss (UPHL) 83: V Phase Loss (VPHL) 84: W Phase Loss (WPHL) 85~89: reserved 90: PLC Force Stop (FStp) 91~96: reserved 97: Ethernet Card Timeout (CD10) 98: reserved 99: CPU Command error (TRAP) 100: reserved	0611	41554	3021
Note: *Status Monitor 1 corresponds to P06.17 Fault Record 1.*						

GS20(X) Addresses (continued)					
Description	***Range***		***Modbus Address***		
			Hex	***Dec***	***Octal***
Status monitor read only	High byte: Warning code / Low Byte: Error code		2100	48449	20400
	bit 1–0	AC motor drive operation status 00B: The drive stops 01B: The drive is decelerating 10B: The drive is in standby status 11B: The drive is operating	2101	48450	20401
	bit 2	1: JOG command			
	bit 4–3	Operation direction 00B: FWD running 01B: From REV running to FWD running 10B: From FWD running to REV running 11B: REV running			
	bit 8	1: Master frequency controlled by the communication interface			
	bit 9	1: Master frequency controlled by the analog / external terminal signal			
	bit 10	1: Operation command controlled by the communication interface			
	bit 11	1: Parameter locked			
	bit 12	1: Enable to copy parameters from keypad			
	bit 15–13	Reserved			
	Frequency command (XXX.XX Hz)		2102	48451	20402
	Output frequency (XXX.XX Hz)		2103	48452	20403
	Display the drive's output current (XX.XX A). When the current is higher than 655.35, it automatically shifts one decimal place as (XXX.X A). Refer to the high byte of 211F for information on the decimal places.		2104	48453	20404
	DC bus voltage (XXX.X V)		2105	48454	20405
	Output voltage (XXX.X V)		2106	48455	20406
	Current step for the multi-step speed operation		2107	48456	20407
	Reserved		2108	48457	20410
	Counter value		2109	48458	20411
	Output power factor angle (XXX.X)		210A	48459	20412
	Output torque (XXX.X %)		210B	48460	20413
	Actual motor speed (XXXXX rpm)		210C	48461	20414

GS20(X) Addresses (continued)					
Description	***Range***		***Modbus Address***		
			Hex	***Dec***	***Octal***
Command write only	bit 1–0	00B: No function	2000	48193	20000
		01B: Stop			
		10B: Run			
		11B: JOG + RUN			
	bit 3–2	Reserved			
	bit 5–4	00B: No function			
		01B: FWD			
		10B: REV			
		11B: Change direction			
	bit 7–6	00B: 1st accel. / decel.			
		01B: 2nd accel. / decel.			
		10B: 3rd accel. / decel.			
		11B: 4th accel. / decel.			
	bit 11–8	000B: Master speed			
		0001B: 1st step speed frequency			
		0010B: 2nd step speed frequency			
		0011B: 3rd step speed frequency			
		0100B: 4th step speed frequency			
		0101B: 5th step speed frequency			
		0110B: 6th step speed frequency			
		0111B: 7th step speed frequency			
		1000B: 8th step speed frequency			
		1001B: 9th step speed frequency			
		1010B: 10th step speed frequency			
		1011B: 11th step speed frequency			
		1100B: 12th step speed frequency			
		1101B: 13th step speed frequency			
		1110B: 14th step speed frequency			
		1111B: 15th step speed frequency			
	bit 12	1: Enable bit 06–11 function			
	bit 14–13	00B: No function			
		01B: Operated by the digital keypad			
		10B: Operated by Pr.00-21 setting			
		11B: Change the operation source			
	bit 15	Reserved			
	Frequency command (XXX.XX Hz)		2001	48194	20001
	bit 0	1: E.F. (External Fault) ON	2002	48195	20002
	bit 1	1: Reset command			
	bit 2	1: B.B. ON			
	bit 4–3	Reserved			
	bit 5	1: Enable fire mode			
	bit 15–6	Reserved			

Serial Communications Overview

The GS20(X) RJ-45 Serial Comm Port will accommodate an RS-485 connection, through which the drive can be controlled by a remote master device on an RS-485 network spanning up to 1200 meters (4000 feet) of cable. RS-232 signals can be converted to RS-485 by using a separate converter.

The GS20(X) AC drive communication address is specified in P9.00, and the remote master device can control each AC drive according to its individual communication address.

The GS20(X) AC drive can be configured to communicate using either Modbus RTU or ASCII. The desired protocol is selected in parameter P09.04, COM1 Protocol. (The GS20(X) drive cannot use both protocols simultaneously.)

- *Standard Modbus protocol using ASCII or RTU transmission modes.*
  Parameter P09.04, Communication Protocol, is used to select the desired mode, number of data bits, parity, and number of stop bits. The mode and serial parameters must be the same for all devices on a Modbus network.

DURApulse GS20(X) drives have a provision for shutting down control or power to the inverter in the event of a communications time out. This feature can be set up through parameters P09.02 (COM1 transmission fault treatment) and P09.03 (COM1 time-out detection).

Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card # GS20A-CM-ENETIP.
Refer to "Appendix B: Optional I/O and Communication Cards" for details.

Serial Communications Connectivity

This section contains information regarding wiring connections to the GS20(X) RS-485 serial communication ports. For information regarding serial connections to AutomationDirect PLCs, please refer to Appendix D of this user manual, or to the applicable PLC user manual.

Minimum AC Drive Parameter Settings For Serial Communication

The following parameters need to be set as shown in order to communicate properly:

Minimum Parameter Settings (for Communication to ADC PLC)		
Parameter Setting	***Description***	***Setting Value Explanation***
P00.21 = 02	1st Source of Operation Command [Remote]	02: RS-485 communication input
P00.31 = 02	2nd Source of Operation Command [Local]	02: RS-485 communication input, Keypad STOP is Enabled (P00.32)
P02.01~P02.07 = 56	Multifunction Inputs (DI1-DI7) Definition	56: Local/Remote selection
P00.20 = 1	1st Source of Frequency Command [Remote]	1: RS-485 communication input
P00.30 = 1	2nd Source of Frequency Command [Local]	1: RS-485 communication input
P09.00 = 1~254	Communication Address	01~254 Drive Comm Address
P09.01 = 4.8~115.2	Transmission Speed	4.8–115.2 Kbps
P09.04 = 1 to 17	COM1 Protocol	1: 7, N, 2 (ASCII) 2: 7, E, 1 (ASCII) 3: 7, O, 1 (ASCII) 4: 7, E, 2 (ASCII) 5: 7, O, 2 (ASCII) 6: 8, N, 1 (ASCII) 7: 8, N, 2 (ASCII) 8: 8, E, 1 (ASCII) 9: 8, O, 1 (ASCII) 10: 8, E, 2 (ASCII) 11: 8, O, 2 (ASCII) 12: 8, N, 1 (RTU) 13: 8, N, 2 (RTU) 14: 8, E, 1 (RTU) 15: 8, O, 1 (RTU) 16: 8, E, 2 (RTU) 17: 8, O, 2 (RTU)

This list of parameter settings is the minimum required to communicate with an AutomationDirect PLC. There may be other parameters that need to be set to meet the needs of your particular application.

Common Third-Party Modbus RTU Masters

- *KEPSERVER EX 5.0 from www.kepware.com*
- *Modbus Poll from www.modbustools.com*

AutomationDirect PLCs as Modbus Master

Serial Modbus-capable AutomationDirect PLCs can communicate with the GS20(X) drive (for GS20(X) Ethernet and Modbus TCP connectivity and control, refer to the GS20A-CM-ENETIP Communication card information in Appendix B).

Serial Modbus control is easier to accomplish from a PLC that has a built-in RS-485 port and supports dedicated Modbus messaging. [RS-232-only PLCs will require an RS-232–RS-485 converter (FA-ISOCON); and older PLCs may require programming to construct the Modbus strings.] We recommend PLCs with built-in RS-485 ports and dedicated Modbus serial commands: CLICK (with RS-485 ports), P1000, P2000, P3000, BRX/Do-more, DirectLogic (DL06, D2-260, or D2-262). Other PLC-Drive connectivity is possible: Please refer to the "Typical ADC PLC to GS20(X) Serial Connectivity Matrix" below.

Typical ADC PLC to GS20(X) Serial Communications Connectivity

Typical ADC PLC to GS20(X) Serial Communications Connectivity Matrix*						
Recommended PLC Connectivity			Communication	Direct Cable	GS20(X)	
PLC	Port #	Port Type			Port Type	Port #
CLICK	3	3 screw terminals	RS-485	Q8304-1 cable	RJ45 or SG+ SG- SGND	RJ45
D2-260	2	HD15	RS-485	D2-DSCBL-2		
D2-262	2	HD15	RS-485	D2-DSCBL-2		
DL06	2	HD15	RS-485	D2-DSCBL-2		
BRX/Do-more	RS-485	3 screw terminals	RS-485	Q8304-1 cable		
Do-more H2-DM1	RS-232	RJ12	RS-232 to RS-485	FA-ISOCON with Q8304-1 cable		
P1-550	RS-485	4 screw terminals	RS-485	Q8304-1 cable		
P2-550	RS-485	3 screw terminals	RS-485	Q8304-1 cable		
P3-530	RS-485	3 screw terminals	RS-485	Q8304-1 cable		
P3-550	RS-485	3 screw terminals	RS-485	Q8304-1 cable		
P3-550E	RS-485	3 screw terminals	RS-485	Q8304-1 cable		
Other PLC Connectivity			–	–		
D2-250-1	2	HD15	RS-485	D2-DSCBL-2		
D4-450/D4-454	1	DB25	RS-232 to RS-485	FA-ISOCON with Q8304-1 cable		
DL05	2	RJ12	RS-232 to RS-485	FA-ISOCON with Q8304-1 cable		
DL06 + DCM	2	HD15	RS-485	D2-DSCBL-2		
Do-more H2-DM1 + H2-SERIO-4	3	5 screw terminals	RS-485	Q8304-1 cable		
Do-more T1H-DM1	RS-232	RJ12	RS-232 to RS-485	FA-ISOCON with Q8304-1 cable		
P2-SCM	4	4 screw terminals	RS-485	Q8304-1 cable		
P3-SCM	4	4 screw terminals	RS-485	Q8304-1 cable		

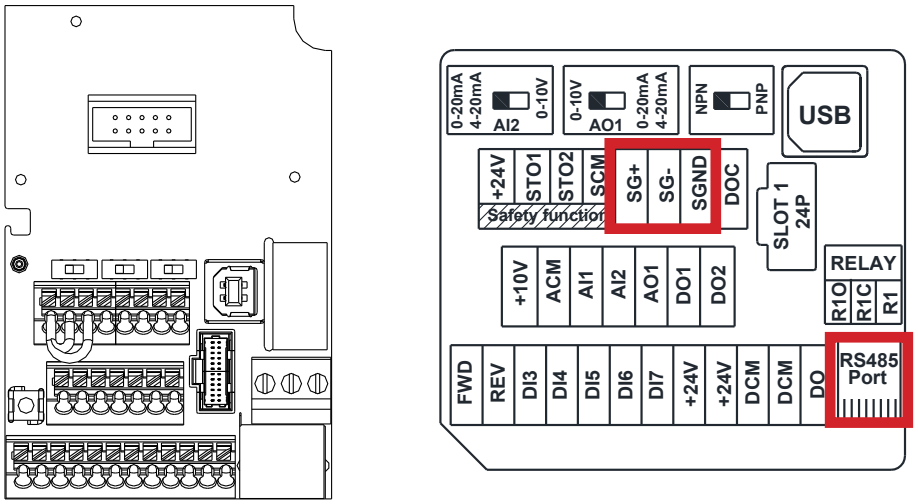
** Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card # GS20A-CM-ENETIP. Refer to "Appendix B: Optional I/O and Communication Cards" for details.*

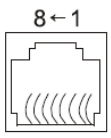
Connecting Communication Cables

A 120 ohm external terminating resistor is required for the drive end. An external termination resistor may be required on the other end of RS-485 network; especially on long runs. Select resistors that match the impedance of the cable (between 100Ω and 500Ω).

The *DURAPULSE* GS20(X) serial communication port is an RS-485 input. Please note that terminals SG+ and SG- are shared with the RJ45 connector. That means the user can use standard RJ45 patch cables or industrial RS-485 cabling to access the comm port. GS20(X) to GS20(X) serial connections can be accomplished with standard Ethernet patch cables (do not use cross-over cables). RS-232 signals can be converted to RS-485 by using a separate converter (see the FA-ISOCON drawings on page 5–12).

DURAPULSE GS20(X) RS-485 Serial Comm Ports





Modbus RS-485
Pin 1, 2, 6: Reserved
Pin 3, 7: SGND
Pin 4: SG-
Pin 5: SG+
Pin 8: +10VS

Note: If using both Modbus connection points (Terminal block and RS-485 Port), ensure you have the same ground reference. Non-equivalent grounding, or grounding from different references, can introduce noise issues that interfere with communications.

Recommended RS-485 cable: Belden 9842, AutomationDirect Q8304-1 series, or equivalent.

RS-232C to RS-485 Conversion

An RS-485 network cable can span up to 1200 meters (4000 feet). However, many AutomationDirect PLCs have only RS-232C communication ports, and require an FA-ISOCON (RS-232C to RS-422/485 network adapter) in order to make an RS-485 connection.

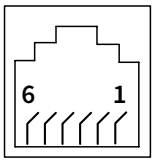
If an FA-ISOCON module is used, set the module dipswitches as required. Refer to the FA-ISOCON manual for more detailed information.

FA-ISOCON Switch Settings:

- *S21–S23: OFF, ON, ON (19200 baud)*
- *S24–S27: OFF (Automatic Network Transmit Enable)*
- *Terminate: ON (end of run term resistors)*
- *Bias (2): ON (end of run bias resistors)*
- *1/2 DPX (2): ON (RS-485 TXD/RXD jumpers)*

Helpful Hint: Some applications require that the FA-ISOCON baud rate is set faster than the drive/network baud rate.

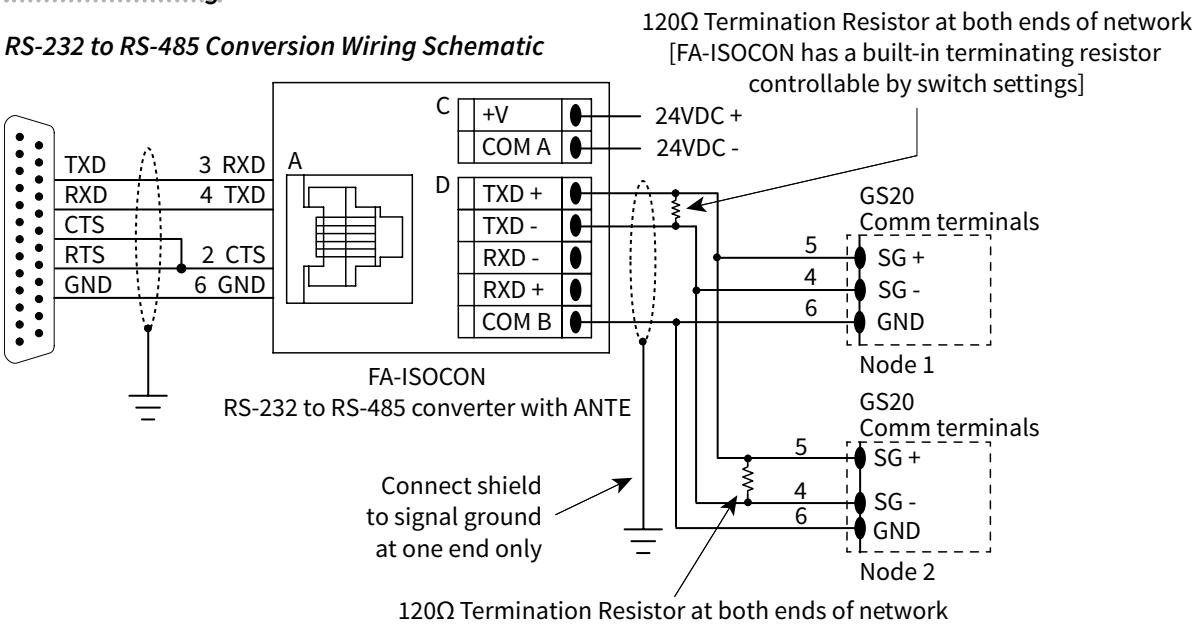
FA-ISOCON RJ-12 Serial Comm Port A
RS-232 Input Port



1: Signal Ground
2: CTS (input)
3: RXD (input)
4: TXD (output)
5: +5VDC in
6: Signal Ground

FA-ISOCON Wiring

RS-232 to RS-485 Conversion Wiring Schematic



For information regarding configuration of AutomationDirect PLCs or other PLCs, please refer to Appendix D of this user manual, or to the applicable PLC user manual for your application.

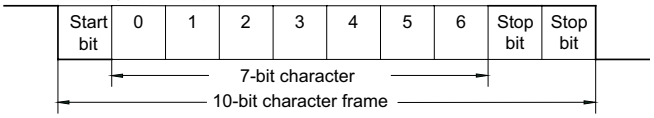
Detailed Serial Modbus Communication Information

The GS20(X) drive follows the standard Modbus RTU and Modbus ASCII protocols. The following pages provide some brief information on this but if your device does not support these protocols natively and you are required to develop this framework on your own, consult the more detailed documentation at http://www.modbus.org.

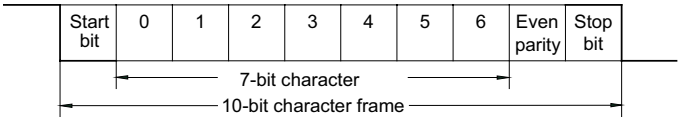
Data Format

ASCII Mode: 10-bit character frame (For 7-bit character):

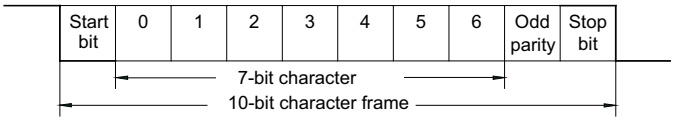
P09.04 = 01 (7 data bits, no parity, 2 stop bits)



P09.04 = 02 (7 data bits, even parity, 1 stop bit)

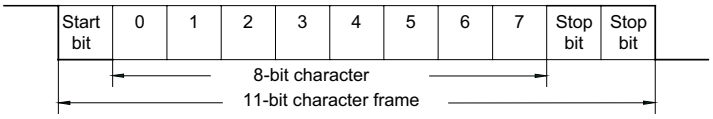


P09.04 = 03 (7 data bits, odd parity, 1 stop bit)

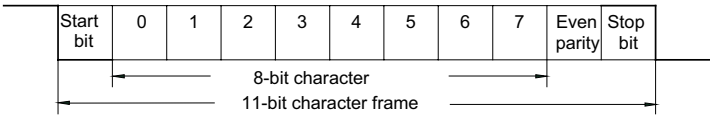


RTU Mode: 11-bit character frame (For 8-bit character):

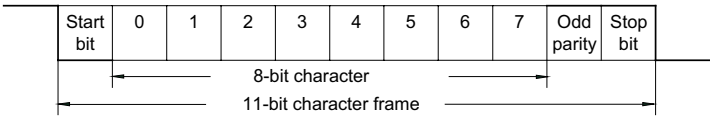
P09.04 = 13 (8 data bits, no parity, 2 stop bits)



P09.04 = 14 (8 data bits, even parity, 1 stop bit)



P09.04 = 15 (8 data bits, odd parity, 1 stop bit)



Communication Protocol

ASCII Mode:

STX	Start Character: (3AH)
ADR 1	Communication Address: 8-bit address consists of 2 ASCII codes
ADR 0	
CMD 1	
CMD 0	
DATA (n-1)	Contents of data: n x 8-bit data consists of 2n ASCII codes. n ≤ 25 maximum of 50 ASCII codes
.....	
DATA 0	
LRC CHK 1	LRC check sum: 8-bit check sum consists of 2 ASCII codes
LRC CHK 0	
END 1	END characters: END 1 = CR (0DH); END 0 = LF (0AH)
END 0	

RTU Mode:

START	A silent interval of more than 10 ms
ADR	Communication Address: 8-bit address
CMD	Command Code: 8-bit command
DATA (n-1)	Contents of data: n x 8-bit data, n ≤ 25
.....	
DATA 0	
CRC CHK Low	CRC check sum: 16-bit check sum consists of 2 8-bit characters
CRC CHK High	
END	A silent interval of more than 10 ms

ADR (Communication Address)

Valid communication addresses are in the range of 0 to 254. A communication address equal to 0 means broadcast to all AC drives, in which case the drives will not acknowledge any message from the master device.

For example, communication to AC drive with address 16 decimal:

- *ASCII mode: (ADR 1, ADR 0)='1','0' => '1'=31H, '0'=30H*
- *RTU mode: (ADR)=10H*

CMD (COMMAND CODE) AND DATA (DATA CHARACTERS)

The format of data characters depends on the command code. The available command codes are described as followed: Command code: 03H, read N words. The maximum value of N is 12. For example, reading continuous 2 words from starting address 2102H of the AC drive with address 01H.

ASCII mode:

Command Message			**Response Message**	
STX	':'		STX ':'	':'
ADR 1 ADR 0	'0' '1'		ADR 1 ADR 0	'0' '1'
CMD 1 CMD 0	'0' '3'		CMD 1 CMD 0	'0' '3'
Starting data address	'2' '1' '0' '2'		Number of data (Count by byte)	'0' '4'
Number of data (Count by word)	'0' '0' '0' '2'		Content of starting data address 2102H	'1' '7' '7' '0'
LRC CHK 1 LRC CHK 0	'D' '7'		Content data address 2103H	'0' '0' '0' '0'
END 1 END 0	CR LF		LRC CHK 1 LRC CHK 0	'7' '1'
			END 1 END 0	CR LF

RTU mode:

Command Message			**Response Message**	
ADR	01H		ADR	01H
CMD	03H		CMD	03H
Starting data address	21H 02H		Number of data (Count by byte)	04H '0'
Number of data (Count by word)	00H 02H		Content of data address 2102H	17H 70H
CRC CHK Low CRC CHK High	6FH F7H		Content of data address 2103H	00H 02H
			CRC CHK Low CRC CHK High	FEH 5CH

Command code: 06H, write 1 word

For example, writing 6000(1770H) to address 0100H of the AC drive with address 01H.

ASCII mode:

Command Message			Response Message	
STX	':'		STX ':'	':'
ADR 1 ADR 0	'0' '1'		ADR 1 ADR 0	'0' '1'
CMD 1 CMD 0	'0' '6'		CMD 1 CMD 0	'0' '6'
Data Address	'0' '1' '0' '0' '1' '7' '7' '0'		Data Address Data Content 	'0' '1' '0' '0' '1' '7' '7' '0'
LRC CHK 1 LRC CHK 0	'7' '1'		LRC CHK 1 LRC CHK 0	'7' '1'
END 1 END 0	CR LF		END 1 END 0	CR LF

RTU mode:

This is an example of using function code 16 for writing to multiple registers.

Command Message			Response Message	
ADR	01H		ADR	01H
CMD	10H		CMD	10H
Starting data address	20H 00H		Starting data address	20H 00H
Number of registers	00H 02H		Number of data (Count by word)	00H 02H
Byte count	04H		CRC CHK Low CRC CHK High	4AH 08H
Content of data address 2000H	00H 02H			
Content of data address 2001H	02H 58H			
CRC CHK Low CRC CHK High	CBH 34H			

NOTE Concerning 2100h: When GS20(X) drive is setup with reference RS-485 (P00.20 = 1 & drive in Remote/Auto) -OR- (P00.30 = 1 & drive in Local/Hand) -AND- Reference > P01.00 Drive Max Out Freq, the GS20(X) drive goes up to Max Out Freq and remains there until Max Out Freq is modified or a lower Freq Ref or a Stop Command is sent to the drive.

CHK (CHECK SUM)

ASCII Mode:

LRC (Longitudinal Redundancy Check) is calculated by summing up module 256, the values of the bytes from ADR1 to last data character, then calculating the hexadecimal representation of the 2's-complement negation of the sum.

For example, reading 1 word from address 0401h of the AC drive with address 01h.

Command Message	
STX	':'
ADR 1 ADR 0	'0' '1'
CMD 1 CMD 0	'0' '3'
Starting data address	'0' '4' '0' '1'
Number of data (Count by word)	'0' '0' '0' '1'
LRC CHK 1 LRC CHK 0	'F' '6'
END 1 END 0	CR LF

01h+03h+04h+01h+00h+01h=0Ah;
the 2's complement negation of 0Ah is F6h.

RTU Mode:

Response Message	
ADR	01h
CMD	03h
Starting data address	21h 02h
Number of data (Count by word)	00h 02h
CRC CHK Low CRC CHK High	6Fh F7h

CRC (Cyclical Redundancy Check) is calculated by the following steps:

10) Load a 16-bit register (called CRC register) with FFFFh.
11) Exclusive OR the first 8-bit byte of the command message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
12) Shift the CRC register one bit to the right with MSB zero filling. Extract and examine the LSB.
13) If the LSB of CRC register is 0, repeat step 3; else Exclusive or the CRC register with the polynomial value A001h.
14) Repeat step 3 and 4 until eight shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
15) Repeat steps 2 to 5 for the next 8-bit byte of the command message.

Continue doing this until all bytes have been processed. The final contents of the CRC register are the CRC value.

When transmitting the CRC value in the message, the upper and lower bytes of the CRC value must be swapped, i.e. the lower order byte will be transmitted first.

The following is an example of CRC generation using C language. The function takes two arguments:

```
Unsigned char* data ← a pointer to the message buffer
Unsigned char length ← the quantity of bytes in the message buffer
    The function returns the CRC value as a type of unsigned integer.
    Unsigned int crc_chk(unsigned char* data, unsigned char length){
        int j;
        unsigned int reg_crc=0xFFFF;
        while(length--){
                reg_crc ^= *data++;
                for(j=0;j<8;j++){
                    if(reg_crc & 0x01){  /* LSB(b0)=1 */
                        reg_crc=(reg_crc>>1) ^ 0xA001;
                }else{
                        reg_crc=reg_crc >>1;
                }
            }
        }
        return reg_crc;
    }
```

RTU mode is preferred. Limited support is available to ASCII users.

Maintenance and Troubleshooting

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Maintenance and Inspections

Modern AC drives are based on solid state electronics technology, including ICs, resistors, capacitors, transistors, cooling fans, relays, etc. These components have a limited life under normal operation. Preventive maintenance is required to operate the GS20(X) drive in its optimal condition, and to ensure a long life. We recommend that a qualified technician perform a regular inspection of the GS20(X) drive. Some items should be checked once a month, and some items should be checked yearly.

NOTE: All inspections should be accomplished with Safety in mind with due and required caution. Some of these Inspection items may require the Drive to be powered down, while others may require power to be applied. Proper safety precautions including the use of PPE are/may be required. Please review cautionary statements in each section

Monthly Inspection

Check the following items at least once a month.

1) *Make sure the motors are operating as expected.*
2) *Make sure the drive installation environment is normal.*
3) *Make sure the enclosure and drive cooling systems are operating as expected.*
4) *Check for irregular vibrations or sounds during operation.*
5) *Make sure the motors are not overheating during operation.*
6) *Check the input voltage to the* GS20(X) *drive and make sure the voltage is within the operating range. Check the voltage with a voltmeter.*

Annual Inspection

Check the following items once annually.

1) *Check the torque of the GS20(X) power and control terminal screws and tighten if necessary. They may loosen due to vibration or changing temperatures.*
2) *Make sure the conductors and insulators are not corroded or damaged.*
3) *Check the resistance of cable insulation with a megohmmeter.*
4) *Clean off any dust and dirt with a vacuum cleaner. Pay special attention to cleaning the ventilation ports and PCBs. Always keep these areas clean. Accumulation of dust and dirt in these areas can cause unforeseen failures.*
5) *Recharge the capacitors of any drive that is in storage or is otherwise unused.*

Recharge Capacitors (for drives not in service)

Recharge the DC link before using any drive that has not been operated within a year:

1) *Disconnect the motor from the drive.*
2) *Apply input power to the drive for 2 hours.*

If the drive is stored or is otherwise unused for more than a year, the drive's internal DC link capacitors should be recharged before use. Otherwise, the capacitors may be damaged when the drive starts to operate. We recommend recharging the capacitors of any unused drive at least once per year.

DISCONNECT AC POWER AND ENSURE THAT THE INTERNAL CAPACITORS HAVE FULLY DISCHARGED BEFORE INSPECTING THE GS20(X) DRIVE! WAIT AT LEAST FIVE MINUTES AFTER ALL DISPLAY LAMPS HAVE TURNED OFF.

CAUTION

☑ Wait 5 seconds after a fault has been cleared before performing reset via keypad or input terminal.
☑ When the power is off after 5 minutes for ≤ 30hp models and 10 minutes for ≥ 40hp models, please confirm that the capacitors have fully discharged by measuring the voltage between + and -. The voltage between + and - should be less than 25VDC.
☑ Only qualified personnel can install, wire and maintain drives. Please take off any metal objects, such as watches and rings, before operation. And only insulated tools are allowed.
☑ Never reassemble internal components or wiring.
☑ Make sure that installation environment complies with regulations without abnormal noise, vibration and smell.

Recommended Inspection Schedules

Before the check-up, always turn off the AC input power and remove the cover. Wait at least 10 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged by measuring the voltage between DC+ and DC-. The voltage between DC+ and DC-should be less than 25VDC.

Ambient environment

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, vibration and see if there are any dust, gas, oil or water drops	Visual inspection and measurement with equipment with standard specification	◯		
If there are any dangerous objects	Visual inspection	◯		

Voltage

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Check if the voltage of main circuit and control circuit is correct	Measure with multimeter with standard specification	◯		

Digital Keypad Display

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Is the display clear for reading	Visual inspection	◯		
Any missing characters	Visual inspection	◯		

Mechanical parts

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual and audible inspection		◯	
If there are any loose screws	Tighten the screws		◯	
If any part is deformed or damaged	Visual inspection		◯	
If there is any color change due to overheating	Visual inspection		◯	
If there is any dust or dirt	Visual inspection		◯	

Recommended Inspection Schedules (continued)

Main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose or missing screws	Tighten or replace the screw	◯		
If any drive or wiring insulation is deformed, cracked, damaged or has changed color due to overheating or aging	Visual inspection **NOTE: Ignore any color change of copper plate**		◯	
If there is any dust or dirt	Visual inspection		◯	

Terminals and wiring of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If the terminal color or the placement has changed due to overheating	Visual inspection		◯	
If the wiring insulation is damaged or there has been a color change	Visual inspection		◯	
If there is any damage	Visual inspection	◯		

DC capacity of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any liquid leaking, color change, crack or deformation	Visual inspection	◯		
If the capacitor safety vent is bulging or inflated.	Visual inspection	◯		
Measure static capacity when required (if drive overloads/faults during normal operation)	Measure with multimeter with standard specification	◯		

Recommended Inspection Schedules (continued)

Resistor of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any peculiar smell or insulation cracks due to overheating	Visual inspection, smell	◯		
If there is any disconnection or discoloration	Visual inspection	◯		
If the connection is damaged	Measure with a multimeter with standard specifications	◯		

Transformer and reactor of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal vibration or peculiar smell	Visual, audible inspection and smell	◯		

Magnetic contactor and relay of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws	Visual and audible inspection	◯		
If the contact works correctly	Visual inspection	◯		

Printed circuit board and connector of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws and connectors	Tighten the screws and press the connectors firmly in place		◯	
If there is any peculiar smell and/or color change	Visual and smell inspection		◯	
If there is any crack, damage, deformation or corrosion	Visual inspection		◯	
If there is any liquid leakage or deformation in capacity	Visual inspection		◯	

Recommended Inspection Schedules (continued)

Cooling fan of cooling system

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual, audible inspection and turn the fan with hand (turn off the power before operation) to see if it rotates smoothly		◯	
If there is any loose screw	Tighten the screw		◯	
If there is any color change due to overheating	Change the fan		◯	

Ventilation channel of cooling system

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any obstruction in the heat sink, air intake or air outlet	Visual inspection		◯	

Please use a clean lint free cloth for cleaning and use a dust cleaner to remove dust when necessary.

Troubleshooting

Warning Codes

The GS20(X) drive has a comprehensive diagnostic system that includes several different warning codes. The most common warning codes can be read on the digital keypad display.

For communication errors, "Upper unit" is referring to the Master controller of the serial network. Always ensure the communication settings of the drive (P09.01 and P09.04) match those of the master controller and network.

Warning Codes					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
n/a	0	No error	n/a	n/a	n/a
CE1	1	Communication error 1 (CE1) RS-485 Modbus illegal function code.	Action Level	When the function code is 03, 06, 10, and 63	1) Check if the communication command is correct 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	"Warning" occurs when P09.02=0 and the motor drive keeps running. The drive resets automatically when receiving the correct function code.	
			Reset condition	Immediately reset	
			Record	N/A	
CE2	2	Communication error 2 (CE2) RS-485 Modbus illegal data address	Action Level	When the input data address is incorrect	1) Check if the communication command is correct. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	"Warning" occurs when P09.02=0 and the motor drive keeps running. The drive resets automatically when receiving the correct data address.	
			Reset condition	Immediately reset	
			Record	N/A	
CE3	3	Communication error 3 (CE3) RS-485 Modbus illegal data value	Action Level	When the length of communication data is too long	1) Check if the communication command is correct. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	"Warning" occurs when P09.02=0 and the motor drive keeps running. The drive resets automatically when receiving the correct communication data value.	
			Reset condition	Immediately reset	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
CE4	4	Communication error 4 (CE4) RS-485 Modbus data is written to read-only address	Action Level	When the data is written to read-only address	1) Check if the communication command is correct 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	"Warning" occurs when P09.02=0 and the motor drive keeps running. The drive resets automatically when receiving the correct written address of communication data.	
			Reset condition	Immediately reset	
			Record	N/A	
CE 10	5	Communication error 10 (CE10) RS-485 Modbus transmission time-out	Action Level	When the communication time exceeds the detection time of P09.03 communication time-out	1) Check if the upper unit transmits the communication command within the setting time for P09.03. 2) Verify the wiring and grounding of the communication circuit. It is recommended to separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
			Action Time	P09.03	
			Warning setting parameter	N/A	
			Reset method	"Warning" occurs when P09.02=0 and the motor drive keeps running. The drive resets automatically when receiving the next communication packet.	
			Reset condition	Immediately reset	
			Record	N/A	
SE 1	7	Save error 1 (SE1) Keypad COPY error 1: Keypad copy time-out	Action Level	"SE1" warning occurs when the GS4-KPD optional keypad does not transmit the COPY command to the drive, and does not transmit any data to the drive again in 10 ms at the time you copy the parameters to the drive.	SE1: The causes of error are mostly communication problems between the keypad and control board. Potential causes include communication signal interference and the unacceptable communication command to the Slave. Check if the error occurs randomly, or only occurs when copying certain parameters (the error displays on the upper right corner of the copy page). If you cannot clear the error, please contact AutomationDirect Technical Support.
			Action Time	10 ms	
			Warning setting parameter	N/A	
			Reset method	Manual reset (or cycle power)	
			Reset condition	Immediately reset	
			Record	N/A	
SE2	8	Save error 2 (SE2) Keypad COPY error 2: parameter writing error	Action Level	"SE2" warning occurs when writing the parameters incorrectly at the time you copy parameters to the drive. For example, you copy the new firmware version with added parameters to the drive with old firmware version.	SE2: In this stage, the copied data has been transmitted to the Slave. The Slave compares and processes the copied data, and then saves the data to the Data ROM. During the process, the data error (should be attribution error) may occur, or the data cannot be saved to EEPROM. At this time, the warning occurs. Check the status of Data ROM and remove the error causes first. If you cannot clear the error, please contact AutomationDirect Technical Support.
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	Manual reset (or cycle power)	
			Reset condition	Immediately reset	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
oHI	9	IGBT over-heating warning (oH1) The AC motor drive detects IGBT overheating and exceeds the protection level of oH1 warning. (When P06.15 is higher than the IGBT overheating protection level, the drive shows oH1 error without displaying oH1 warning.)	Action Level	P06.15	1) Check the ambient temperature. 2) Regularly inspect the ventilation hole of the control cabinet. 3) Change the installed location if there are heating objects, such as braking resistors, in the surroundings. 4) Install/add cooling fan or air conditioner to lower the temperature inside the cabinet. 5) Check for and remove obstructions or replace the cooling fan. 6) Increase ventilation space of the drive. 7) Decrease loading. 8) Decrease the carrier wave. 9) Replace the drive with higher capacity model.
			Action Time	"oH1" warning occurs when IGBT temperature is higher than P06.15 setting value.	
			Warning setting parameter	N/A	
			Reset method	Auto-reset	
			Reset condition	The drive auto-resets when IGBT temperature is lower than oH1 warning level minus (–) 5°C	
			Record	N/A	
PId	11	PID feedback error (PID) PID feedback loss (warning for analog feedback signal; works only when PID enables)	Action Level	When the analog input is lower than 4 mA (only detects analog input 4–20 mA)	1) Check the PID feedback wiring and tighten the terminals. 2) Replace the cable. 3) Replace the feedback device. 4) If the PID error still occurs after checking all the wiring, contact AutomationDirect Technical Support.
			Action Time	P08.08	
			Warning setting parameter	P08.09 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: Warn and operate at last frequency	
			Reset method	1) Auto: "Warning" occurs when P08.09=0 or 3. The "Warning" automatically clears when the feedback signal is larger than 4 mA. 2) Manual: "Error" occurs when P08.09=1 or 2. You must reset manually.	
			Reset condition	Immediately reset	
			Record	Records when P08.09=1 or 2 ("Error"). Does not record when P08.09=3 ("Warning").	

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Warning Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**	**Corrective Action**
AnL	12	AI2 analog signal loss (AnL) Analog input current loss (including all analog 4–20 mA signals)	Action Level: When the analog input is lower than 4 mA (only detects analog input 4–20 mA) Action Time: Immediately act Warning setting parameter: P03.19 setting is: 0: Disable 1: Continue operation at the last frequency (warning, keypad displays ANL) 2: Decelerate to 0 Hz (warning, keypad displays ANL) 3: Stop immediately and display "ACE" Reset method: 1) Auto: "Warning" occurs when P03.19=1 or 2. The "Warning" automatically clears when the feedback signal is larger than 4 mA. 2) Manual: "Error" occurs when P03.19=3. You must reset manually. Reset condition: Immediately reset Record: Does not record when P03.19=1 or 2 ("Warning").	1) Check the AI2 wiring and tighten the terminals. 2) Replace the cable. 3) Replace the external device. 4) If the AnL error still occurs after checking all the wiring, contact AutomationDirect Technical Support.
uC	13	Under current (uC) Low current	Action Level: P06.71 Action Time: P06.72 Warning setting parameter: P06.73 setting is: 0: No function 1: Fault and coast to stop 2: Fault and ramp to stop by the 2nd deceleration time 3: Warn and continue operation Reset method: 1) Auto: "Warning" occurs when P06.73=3. The "Warning" automatically clears when the output current is larger than (P06.71+0.1 A). 2) Manual: "Error" occurs when P06.73=1 or 2. You must reset manually. Reset condition: Immediately reset Record: Does not record when P06.73=3 and uC displays ("Warning").	1) Check for a broken motor cable, then exclude the connection issue of the motor and its load. 2) Verify low current protection settings. If needed, set the proper settings for P06.71, P06.72 and P06.73. 3) Check the loading status and make sure the loading matches the motor capacity.
oSPd	17	Over speed warning (oSPd) Over speed warning	Action Level: The encoder feedback speed > P10.10 Action Time: P10.11 Warning setting parameter: P10.12=0 0: Warn and continue operation Reset method: "Warning" automatically clears when the drive stops Reset condition: "Warning" automatically clears when the drive stops Record: N/A	1) Verify setting of P10.25. Decrease value if needed. 2) Verify bandwidth setting for ASR speed control and increase the bandwidth setting if needed. 3) Reset motor parameter and run parameter tuning. 4) Verify the wiring of the control circuit, and the wiring/grounding of the main circuit to prevent interference.

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
dAvE	18	Deviation Warning (dAvE) Over speed deviation warning	Action Level	P10.13	1) Verify parameter setting for slip error and reset value for P10.13 and P10.14 if needed. 2) Reset ASR parameters and set proper accel./ decel. time. 3) Verify motor status and remove any causes if the motor is locked. 4) Check status of the mechanical brake and verify the action timing of the system if the brake is not released. 5) Verify torque limit and adjust parameters P06.12 and P11.17-P11.20 as needed. 6) Verify the wiring of the control circuit, and the wiring/grounding of the main circuit to prevent interference.
			Action Time	P10.14	
			Warning setting parameter	P10.15 Encoder Stall and Slip Error Action =0 0: Warn and continue operation	
			Reset method	"Warning" automatically clears when the drive stops	
			Reset condition	After the drive stops	
			Record	N/A	
PHL	19	Phase loss (PHL) Input phase loss warning	Action Level	One of the phases outputs less than P06.47	1) Verify the wiring of the main circuit. 2) Verify a single-phase power input is not being used on a three-phase model. Use the model with voltage that matches the power. 3) If the power of main circuit works well, check if the MC of the main circuit is broken. Cycle the power after verifying the power is normal. If PHL still occurs, contact AutomationDirect Technical Support. 4) Tighten the terminal screws with the torque listed in the user manual. 5) Verify the input cable is not broken. Make sure the wiring is correct. Replace the broken part of the cable if needed. 6) Verify the three-phase power is not unbalanced.
			Action Time	P06.46	
			Warning setting parameter	P06.45 Output Phase Loss Detection Action (OPHL) =0 0: Warn and continue operation	
			Reset method	"Warning" automatically clears when the drive stops	
			Reset condition	After the drive stops	
			Record	N/A	

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Warning Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**	**Corrective Action**
oL 1	20	Over-torque 1 (ot1) Over-torque 1 warning	Action Level: P06.07 Action Time: P06.08 Warning setting parameter: P06.06 Over-torque Detection Selection (Motor 1) =1 or 3 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN Reset method: When the output current < P06.07, the ot1 warning automatically clears Reset condition: When the output current < P06.07, the ot1 warning automatically clears Record: N/A	1) Configure the settings for P06.07 and P06.08 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 1, P01.01–P01.08), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.26 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
oL2	21	Over-torque (ot2) Over-torque 2 warning	Action Level	P06.10	1) Configure the settings for P06.10 and P06.11 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 2, P01.35–P01.42), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.71 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.
			Action Time	P06.11	
			Warning setting parameter	P06.09 Over-torque Detection Selection (Motor 2) =1 or 3 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	
			Reset method	When the output current < P06.10, the ot2 warning automatically clears	
			Reset condition	When the output current < P06.10, the ot2 warning automatically clears	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
oH3	22_1	Motor over-heating (oH3) PTC Motor overheating warning. The AC motor drive detects the temperature inside the motor is too high	Action Level	P03.00=6 (PTC), PTC input level > P06.30 PTC level (default=50%)	1) Check if motor is locked and clear the motor lock status. 2) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 3) Verify ambient temperature and change the installed location if there are heating devices in the surroundings, or install/add cooling fan or air conditioner to lower the ambient temperature. 4) Check the cooling system and ensure it's working normally. 5) Verify the motor fan is working and replace the fan if needed. 6) Verify duration of low speed operation. Decrease low-speed operation time. Change to dedicated motor for the drive. Increase the motor capacity. 7) Verify accel/decel time and increase setting values for P01.12–P01.19 (accel./ decel. time) if working cycle is too short. 8) Verify V/F voltage and adjust settings for P01.01–P01.08 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 9) Verify the motor rated current matches the motor nameplate and configure the correct rated current value of the motor if needed. 10) Check the connection between PTC thermistor and the heat protection. 11) Verify stall prevention setting and set the stall prevention to the proper value if needed. 12) Check for unbalanced three-phase motor impedance. Replace the motor if needed. 13) Verify harmonics and reduce harmonics if too high.
			Action Time	Immediately act	
			Warning setting parameter	Error treatment: P06.29 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning When P06.29=0 and when the temperature is ≤ P06.30 level, the oH3 warning automatically clears. When P06.29=0 ("Warning"), it automatically resets.	
			Reset method	When P06.29=0, oH3 displays as "Warning". When the temperature is ≤ P06.30 level, the oH3 warning automatically clears.	
			Reset condition	When the temperature is ≤ P06.30 level, the oH3 warning automatically clears.	
			Record	N/A	
oSL	24	Over slip warning (oSL) Over slip warning. By using the maximum slip (P10.29) as the base, when the drive outputs at constant speed, and the F>H or F<H exceeds P07.29 level and P.07.30 setting time, 100% P07.29 = P10.29.	Action Level	When the drive outputs at constant speed, and F>H or F<H exceeds the P07.29 level	1) Check the motor parameter. 2) Verify load and decrease the loading if needed. 3) Verify the parameter settings for oSL protection (P07.29, P07.30, and P10.29) are correctly set.
			Action Time	P07.30	
			Warning setting parameter	P07.31=0 Warning 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning	
			Reset method	When P07.31=0 and when the drive outputs at constant speed, and F>H or F<H no longer exceeds the P07.29 level, the oSL warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
tUn	25	Auto tuning (tUn) Parameter auto-tuning is processing. When running auto-tuning, the keypad displays "tUn".	Action Level	When running P05.00 motor parameter auto-tuning, the keypad displays "tUn".	When the auto-tuning is finished, the warning automatically clears.
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	When auto-tuning is finished and no error occurs, the warning automatically clears.	
			Reset condition	When auto-tuning is finished and no error occurs.	
			Record	N/A	
oPHL	28	Output phase loss (oPHL) Output phase loss of the drive	Action Level	P06.47	1) Check for unbalanced three-phase motor impedance and replace the motor if needed. 2) Check the cable and replace if needed. 3) Ensure a three-phase motor is being used. 4) Check if the control board cable is loose. If yes, reconnect the cable and run the drive to test. If the error still occurs, contact AutomationDirect Technical Support. 5) Check if the three-phase current is balanced with a current clamp meter. If the current is balanced and the oPHL error still shows on the display, contact AutomationDirect Technical Support. 6) Verify the drive's capacity matches or exceeds the motor's.
			Action Time	N/A	
			Warning setting parameter	P06.45 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning	
			Reset method	If P06.45 is set to 0, the oPHL warning automatically clears after the drive stops.	
			Reset condition	N/A	
			Record	N/A	
SE3	30	Copy model error 3 (SE3) Keypad COPY error 3: copy model error	Action Level	"SE3" warning occurs when different drive identity codes are found during copying parameters.	It is mainly to prevent parameter copies between different HP/models.
			Action Time	Immediately act when the error is detected	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
oL3	31	Over-torque (ot3) Over-torque 3 warning	Action Level	P14.75	1) Configure the settings for P14.75 and P14.76 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 3, P01.54–P01.61), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.73 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.
			Action Time	P14.76	
			Warning setting parameter	P14.74 Over-torque Detection Selection (Motor 3) =1 or 3 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	
			Reset method	When the output current < P14.75, the ot3 warning automatically clears	
			Reset condition	When the output current < P14.75, the ot3 warning automatically clears	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
oL4	32	Over-torque (ot4) Over-torque 4 warning	Action Level	P14.78	1) Configure the settings for P14.78 and P14.79 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 3, P01.63–P01.70), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.75 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.
			Action Time	P14.79	
			Warning setting parameter	P14.77 Over-torque Detection Selection (Motor 4) =1 or 3 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN	
			Reset method	When the output current < P14.78, the ot4 warning automatically clears	
			Reset condition	When the output current < P14.79, the ot4 warning automatically clears	
			Record	N/A	
PLod	50	PLC opposite defect (PLod) PLC download error warning	Action Level	During PLC downloading, the program source code detects incorrect address (e.g. the address exceeds the range), then the PLod warning occurs.	Verify the data number used when downloading the PLC program and use the correct data number.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	N/A	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLSu	51	PLC save memory error (PLSv) Data error during PLC operation	Action Level	The program detects incorrect written address (e.g. the address exceeds the range) during PLC operation, then the PLSv warning occurs.	Make sure the written address is correct and download the program again.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	N/A	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
PLdA	52	Data defect (PLdA) Data error during PLC operation	Action Level	The program detects incorrect written address when translating the program source code (e.g. the address exceeds the range) during PLC downloading, then PLdA warning occurs.	Check if the upper unit transmits the correct command.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	N/A	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLFn	53	Function defect (PLFn) PLC download function code error	Action Level	The program detects incorrect command (unsupported command) during PLC downloading, then PLFn warning occurs.	Check the drive firmware and if not the latest version, download and install the latest version from the ADC support website
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	N/A	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLor	54	PLC buffer overflow (PLor) PLC register overflow	Action Level	When PLC runs the last command and the command exceeds the maximum capacity of the program, then PLor warning occurs.	Follow the steps below to reset the PLC software: 1) Disable PLC 2) Reset the PLC program (P00.02=6) 3) Enable PLC 4) Re-download the PLC program
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	N/A	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
PLFF	55	Function defect (PLFF) Function code error during PLC operation	Action Level	The program detects incorrect command (unsupported command) during PLC operation, then PLFF warning occurs.	When starting the PLC function and there is no program in the PLC, the PLFF warning occurs. This is a normal warning, please download the program.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLSn	56	Checksum error (PLSn) PLC checksum error	Action Level	PLC checksum error is detected after the drive is powered on, then PLSn warning occurs.	Follow the steps below to reset the PLC software: 1) Disable PLC 2) Reset the PLC program (P00.02=6) 3) Enable PLC 4) Re-download the PLC program
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLEd	57	No end command (PLEd) PLC end command is missing	Action Level	The "End" command is missing. Until the last command is executed, the PLEd warning occurs.	Follow the steps below to reset the PLC software: 1) Disable PLC 2) Reset the PLC program (P00.02=6) 3) Enable PLC 4) Re-download the PLC program
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLCr	58	PLC MCR error (PLCr) PLC MCR command error	Action Level	The MC command is detected during PLC operation, but there is no corresponding MCR command, then the PLCr warning occurs.	The MC command cannot be used continuously for 9 times. Check and reset the program, then re-download the program.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check if the program is correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
PLdF	59	PLC download fail (PLdF) PLC download failure	Action Level	PLC download failure due to momentary power loss during download. After the power is again present, the PLdF warning occurs.	Check for programming errors, if they exist, correct and download the program again.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check for programming errors, if they exist, correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
PLSF	60	PLC scan time fail (PLSF) PLC scan time exceeds the maximum allowable time	Action Level	When the PLC scan time exceeds the maximum allowable time (400 ms), the PLSF warning occurs.	Check for Source Code errors, if they exist, correct and download the program again.
			Action Time	Immediately act when the fault is detected	
			Warning setting parameter	NA	
			Reset method	Check for programming errors, if they exist, correct and download the program again. If the fault does not exist, the warning automatically clears.	
			Reset condition	N/A	
			Record	N/A	
ECLv	71	ExCom power loss (ECLv) Low voltage of the communication card	Action Level	The 5V power that the drive provides to the communication card is too low	1) Make sure the communication card is well inserted and not loose. 2) Use the same communication card with another GS20 drive to check if the ECLv warning still occurs. If yes, replace with a new communication card; if not, replace the drive. 3) Use another communication card to test if the ECLv warning still occurs on the same drive. If not, replace the card; if yes, replace the drive.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Cycle the power	
			Reset condition	N/A	
			Record	N/A	
ECtt	72	ExCom test mode (ECtt) The communication card is in the test mode	Action Level	The communication card is in the test mode	Cycle the power
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Cycle the power and enter the normal mode	
			Reset condition	N/A	
			Record	N/A	
ECFF	75	ExCom factory defect (ECFF) Factory default setting error	Action Level	Factory default setting error	Use GSoft2 to download a new parameter set into the drive.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Cycle the power	
			Reset condition	N/A	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
EC iF	76	ExCom inner error (ECiF) Serious internal error	Action Level	Internal memory saving error	1) Verify the wiring of the control circuit, and the wiring/grounding of the main circuit to prevent interference. 2) Cycle the power. 3) Reset to the default value and check if the error still exists. If yes, replace the communication card.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Cycle the power	
			Reset condition	N/A	
			Record	N/A	
ECEF	80	Ethernet link fail (ECEF) The Ethernet cable is not connected	Action Level	Hardware detection	1) Re-connect the cable 2) Replace the cable
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	N/A	
			Record	N/A	
ECCS	82	Checksum error (ECCS) Checksum error for the communication card and the drive	Action Level	Software detection	Verify the wiring of the control circuit, and the wiring/grounding of the main circuit to prevent interference.
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Immediately reset	
			Record	N/A	
ECrF	83	Return defect (ECrF) Communication card returns to the default setting	Action Level	Communication card returns to the default setting	No actions required.
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Immediately reset	
			Record	N/A	
ECo0	84	Modbus TCP over (ECo0) Modbus TCP exceeds the maximum communication value	Action Level	Hardware detection	1) Verify the Master communication value does not exceed the allowable number of communication cards. If it does, decrease the Master communication value. 2) Check if the connection is occupied due to not disconnecting the Modbus TCP while the upper unit is connected without communicating. If it is, revise the program of the upper unit to disconnect the connection while the communication is not used for a long time. 3) Check if a new Modbus TCP connection is built whenever the upper unit is connected to the communication card. If so, revise the program of the upper unit to use the same Modbus TCP connection when connecting to the same communication card.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Immediately reset	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
ECo1	85	EtherNet/IP over (ECo1) EtherNet/IP exceeds the maximum communication value	Action Level	Hardware detection	1) Verify the Master communication value does not exceed the allowable number of communication cards. If it does, decrease the Master communication value. 2) Check if the connection is occupied due to not disconnecting the Modbus TCP while the upper unit is connected without communicating. If it is, revise the program of the upper unit to disconnect the connection while the communication is not used for a long time. 3) Check if a new Modbus TCP connection is built whenever the upper unit is connected to the communication card. If so, revise the program of the upper unit to use the same Modbus TCP connection when connecting to the same communication card.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Immediately reset	
			Record	N/A	
EC iP	86	IP fail (ECiP) IP setting error	Action Level	Software detection	1) Reset IP 2) Contact MIS to check if DHCP Server works normally
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Immediately reset	
			Record	N/A	
ECbY	88	ExCom busy (ECbY) Communication card busy: too many packets are received	Action Level	Software detection	Decrease communication packets
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	N/A	
			Record	N/A	
ECCb	89	ExCom card break (ECCb) Communication card break off warning	Action Level	Communication card break off	Re-install the communication card
			Action Time	N/A	
			Warning setting parameter	N/A	
			Reset method	Auto-resets after the communication card is re-installed	
			Reset condition	Immediately reset	
			Record	N/A	
CPLP	90	Copy PLC: password error (CPLP) Copy PLC password error. When PLC copy is processing and the PLC password is incorrect, the CPLP warning occurs.	Action Level	PLC password is incorrect	Reset and enter the correct PLC password
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
CPL0	91	Copy PLC: Read mode error (CPL0) Copy PLC read mode error	Action Level	Incorrect process when copying the PLC read mode	Cycle the power and copy the PLC read mode again
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	

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Warning Codes (continued)					
Display on GS20(X) Keypad	**ID No.**	**Warning Name and Description**	**Action and Reset**		**Corrective Action**
CPL1	92	Copy PLC: Write mode (CPL1) Copy PLC write mode error	Action Level	Incorrect process when copying the PLC write mode	Cycle the power and copy the PLC write mode again
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
CPLu	93	Copy PLC: version error (CPLv) Copy PLC version error. When a non-GS20(X) built-in PLC is copied to the GS20(X) drive, the CPLv warning occurs.	Action Level	Software detection	Check if the copied PLC program is for GS20(X). If not, use the correct GS20(X) PLC program.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
CPLS	94	Copy PLC: size error (CPLS) Copy PLC capacity error	Action Level	Software detection	Check if the copied PLC program is for GS20(X). Use the correct capacity for the GS20(X) PLC program.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
CPLF	95	Copy PLC: PLC function (CPLF) Copy PLC function must be executed when PLC is disabled.	Action Level	Software detection	Disable the PLC function first, and then run the PLC copy function again.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
CPLt	96	Copy PLC: time-out (CPLt) Copy PLC time-out	Action Level	Software detection	The GS20-KPD cannot be removed during the PLC copy process
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Manual reset	
			Reset condition	Directly reset	
			Record	N/A	
ictn	101	InrCOM time-out (ictn) Internal communication time-out	Action Level	When P09.31= (-1) – (-10) (no -9) and the internal communication between Master and Slave is abnormal, the ictn warning occurs.	1) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 2) Check if the setting for P09.04 is the same as the setting for the upper unit 3) Check the cable and replace it if necessary.
			Action Time	Immediately act	
			Warning setting parameter	N/A	
			Reset method	Auto-reset	
			Reset condition	The warning automatically clears when the communication is back to normal condition	
			Record	N/A	

Fault Codes

The GS20(X) drive has a comprehensive fault diagnostic system that include a variety of fault messages. When a fault is detected, the GS20(X) drive will shut down in order to protect internal components. The following faults are displayed as shown on the GS20(X) digital keypad display.

For communication errors, "Upper unit" is referring to the Master controller of the serial network. Always ensure the communication settings of the drive (P09.01 and P09.04) match those of the master controller and network.

Gaps in the fault ID numbers below are set aside as "reserved" faults for possible future use. Should your GS20(X) drive repeatedly display a reserved fault, please note the fault ID number and contact AutomationDirect technical support.

Fault Codes				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ocA	1	Over-current during acceleration (ocA) Output current exceeds three times of the rated current during acceleration. When ocA occurs, the drive closes the gate of the output immediately, the motor runs freely, and the display shows an ocA error.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Check acceleration time. If too short: a) Increase the acceleration time b) Increase the acceleration time of S-curve c) Set auto-acceleration and auto-deceleration parameter (P01.44) d) Set over-current stall prevention function (P06.03) e) Replace the drive with a larger capacity model. 2) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 3) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 4) Check if the output current during the whole working process exceeds the AC motor drive's rated current. If yes, replace the AC motor drive with a larger capacity model. 5) Reduce the load or increase the capacity of AC motor drive. 6) Check the motor capacity (the rated current on the motor's nameplate should ≤ the rated current of the drive). 7) Check the action timing of the contactor and make sure it is not turned ON/OFF when the drive outputs the voltage. 8) Adjust the V/F curve setting and frequency/voltage. When the fault occurs, and the frequency voltage is too high, reduce the voltage. 9) Adjust the torque compensation (refer to P07.26 torque compensation gain) until the output current reduces and the motor does not stall. 10) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 11) Enable speed tracking during start-up of P07.12. 12) Correct the parameter settings for speed tracking. a) Start the speed tracking function. b) Adjust the maximum current for P07.09 speed tracking. 13) Check the settings for P00.11 control mode: a) For IM, P00.11=0, 1, 2, 5 b) For PM, P00.11=2 14) Increase the AC motor drive's capacity. 15) Install AC reactor(s) on the output side (U/V/W).

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ocA	1	ocA (continued)	Corrective Actions (cont'd)	16) In the case of hardware failure, the ocA occurs due to the short circuit or ground fault at the output side of the drive. a) Check for possible short circuits between terminals with the electric meter: b) B1 corresponds to U, V and W; DC- corresponds to U, V and W; corresponds to U, V and W. c) If short circuit occurs, contact AutomationDirect Technical Support. 17) Check the stall prevention setting and set the stall prevention to the proper value.
ocd	2	Over-current during deceleration (ocd) Output current exceeds three times of the rated current during deceleration. When ocd occurs, the drive closes the gate of the output immediately, the motor runs freely, and the display shows an ocd error.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Check if the deceleration time is too short. If so: a) Increase the deceleration time b) Increase the deceleration time of S-curve c) Set auto-acceleration and auto-deceleration parameter (P01.44) d) Set over-current stall prevention function (P06.03) e) Replace the drive with a larger capacity model 2) Check if the mechanical brake of the motor activates too early. 3) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 4) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 5) Check if the output current during the whole working process exceeds the AC motor drive's rated current. If yes, replace the AC motor drive with a larger capacity model. 6) Check the impulsive change of the load and reduce the load or increase the capacity of AC motor drive as needed. 7) Verify the motor capacity, the rated current on the motor's nameplate should ≤ the rated current of the drive. 8) If using an ON/OFF controller at the (U/V/W) drive output, check the action timing of the contactor and make sure it is not turned ON/OFF when the drive outputs the voltage. 9) Adjust the V/F curve settings and frequency/voltage. When the fault occurs, and the frequency voltage is too high, reduce the voltage. 10) Adjust the P07.26 torque compensation gain until the output current reduces and the motor does not stall. 11) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 12) Check the length of the motor cable. If it is too long, increase the AC motor drive's capacity or install AC reactor(s) on the output side (U/V/W). 13) In the case of a hardware error, the ocd occurs due to the short circuit or ground fault at the output side of the drive. a) Check for possible short circuits between terminals with the electric meter: b) B1 corresponds to U, V and W; DC- corresponds to U, V and W; corresponds to U, V and W. c) If short circuits occurs, contact AutomationDirect Technical Support. 14) Verify the stall prevention setting and set the stall prevention to the proper value.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ocn	3	Over-current during steady operation (ocn) Output current exceeds three times of the rated current during constant speed. When ocn occurs, the drive closes the gate of the output immediately, the motor runs freely, and the display shows an ocn error.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 2) Check for possible shaft lock, burnout or aging insulation of the motor. a) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 3) Check for impulsive change of the load, and reduce the load or increase the capacity of AC motor drive. 4) Check motor capacity (the rated current on the motor's nameplate should ≤ the rated current of the drive) 5) If using an ON/OFF controller at the drive output, check the action timing of the contactor and make sure it is not turned ON/OFF when the drive outputs the voltage. 6) Adjust the V/F curve settings and frequency/voltage. When the fault occurs, and the frequency voltage is too high, reduce the voltage. 7) Adjust P07.26 torque compensation gain until the output current reduces and the motor does not stall. 8) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 9) Check the length of the motor cable. If too long: a) Increase the AC motor drive's capacity. b) Install AC reactor(s) on the output side (U/V/W). 10) In the case of hardware failure, the ocn may occur due to a short circuit or ground fault at the output side of the drive. a) Check for possible short circuit between terminals with the electric meter: b) B1 corresponds to U, V and W; DC- corresponds to U, V, and W; corresponds to U, V, and W. c) If short circuits occurs, contact AutomationDirect Technical Support.
GFF	4	Ground fault (GFF) When the drive detects grounding short circuit on the output terminals (U/V/W), the drive closes the gate of the output immediately, the motor runs freely, and the display shows a GFF error.	Action Level	N/A
			Action Time	N/A
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Check for motor burnout or aging insulation. a) Check the motor insulation value with megger. b) Replace the motor if the insulation is poor. 2) Check the cable for short circuits and replace the cable if needed. 3) If the motor cable length exceeds 100 m, decrease the setting value for the carrier frequency and take remedies to reduce stray capacitance. 4) Verify the grounding and wiring of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 5) Cycle the power after checking the status of motor, cable, and cable length. If GFF still exists, contact AutomationDirect Technical Support. 6) Refer to the corrective actions for ocn. 7) Refer to the corrective actions for ocA. 8) Refer to the corrective actions for ocd.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oc5	6	Over-current at stop (ocS) Over-current or hardware failure in current detection at stop. Cycle the power after ocS occurs. If the hardware failure occurs, the display shows cd1, cd2 or cd3.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 2) Check if other error codes such as cd1–cd3 occur after cycling the power. If yes, return to the factory for repair.
ouA	7	Over-voltage during acceleration (ovA) DC bus over-voltage during acceleration. When ovA occurs, the drive closes the gate of the output, the motor runs freely, and the display shows an ovA error.	Action Level	120V/230V series: 410VDC 460V series: 820VDC 575V series: 1116VDC
			Action Time	Immediately act when the DC bus voltage is higher than the level
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset only when the DC bus voltage is lower than 90% of the over-voltage level
			Record	Yes
			Corrective Actions	1) Check acceleration. If too slow: a) Decrease the acceleration time b) Use a braking unit or DC bus c) Replace the drive with a larger capacity model. 2) Check the setting for stall prevention level. If the value is lower than no-load current, adjust it to be higher than no-load current. 3) Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. 4) If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. 5) Check for regenerative voltage of motor inertia. If regenerative voltage is being generated: a) Use over-voltage stall prevention function (P06.01) b) Use auto-acceleration and auto-deceleration setting (P01.44) c) Use a braking unit or DC bus 6) Check if the over-voltage Fault occurs after acceleration stops, which indicates acceleration time is too short. Do the following: a) Increase the acceleration time b) Set P06.01 over-voltage stall prevention c) Increase the setting value for P01.25 S-curve acceleration arrival time 2 7) The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is a ground fault on the motor cable, wiring box, or its internal terminals. 8) If using a braking resistor or brake unit, check the wiring. 9) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oud	8	Over-voltage during deceleration (ovd) DC bus over-voltage during deceleration. When ovd occurs, the drive closes the gate of the output immediately, the motor runs freely, and the display shows an ovd error.	Action Level	120V/230V series: 410VDC 460V series: 820VDC 575V series: 1116VDC
			Action Time	Immediately act when the DC bus voltage is higher than the level
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset only when the DC bus voltage is lower than 90% of the over-voltage level
			Record	Yes
			Corrective Actions	1) Deceleration time may be too short, resulting in too much regenerative energy. a) Increase the setting value of P01.13, P01.15, P01.17 and P01.19 (deceleration time) b) Connect a braking resistor, braking unit or DC bus on the drive. c) Reduce the braking frequency. d) Replace the drive with a larger capacity model. e) Use S-curve acceleration/deceleration. f) Use over-voltage stall prevention (P06.01). g) Use auto-acceleration and auto-deceleration (P01.44). h) Adjust the braking level (P07.01 or the bolt position of the braking unit). 2) Verify that the setting for stall prevention level is larger than no-load current 3) Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. 4) If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. 5) The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box, or its internal terminals. 6) If using a braking resistor or braking unit, check the wiring. 7) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.
ovn	9	Over-voltage during constant speed (ovn) DC bus over-voltage at constant speed. When ovn occurs, the drive closes the gate of the output immediately, the motor runs freely, and the display shows an ovn error.	Action Level	120V/230V series: 410VDC 460V series: 820VDC 575V series: 1116VDC
			Action Time	Immediately act when the DC bus voltage is higher than the level
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset only when the DC bus voltage is lower than 90% of the over-voltage level
			Record	Yes
			Corrective Actions	1) Check for impulsive change of the load, then do the following: a) Connect a brake resistor, braking unit or DC bus to the drive. b) Reduce the load. c) Replace the drive with a larger capacity model. d) Adjust the braking level (P07.01 or bolt position of the brake unit). 2) Verify the stall prevention level setting is higher than no-load current. 3) Check for regenerative voltage, then enable over-voltage stall prevention function (P06.01) or use a braking unit or DC bus 4) Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. 5) If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. 6) The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box, or its internal terminals. 7) If using a braking resistor or braking unit, check the wiring. 8) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ouS	10	Over-voltage at stop (ovS) Over-voltage at stop	Action Level	120V/230V series: 410VDC 460V series: 820VDC 575V series: 1116VDC
			Action Time	Immediately act when the DC bus voltage is higher than the level
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset only when the DC bus voltage is lower than 90% of the over-voltage level
			Record	Yes
			Corrective Actions	1) Check if the input voltage is within the rated AC motor drive input voltage range, and check for possible voltage spikes. 2) If the phase-in capacitor or active power supply unit acts in the same power system, the input voltage may surge abnormally in a short time. In this case, install an AC reactor. 3) The ground short circuit current charges the capacitor in the main circuit through the power. Check if there is ground fault on the motor cable, wiring box, or its internal terminals. 4) If using a braking resistor or braking unit, check the wiring. 5) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 6) Check if other error codes such as cd1–cd3 occur after cycling the power. If yes, contact AutomationDirect Technical Support.
LuA	11	Low-voltage during acceleration (LvA) DC bus voltage is lower than P06.00 setting value during acceleration	Action Level	P06.00 (120V/230V series = 180VDC 460V series = 360VDC 575V series = 450VDC)
			Action Time	Immediately act when the DC bus voltage is lower than P06.00
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset when the DC bus voltage is higher than P06.00 + 30 V
			Record	Yes
			Corrective Actions	1) Improve power supply condition. 2) Adjust voltage to the power range of the drive 3) Check the power system and increase the capacity of power equipment if needed. 4) The load may be too heavy. If so: a) Reduce the load. b) Increase the drive capacity. c) Increase the acceleration time. 5) Check the DC bus and install DC reactor(s). 6) Check for a short circuit plate or DC reactor installed between terminal +1 and +2. Connect short circuit plate or DC reactor between terminal +1 and +2. 7) If the error still exists, contact AutomationDirect Technical Support.
Lud	12	Low-voltage during deceleration (Lvd) DC bus voltage is lower than P06.00 setting value during deceleration	Action Level	P06.00 (120V/230V series = 180VDC 460V series = 360VDC 575V series = 450VDC)
			Action Time	Immediately act when the DC bus voltage is lower than P06.00
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset when the DC bus voltage is higher than P06.00 + 30 V
			Record	Yes
			Corrective Actions	1) Improve power supply condition. 2) Adjust voltage to the power range of the drive 3) Check the power system and increase the capacity of power equipment if needed. 4) The fault may be triggered by sudden load. If so: a) Reduce the load. b) Increase the drive capacity. 5) Check the DC bus and install DC reactor(s).

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
Lun	13	Low-voltage at constant speed (Lvn) DC bus voltage is lower than P06.00 setting value at constant speed	Action Level	P06.00 (120V/230V series = 180VDC 460V series = 360VDC 575V series = 450VDC)
			Action Time	Immediately act when the DC bus voltage is lower than P06.00
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset when the DC bus voltage is higher than P06.00 + 30 V
			Record	Yes
			Corrective Actions	1) Improve power supply condition. 2) Adjust voltage to the power range of the drive 3) Check the power system and increase the capacity of power equipment if needed. 4) The fault may be triggered by sudden load. If so: a) Reduce the load. b) Increase the drive capacity. 5) Check the DC bus and install DC reactor(s).
LuS	14	Low-voltage at stop (LvS) DC bus voltage is lower than P06.00 setting value at stop or a hardware failure in voltage detection had occurred.	Action Level	P06.00 (120V/230V series = 180VDC 460V series = 360VDC 575V series = 450VDC)
			Action Time	Immediately act when the DC bus voltage is lower than P06.00
			Fault setting parameter	N/A
			Reset method	Manual / Auto: 120V/230V series: Lv level + 30VDC + 500ms 460V series: Lv level + 60VDC + 500ms 575V series: Lv level + 75VDC + 500ms
			Reset condition	500 ms
			Record	Yes
			Corrective Actions	1) Improve power supply condition. 2) Check if the power specification matches the drive. 3) Adjust voltage to the power range of the drive. 4) Cycle the power after checking the power. If LvS error still exists, return to the factory for repair. 5) Check the power system. 6) Increase the capacity of power equipment. 7) Install DC reactor(s).
orP	15	Phase loss protection (orP) Phase loss of power input	Action Level	When DC bus ripple is higher than the protection level, and the output current exceeds 50% of the rated current, the drive starts counting. When the counting value reaches the upper limit, an orP error occurs.
			Action Time	The action time varies with different output current.
			Fault setting parameter	P06.53
			Reset method	Manual reset
			Reset condition	Immediately reset when DC bus is higher than P07.00
			Record	Yes
			Corrective Actions	1) Verify the wiring of the main circuit power is installed correctly. 2) Check that a single-phase power supply is not being used with a three-phase model. Choose the model whose power matches the voltage. 3) Power voltage changes can trigger this fault. If the main circuit power works normally, verify the main circuit. Cycle the power after checking the power, if orP error still exists, contact AutomationDirect Technical Support. 4) Check for loose terminal wiring, tighten the terminal screws according to the torque described in the user manual. 5) Verify the input cable is undamaged and replace if needed. 6) Check for unbalanced three-phase input power.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oH 1	16	IGBT overheating (oH1) IGBT temperature exceeds the protection level. Protection level is model default of P06.15 + 5°C	Action Level	Depending on the model power, model default of P06.15 +5°C. When the setting for P06.15 is higher than the oH1 level, oH1 error occurs instead of oH1 warning. An IGBT overheating error occurs, and the drive stops.
			Action Time	Immediately when limit is reached.
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset only when IGBT temperature is lower than oH1 error level minus (-) 10°C
			Record	Yes
			Corrective Actions	1) Check the ambient temperature. 2) Regularly inspect the ventilation hole of the control cabinet. 3) Change the installed location if there are heating objects, such as braking resistors, in the surroundings. 4) Install/add cooling fan or air conditioner to lower the temperature inside the cabinet. 5) Check for and remove obstructions or replace the cooling fan. 6) Increase ventilation space of the drive. 7) Decrease loading. 8) Decrease the carrier wave. 9) Replace the drive with higher capacity model.
tH1o	18	IGBT temperature detection failure (tH1o) IGBT hardware failure in temperature detection	Action Level	NTC broken or wiring failure
			Action Time	When the IGBT temperature is higher than the protection level, and detection time exceeds 100 ms, the tH1o protection activates.
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	Wait for 10 minutes, and then cycle the power. Check if tH1o protection still exists. If yes, contact AutomationDirect Technical Support.
oL	21	Over load (oL) The AC motor drive detects excessive drive output current. Overload capacity: • Variable Torque (VT): Sustains for one minute when the drive outputs 120% of the drive's rated output current. Sustains for three seconds when the drive outputs 150% of the drive's rated output current. • Constant Torque (CT): Sustains for one minute when the drive outputs 150% of the drive's rated output current. Sustains for three seconds when the drive outputs 200% of the drive's rated output current.	Action Level	Based on overload curve and derating curve.
			Action Time	When the load is higher than the protection level and exceeds allowable time, the oL protection activates.
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Reduce the load. 2) Increase the setting value for P01.12–P01.19 (accel./decel. time) 3) Adjust the settings for P01.01–P01.08 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). Refer to the V/F curve selection of P01.43. 4) Replace the drive with a larger capacity model. 5) If the oL only occurs during low-speed operations: a) Reduce the load during low-speed operation. b) Increase the drive capacity. c) Decrease the carrier frequency of P00.17. 6) Adjust P07.26 Torque Compensation Gain until the output current reduces and the motor does not stall. 7) Verify stall prevention is set to the proper value. 8) Check the status of three-phase motor and verify the cable is not broken or screws are loose. 9) Verify the parameter settings for speed tracking. a) Start the speed tracking function. b) Adjust the maximum current for P07.09 speed tracking.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
EoL 1	22	Electronics thermal relay 1 protection (EoL1) Electronics thermal relay 1 protection. The drive coasts to stop once it activates.	Action Level	Start counting when the output current > 150% of the motor 1 rated current
			Action Time	P06.14 (If the output current is larger than 105% of the motor 1 rated current again within 60 sec., the counting time reduces and is less than P06.14)
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Reduce the load. 2) Increase the setting value for P01.12–P01.19 (accel./decel. time) 3) Adjust the settings for P01.01–P01.08 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). Refer to the V/F curve selection of P01.43. 4) If the EoL1 only occurs during low-speed operations: a) Replaced the drive with a dedicated VFD model. b) Increase the motor capacity. 5) If using a VFD dedicated motor, verify P06.13=1: Standard motor (motor with fan on the shaft). 6) Verify motor rated current and reset if needed. 7) Verify motor rated frequency and reset if needed. 8) If using one drive to run multiple motors, set P06.13=2: Disable, and install thermal relay on each motor. 9) Set stall prevention to the proper value. 10) Adjust P07.26 torque compensation gain until the current reduces and the motor does not stall. 11) Check the status of the fan, or replace the fan. 12) Replace the motor.
EoL2	23	Electronic thermal relay 2 protection (EoL2) Electronic thermal relay 2 protection. The drive coasts to stop once it activates.	Action Level	Start counting when the output current > 150% of the motor 2 rated current
			Action Time	P06.28 (If the output current is larger than 105% of the motor 2 rated current again within 60 sec., the counting time reduces and is less than P06.28)
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Reduce the load. 2) Increase the setting value for P01.12–P01.19 (accel./decel. time) 3) Adjust the settings for P01.35–P01.42 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). Refer to the V/F curve selection of P01.43. 4) If the EoL2 only occurs during low-speed operations: a) Replaced the drive with a dedicated VFD model. b) Increase the motor capacity. 5) If using a VFD dedicated motor, verify P06.27=1: Standard motor (motor with fan on the shaft). 6) Verify motor rated current and reset if needed. 7) Verify motor rated frequency and reset if needed. 8) If using one drive to run multiple motors, set P06.27=2: Disable, and install thermal relay on each motor. 9) Set stall prevention to the proper value. 10) Adjust P07.71 torque compensation gain until the current reduces and the motor does not stall. 11) Check the status of the fan, or replace the fan. 12) Replace the motor.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oH3	24_1	Motor overheating (oH3) PTC Motor overheating (PTC) (P03.00–P03.01=6 PTC), when PTC input > P06.30, the fault treatment acts according to P06.29.	Action Level	PTC input value > P06.30 setting (Default = 50%)
			Action Time	Immediately act
			Fault setting parameter	P06.29 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	When P06.29=0, oH3 is a "Warning". The "Warning" is automatically cleared. When P06.29=1 or 2, oH3 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P06.29=1 or 2, oH3 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Check if motor is locked and remove the motor shaft lock. 2) Verify load and decrease the loading or replace motor with a higher capacity model if load is too high. 3) Verify ambient temperature and change the installation location if there are heating devices in the surroundings, or install/add cooling fan or air conditioner to lower the ambient temperature. 4) Check the cooling system and ensure it's working normally. 5) Verify the motor fan is working and replace the fan if needed. 6) Verify duration of low speed operation. a) Decrease low-speed operation time. b) Change to dedicated motor for the drive. c) Increase the motor capacity. 7) Verify accel/decel time and increase setting values for P01.12–P01.19 (accel./ decel. time) if working cycle is too short. 8) Verify V/F voltage and adjust settings for P01.01–P01.08 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 9) Verify the motor rated current matches the motor nameplate and configure the correct rated current value of the motor if needed. 10) Check the connection between PTC thermistor and the heat protection. 11) Verify stall prevention is set correctly and adjust the value if needed. 12) Check for unbalanced three-phase motor impedance. Replace the motor if needed. 13) Verify harmonics and reduce harmonics if too high.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oH3	24_2	Motor overheating (oH3) PT100 RTD Motor overheating (PT100) (P03.00–P03.01=11 PT100). When PT100 input > P06.57 (default = 7V), the fault treatment acts according to P06.29.	Action Level	PT100 RTD input value > P06.57 setting (default = 7V)
			Action Time	Immediately act
			Fault setting parameter	P06.29 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	When P06.29=0 and the temperature < P06.56, oH3 is automatically cleared. When P06.29=1 or 2, oH3 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P06.29=1 or 2, oH3 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Check if motor is locked and remove the motor shaft lock. 2) Verify load and decrease the loading or replace motor with a higher capacity model if load is too high. 3) Verify ambient temperature and change the installation location if there are heating devices in the surroundings, or install/add cooling fan or air conditioner to lower the ambient temperature. 4) Check the cooling system and ensure it's working normally. 5) Verify the motor fan is working and replace the fan if needed. 6) Verify duration of low speed operation. a) Decrease low-speed operation time. b) Change to dedicated motor for the drive. c) Increase the motor capacity. 7) Verify accel/decel time and increase setting values for P01.12–P01.19 (accel./ decel. time) if working cycle is too short. 8) Verify V/F voltage and adjust settings for P01.01–P01.08 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 9) Verify the motor rated current matches the motor nameplate and configure the correct rated current value of the motor if needed. 10) Check the connection of PT100 RTD. 11) Verify stall prevention is set correctly and adjust the value if needed. 12) Check for unbalanced three-phase motor impedance. Replace the motor if needed. 13) Verify harmonics and reduce harmonics if too high.
ot1	26	Over torque 1 (ot1) When the output current exceeds the over-torque detection level (P06.07) and exceeds over-torque detection time (P06.08), and when P06.06 or P06.09 is set to 2 or 4, the ot1 error displays.	Action Level	P06.07
			Action Time	P06.08
			Fault setting parameter	P06.06 setting is: 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN
			Reset method	When P06.06=1 or 3, ot1 is a "Warning". The warning is automatically cleared when the output current < (Pr.06-07 – 5%) When P06.06=2 or 4, ot1 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P06.06=2 or 4, ot1 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Verify the settings for P06.07 and P06.08. 2) Check for mechanical failure and remove any causes of malfunction. 3) Reduce the load or replace the motor with a higher capacity model. 4) Increase the setting values for P01.12–P01.19 (accel./decel. time) 5) Adjust the V/F curve (Motor 1, P01.01–P01.08), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). 6) If error occurs during low-speed operation: a) Decrease low-speed operation time. b) Increase the motor capacity. 7) Adjust P07.26 torque compensation gain until the current reduces and the motor does not stall. 8) Very speed tracking settings and correct the parameter settings as needed. a) Start the speed tracking function. b) Adjust the maximum current for P07.09 speed tracking.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oL2	27	Over torque 2 (ot2) When the output current exceeds the over-torque detection level (P06.10) and exceeds over-torque detection time (P06.11), and when P06.09 is set to 2 or 4, the ot2 error displays.	Action Level	P06.10
			Action Time	P06.11
			Fault setting parameter	P06.09 setting is: 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN
			Reset method	When P06.09=1 or 3, ot2 is a "Warning". The warning is automatically cleared when the output current < (P06.10 – 5%). When P06.09=2 or 4, ot2 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P06.09=2 or 4, ot2 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Verify the settings for P06.10 and P06.11. 2) Check for mechanical failure and remove any causes of malfunction. 3) Reduce the load or replace the motor with a higher capacity model. 4) Increase the setting values for P01.12–P01.19 (accel./decel. time) 5) Adjust the V/F curve (Motor 1, P01.35–P01.42), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). 6) If error occurs during low-speed operation: a) Decrease low-speed operation time. b) Increase the motor capacity. 7) Adjust P07.71 torque compensation gain until the current reduces and the motor does not stall. 8) Very speed tracking settings and correct the parameter settings as needed. a) Start the speed tracking function. b) Adjust the maximum current for P07.09 speed tracking.
uC	28	Under current (uC) Low current detection	Action Level	P06.71
			Action Time	P06.72
			Fault setting parameter	P06.73 setting is: 0: No function 1: Fault and coast to stop 2: Fault and ramp to stop by the 2nd deceleration time 3: Warn and continue operation
			Reset method	When P06.73=3, uC is a "Warning". The warning is automatically cleared when the output current > (P06.71+0.1A). When P06.73=1 or 2, uC is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P06.71=1 or 2, uC is a "Fault", and the fault is recorded.
			Corrective Actions	1) Confirm the motor cable is connected properly. 2) Verify settings of P06.71, P06.72, and P06.73 and set to correct values if needed. 3) Check if the load is too low and whether the motor capacity matches the load.
cF2	31	EEPROM read error (cF2) Internal EEPROM cannot be read	Action Level	Firmware internal detection
			Action Time	cF2 acts immediately when the drive detects the fault
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Press "RESET" key or reset the parameter to the default setting. If cF2 still occurs, contact AutomationDirect Technical Support. 2) Cycle the power, if cF2 error still occurs, contact AutomationDirect Technical Support.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
cd1	33	U-phase error (cd1) U-phase current detection error when power is ON	Action Level	Hardware detection
			Action Time	cd1 acts immediately when the drive detects the fault
			Fault setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power, if cd1 error still occurs, contact AutomationDirect Technical Support.
cd2	34	V-phase error (cd2) V-phase current detection error when power ON	Action Level	Hardware detection
			Action Time	cd2 acts immediately when the drive detects the fault
			Warning setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power, if cd2 error still occurs, contact AutomationDirect Technical Support.
cd3	35	W-phase error (cd3) W-phase current detection error when power ON	Action Level	Hardware detection
			Action Time	cd3 acts immediately when the drive detects the fault
			Warning setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power, if cd3 error still occurs, contact AutomationDirect Technical Support.
Hd0	36	cc hardware error (Hd0) cc (current clamp) hardware protection error when power is ON	Action Level	Hardware detection
			Action Time	Hd0 acts immediately when the drive detects the fault
			Fault setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power, if Hd0 error still occurs, contact AutomationDirect Technical Support.
Hd1	37	oc hardware error (Hd1) oc hardware protection error when power is ON	Action Level	Hardware detection
			Action Time	Hd1 acts immediately when the drive detects the fault
			Fault setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power, if Hd1 error still occurs, contact AutomationDirect Technical Support.
AUE	40	Auto-tuning error (AUE) Motor auto-tuning error	Action Level	Hardware detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) This error can occur if you press the STOP key during auto-tuning. Re-execute auto-tuning. 2) Check motor capacity and related parameters. a) Set the correct parameters P01.01–P01.02. b) Set P01.00 larger than the motor rated frequency. 3) Check the motor wiring. 4) Check for motor shaft lock and remove cause of lock if needed. 5) Check for electromagnetic contactor at output (U/V/W) and make sure the electromagnetic valve is OFF. 6) Verify load. If too heavy: a) Reduce the load. b) Replace the motor with a larger capacity model. 7) Check if accel/decel time is too short, then increase the setting values for P01.12–P01.19 (accel./decel. time) if needed.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
AFE	41	PID loss AI2 (AFE) PID feedback loss (analog feedback signal is only valid when the PID function is enabled)	Action Level	When the analog input < 4 mA (only detects 4–20 mA analog input)
			Action Time	P08.08
			Fault setting parameter	P08.09 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: Warn and operate at last frequency
			Reset method	When P08.09=3 or 4, AFE is a "Warning". When the feedback signal is > 4 mA, the "Warning" is automatically cleared. When P08.09=1 or 2, AFE is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P08.09=1 or 2, AFE is a "Fault", and the fault is recorded; when P08.09=3 or 4, AFE is a "Warning", and the warning is not recorded.
			Corrective Actions	1) Check the PID feedback cable and tighten the terminal. Replace the cable with a new one if needed. 2) Check for feedback device failure and replace the device with a new one. 3) Check all the wiring. If AFE fault still exists, contact AutomationDirect Technical Support.
PGF2	43	PG feedback loss (PGF2) P10.00 and P10.02 is not set in the PG control mode. When press "RUN" key, PGF2 fault occurs.	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Reset encoder parameters (P10.00 and P10.02) 2) Verify correct control mode is selected (P00.11=1).
PGF3	44	PG feedback stall (PGF3) Under PG mode, when the motor frequency exceeds the encoder observer stall level (P10.10) and starts to count, the fault time is longer than the detection time of encoder observer stall (P10.11), then PGF3 fault occurs.	Action Level	P10.10
			Action Time	P10.11
			Fault setting parameter	P10.12 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Reset encoder parameter (P10.01) 2) Value for P01.00 may be too low, set a higher value. 3) Reset ASR parameters. Verify accel/decel times and reset if needed. 4) Reset PG feedback stall values, P10.10 and P10.11.
PGF4	45	PG slip error (PGF4) Under PG mode, when the motor frequency exceeds encoder observer slip range (P10.13) and starts to count, the fault time is longer than the detection time of encoder observer slip (P10.14), PGF4 fault occurs.	Action Level	P10.13
			Action Time	P10.14
			Fault setting parameter	P10.15 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop
			Reset method	Auto: When P10.15=0, PGF4 is a "Warning". When the deviation between the output frequency and motor frequency is smaller than the encoder observer slip range, the warning is automatically cleared. Manual: When P10.15=1 or 2, PGF4 is a "Fault" and you must reset manaully.
			Reset condition	Immediately reset
			Record	When P10.15=1 or 2, PGF4 is a "Fault" and the fault is recorded.
			Corrective Actions	1) Reset PG feedback parameters (P10.13 and P10.14) 2) Reset ASR parameters. Verify accel/decel times and reset if needed. 3) Reset encoder parameters (P0.01). 4) Verify torque limit and set new values if needed (P06.12, P11.17-P11.20) 5) Check for and resolve any causes of motor shaft lock. 6) Check the mechanical brake has released correctly and verify the timing of the system.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ACE	48	AI2 loss (ACE) Analog input loss (including all the 4–20 mA analog signal)	Action Level	When the analog input is < 4 mA (only detects 4–20 mA analog input)
			Action Time	Immediately act
			Fault setting parameter	P03.19 setting is: 0: Disable 1: Continue operation at the last frequency (warning, ANL is displayed on the keypad) 2: Decelerate to stop (warning, ANL is displayed on the keypad) 3: Stop immediately and display ACE
			Reset method	When P03.19=1 or 2, ACE is a "Warning". When analog input signal is > 4 mA, the warning is automatically cleared. When P03.19=3, ACE is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	When P03.19=3, ACE is a "Fault", and the fault is recorded.
			Corrective Actions	1) Check the AI2 feedback cable and tighten the terminal. Replace the cable with a new one if needed. 2) Check for external device failure and replace the device with a new one. 3) Check all the wiring. If ACE fault still exists, contact AutomationDirect Technical Support.
EF	49	External fault (EF) External fault. When the drive decelerates based on the setting of P07.20, the EF fault displays on the keypad.	Action Level	DIx=10: External fault (EF) and the DI terminal is ON
			Action Time	Immediately act
			Fault setting parameter	P07.20 setting is: 0: Coast to stop 1: Stop by the 1st deceleration time 2: Stop by the 2nd deceleration time 3: Stop by the 3rd deceleration time 4: Stop by the 4th deceleration time 5: System deceleration 6: Automatic deceleration (P01.46)
			Reset method	Manual reset
			Reset condition	Manual reset only after the external fault is cleared (terminal status is recovered)
			Record	Yes
			Corrective Actions	Press RESET key after the fault is cleared.
EF1	50	Emergency stop (EF1) When the contact of DIx=EF1 is ON, the output stops immediately and displays EF1 on the keypad. The motor is in free running.	Action Level	DIx=28: Emergency Stop (EF1) and the DI terminal is ON
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Manual reset only after the external fault is cleared (terminal status is recovered)
			Record	Yes
			Corrective Actions	Verify if the system is back to normal condition, and then press "RESET" key to go back to the default.
bb	51	External base block (bb) When the contact of DIx=bb is ON, the output stops immediately and displays bb on the keypad. The motor is in free running.	Action Level	DIx=11: Base Block (BB) and the DI terminal is ON
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	The display "bb" is automatically cleared after the fault is cleared.
			Reset condition	N/A
			Record	No
			Corrective Actions	Verify if the system is back to normal condition, and then press "RESET" key to go back to the default.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
Pcod	52	Password is locked (Pcod) Entering the wrong password three consecutive times through P00.07	Action Level	Entering the wrong password three consecutive times
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Power-off
			Record	Yes
			Corrective Actions	1) Input the correct password after rebooting the motor drive. 2) If you forget the password, do the following steps: a) Step 1: Input 9999 and press ENTER. b) Step 2: Repeat step 1. Input 9999 and press ENTER. (You need to finish step 1 and step 2 within 10 seconds. If you don't finish the two steps in 10 seconds, try again.) 3) The parameter settings return to the default when the "Input 9999" process is finished.
CE1	54	Illegal command (CE1) Communication command is illegal	Action Level	When the function code is not 03, 06, 10, or 63.
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	No
			Corrective Actions	1) Check if the communication command is correct. 2) Verify the wiring and grounding of the communication circuit. It is recommended to separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
CE2	55	Illegal data address (CE2) Data address is illegal	Action Level	When the data address is correct.
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	No
			Corrective Actions	1) Check if the communication command from the upper limit is correct. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
CE3	56	Illegal data value (CE3) Data value is illegal	Action Level	When the data length is too long
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	No
			Corrective Actions	1) Check if the communication command from the upper limit is correct. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
CE4	57	Data is written to read-only address (CE4) Data is written to read-only address	Action Level	When the data is written to read-only address.
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	No
			Corrective Actions	1) Check if the communication command from the upper limit is correct. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
CE10	58	Modbus transmission time-out (CE10) Modbus transmission time-out occurs	Action Level	When the communication time exceeds the detection time for P09.03 communication time-out.
			Action Time	P09.03
			Fault setting parameter	P09.02 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning, no fault, and continue operation
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Check if the upper unit transmits the communication command within the setting time for P09.03. 2) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 3) Check if the setting for P09.04 is the same as the setting for the upper unit. 4) Check the cable and replace it if necessary.
ydc	61	Y-connection / Δ-connection switch error (ydc) An error occurs when Y-Δ switches	Action Level	1) ydc occurs when the confirmation signals of Y-connection and Δ-connection are conducted at the same time. 2) If any of confirmation signals is not conducted within P05.25, ydc occurs.
			Action Time	P05.25
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Can be reset only when the confirmation signal of Y-connection is conducted if it is Y-connection, or when the confirmation signal of Δ-connection is conducted if it is Δ-connection.
			Record	Yes
			Corrective Actions	1) Check if the electromagnetic valve works normally during switch. If not, replace it. 2) Check if related parameters are all set up and set correctly. 3) Check the wiring of the Y-Δ switch function.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
dEb	62	Deceleration energy backup error (dEb) When P07.13 is not 0, and the power is suddenly off, causing the DC bus voltage lower than the dEb action level, the dEb function acts and the motor ramps to stop. Then dEb displays on the keypad.	Action Level	When P07.13 is not 0, and the DC bus voltage is lower than the level of dEb.
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	When P07.13=2 (dEb with auto-acceleration / auto-deceleration, the drive outputs the frequency after the power is restored): dEb is automatically cleared. When P07.13=1 (dEb with auto-acceleration / auto-deceleration, the drive does not output the frequency after the power is restored): The drive stops when dEb acts and the rotation speed becomes 0 Hz, then the drive can be reset manually.
			Reset condition	Auto: The fault is automatically cleared. Manual: When the drive decelerates to 0 Hz.
			Record	Yes
			Corrective Actions	1) Check that the power system is not unstable or off. 2) If another large load operates in the same power system: a) Replace power system with a larger capacity model. b) Ensure the large load system is on a different power system.
oSL	63	Over slip error (oSL) On the basis of the maximum slip limit set via P10.29, the speed deviation is abnormal. When the motor drive outputs at constant speed, F>H or F<H exceeds the level set via P07.29, and it exceeds the time set via P07.30, oSL shows. oSL occurs in induction motors only.	Action Level	P07.29 100% of P07.29 = the maximum limit of the slip frequency (P10.29)
			Action Time	P07.30
			Fault setting parameter	P07.31 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	P07.31=0 is a warning. When the motor drive outputs at constant speed, and F>H or F<H does not exceed the level set via P07.29 anymore, oSL warning will be cleared automatically. When P07.31=1 or 2, oSL is an error, and it needs to reset manually.
			Reset condition	Immediately reset
			Record	P07.31=1 or 2, oSL is "Fault", and the fault is recorded.
			Corrective Actions	1) Verify the group 5 motor parameters. 2) Decrease the load 3) Check the setting of oSL protection function related parameters P07.29, P07.30, and P10.29
SrL1	72	STO Loss 1 (STL1) STO1–SCM1 internal loop detection error	Action Level	Hardware detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Hardware failure, and cannot reset. Cycle the power.
			Reset condition	N/A
			Record	Yes
			Corrective Actions	1) Verify the STO1 and SCM1 short circuit lines are connected. Re-connect the short circuit line if needed. Ensure all wiring is correct. 2) Verify the connections at the drive control terminals. 3) If issue still persists, contact AutomationDirect Technical Support.
Sro	76	STO (STo) Safety Torque Off function active	Action Level	Hardware detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	When P06.44=1 and after STo error is cleared, it automatically resets. When P06.44=0 and after STo error is cleared, reset it manually.
			Reset condition	Reset only after STo error is cleared.
			Record	Yes
			Corrective Actions	1) Reset the STO1/SCM1 and STO2/SCM2 switch (ON) and cycle the power. 2) Verify the connections at the drive control terminals. 3) If issue still persists, contact AutomationDirect Technical Support.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
SrL2	77	STO Loss 2 (STL2) STO2–SCM2 internal loop detection error	Action Level	Hardware detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Hardware failure, and cannot reset. Cycle the power.
			Reset condition	N/A
			Record	Yes
			Corrective Actions	1) Verify the STO2 and SCM2 short circuit lines are connected. Re-connect the short circuit line if needed. Ensure all wiring is correct. 2) Verify the connections at the drive control terminals. 3) If the issue persists, contact AutomationDirect Technical Support.
SrL3	78	STO Loss 3 (STL3) STO1–SCM1 and STO2–SCM2 internal loop detection error	Action Level	Hardware detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Hardware failure, and cannot reset. Cycle the power.
			Reset condition	N/A
			Record	Yes
			Corrective Actions	1) Verify the STO1 and SCM1 or STO2 and SCM2 short circuit lines are connected. Re-connect the short circuit line if needed. Ensure all wiring is correct. 2) Verify the connections at the drive control terminals. 3) If the issue persists, contact AutomationDirect Technical Support.
Aoc	79	U-phase over-current before run (Aoc) U-phase short circuit detected when the output wiring detection is performed before the drive runs.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault clears
			Record	Yes
			Corrective Actions	1) Check if the motor's internal wiring and the UVW wiring of the drive output terminal are correct. 2) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 3) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 4) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 5) Check the length of the motor cable. If it's too long: a) Increase the AC motor drive's capacity. b) Install AC reactor(s) on the output side (U/V/W). 6) The Aoc may occur due to a short circuit or ground fault at the output side of the drive. Check for possible short circuits between terminals with an electric meter: a) B1 corresponds to U, V and W; DC- corresponds to U, V and W; corresponds to U, V and W. b) If short circuit occurs, contact AutomationDirect Technical Support.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
boc	80	V-phase over-current before run (boc) V-phase short circuit detected when the output wiring detection is performed before the drive runs.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault clears
			Record	Yes
			Corrective Actions	1) Check if the motor's internal wiring and the UVW wiring of the drive output terminal are correct. 2) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 3) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 4) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 5) Check the length of the motor cable. If it's too long: a) Increase the AC motor drive's capacity. b) Install AC reactor(s) on the output side (U/V/W). 6) The Aoc may occur due to a short circuit or ground fault at the output side of the drive. Check for possible short circuits between terminals with an electric meter: a) B1 corresponds to U, V and W; DC- corresponds to U, V and W; corresponds to U, V and W. b) If short circuit occurs, contact AutomationDirect Technical Support.
coc	81	W-phase over-current before run (coc) W-phase short circuit detected when the output wiring detection is performed before the drive runs.	Action Level	300% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault clears
			Record	Yes
			Corrective Actions	1) Check if the motor's internal wiring and the UVW wiring of the drive output terminal are correct. 2) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 3) Check the motor insulation value with megger. Replace the motor if the insulation is poor. 4) Verify the wiring of the control circuit and the wiring/grounding of the main circuit to prevent interference. 5) Check the length of the motor cable. If it's too long: a) Increase the AC motor drive's capacity. b) Install AC reactor(s) on the output side (U/V/W). 6) The Aoc may occur due to a short circuit or ground fault at the output side of the drive. Check for possible short circuits between terminals with an electric meter: a) B1 corresponds to U, V and W; DC- corresponds to U, V and W; corresponds to U, V and W. b) If short circuit occurs, contact AutomationDirect Technical Support.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oPL 1	82	Output phase loss U phase (oPL1) U phase output phase loss	Action Level	P06.47
			Action Time	P06.46 P06.48: Use the setting value of P06.48 first. If DC braking function activates, use that of P06.46.
			Fault setting parameter	P06.45 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	P06.45=1 or 2 is "Fault", and the fault is recorded.
			Corrective Actions	1) Check for unbalanced three-phase motor impedance. If unbalanced, replace the motor. 2) Verify motor is wired correctly. Check the cable condition and replace the cable if necessary. 3) Ensure a single-phase motor is not being used with a three-phase drive 4) Check the flat cable of the control board. Re-do the wiring and test again if the flat cable is loose. If the fault still exists, contact AutomationDirect Technical Support. 5) Verify that the three-phase current is balanced with a current clamp meter. If it is balanced and the oPL1 fault still exists, contact AutomationDirect Technical Support. 6) Make sure the capacity of the drive and motor match each other.
oPL2	83	Output phase loss V phase (oPL2) V phase output phase loss	Action Level	P06.47
			Action Time	P06.46 P06.48: Use the setting value of P06.48 first. If DC braking function activates, use that of P06.46.
			Fault setting parameter	P06.45 setting is: 0: Warn and keep operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	When P06.45=1 or 2, oPL2 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Check for unbalanced three-phase motor impedance. If unbalanced, replace the motor. 2) Verify motor is wired correctly. Check the cable condition and replace the cable if necessary. 3) Ensure a single-phase motor is not being used with a three-phase drive 4) Check the flat cable of the control board. Re-do the wiring and test again if the flat cable is loose. If the fault still exists, contact AutomationDirect Technical Support. 5) Verify that the three-phase current is balanced with a current clamp meter. If it is balanced and the oPL2 fault still exists, contact AutomationDirect Technical Support. 6) Make sure the capacity of the drive and motor match each other.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oPL3	84	Output phase loss W phase (oPL3) W phase output phase loss	Action Level	P06.47
			Action Time	P06.46 P06.48: Use the setting value of P06.48 first. If DC braking function activates, use that of P06.46.
			Fault setting parameter	P06.45 setting is: 0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	When P06.45=1 or 2, oPL3 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Check for unbalanced three-phase motor impedance. If unbalanced, replace the motor. 2) Verify motor is wired correctly. Check the cable condition and replace the cable if necessary. 3) Ensure a single-phase motor is not being used with a three-phase drive 4) Check the flat cable of the control board. Re-do the wiring and test again if the flat cable is loose. If the fault still exists, contact AutomationDirect Technical Support. 5) Verify that the three-phase current is balanced with a current clamp meter. If it is balanced and the oPL3 fault still exists, contact AutomationDirect Technical Support. 6) Make sure the capacity of the drive and motor match each other.
oL3	87	Low frequency overload protection (oL3) Low frequency and high current protection	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Enhance the heat dissipation capacity for the cabinet. 2) Lower the carrier frequency (P00.17). 3) Decrease the voltage settings that correspond to frequency below 15 Hz in the V/F curve. 4) Set P00.11=0 (V/F, general control mode). 5) Replace the drive with a higher power model.
roPd	89	Rotor position detection error (roPd) Rotor position detection error protection	Action Level	Reset the software
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Check the motor cable for damage and replace if needed. 2) Check the motor coil, if damaged replace the motor. 3) IGBT may be broken. If so, contact AutomationDirect Technical Support. 4) Cycle the power. If roPd still occurs during operation, contact AutomationDirect Technical Support.
Cd10	97	Ethernet Card Timeout (CD10) Ethernet communication has not been received from the external controller (within the Ethernet Timeout window).	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediate reset
			Record	Yes
			Corrective Actions	1) Initiate Ethernet communications from the master controller again. 2) Disable checking for Ethernet Timeout in P9.94.

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Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
ictE	111	InrCOM time-out error (ictE) Internal communication overtime error	Action Level	P09.31=-1 – -10 (there is no -9), when the internal communication between Slave and Master is abnormal, ictE fault occurs.
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Automatically reset after the internal communication is normal
			Reset condition	N/A
			Record	Yes
			Corrective Actions	1) Verify the wiring and grounding of the communication circuit. Separate the communication circuit from the main circuit, or wire in 90 degree for effective anti-interference performance. 2) Verify the setting for P09.04 is the same as the setting for the upper unit. 3) Check the cable and replace it if necessary.
CP20	121	Internal communication error (CP20) Internal communication time-out	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	N/A
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Contact AutomationDirect Technical Support.
CP22	123	Internal communication error (CP22) Abnormal internal communication	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	N/A
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Contact AutomationDirect Technical Support.
CP30	124	Internal communication error (CP30) Abnormal internal communication	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	N/A
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Contact AutomationDirect Technical Support.
CP32	126	Internal communication error (CP32) Abnormal internal communication	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	N/A
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Contact AutomationDirect Technical Support.
CP33	127	Internal communication error (CP33) Abnormal internal communication	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	N/A
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Contact AutomationDirect Technical Support.

(continued next page)

Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
oL3	128	Over-torque 3 (ot3) When the output current exceeds the over-torque detection level (P14.75) and exceeds over-torque detection time (P14.76), and when P14.74 is set to 2 or 4, the ot3 error displays.	Action Level	P14.75
			Action Time	P14.76
			Fault setting parameter	P14.74 setting is: 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN
			Reset method	When P14.74=1 or 3, ot3 is a "Warning". The warning is automatically cleared when the output current < P14.75. When P14.74=2 or 4, ot3 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	P14.74=2 or 4, ot3 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Configure the settings for P14.75 and P14.76 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 3, P01.54–P01.61), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.73 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.
oL4	129	Over-torque 4 (ot4) When the output current exceeds the over-torque detection level (P14.78) and exceeds over-torque detection time (P14.79), and when P14.77 is set to 2 or 4, the ot4 error displays.	Action Level	P14.78
			Action Time	P14.79
			Fault setting parameter	P14.77 setting is: 0: No function 1: Continue operation after over-torque detection during constant speed operation 2: Stop after over-torque detection during constant speed operation 3: Continue operation after over-torque detection during RUN 4: Stop after over-torque detection during RUN
			Reset method	When P14.77=1 or 3, ot3 is a "Warning". The warning is automatically cleared when the output current < P14.75. When P14.77=2 or 4, ot3 is a "Fault". You must reset manually.
			Reset condition	Immediately reset
			Record	P14.77=2 or 4, ot3 is a "Fault", and the fault is recorded.
			Corrective Actions	1) Configure the settings for P14.78 and P14.79 again. 2) Check for mechanical error and remove the causes of malfunction. 3) Verify load and decrease the loading or replace with a motor with larger capacity if load is too high. 4) Verify accel/decel time and increase the setting values for P01.12–P01.19 (accel./ decel. time) if work cycle is too short. 5) Verify V/F voltage and adjust the V/F curve (Motor 3, P01.63–P01.70), especially the setting value for the mid-point voltage (if the mid-point voltage is set too small, the load capacity decreases at low-speed). 6) Replace motor with a larger capacity motor. 7) Check for overload during low-speed operation and decrease the loading during low-speed operation or increase the motor capacity. 8) Verify torque compensation and adjust P07.75 torque compensation gain until the output current decreases and the motor does not stall. 9) Correct the parameter settings for speed tracking. Start the speed tracking function. Adjust the maximum current for P07.09 speed tracking.

(continued next page)

Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
EoL3	134	Internal communication error (EoL3) Electronic thermal relay 3 protection. The drive coasts to stop once it activates.	Action Level	Start counting when output current > 150% of the motor 3 rated current.
			Action Time	P14.81 (If the output current is larger than 105% of the motor 3 rated current again within 60 sec., the counting time reduces and is less than P14.81)
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Reduce the load. 2) Increase the setting value for P01.12–P01.19 (accel./decel. time) 3) Adjust the settings for P01.54–P01.61 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). Refer to the V/F curve selection of P01.43. 4) If the EoL3 only occurs during low-speed operations: a) Replaced the drive with a dedicated VFD model. b) Increase the motor capacity. 5) If using a VFD dedicated motor, verify P14.80=1: Standard motor (motor with fan on the shaft). 6) Verify motor rated current and reset if needed. 7) Verify motor rated frequency and reset if needed. 8) If using one drive to run multiple motors, set P14.80=2: Disable, and install thermal relay on each motor. 9) Set stall prevention to the proper value. 10) Adjust P07.73 torque compensation gain until the current reduces and the motor does not stall. 11) Check the status of the fan, or replace the fan. 12) Replace the motor.
EoL4	135	Internal communication error (EoL4) Electronic thermal relay 4 protection. The drive coasts to stop once it activates.	Action Level	Start counting when the output current > 150% of the motor 4 rated current.
			Action Time	P14.83 (If the output current is larger than 105% of motor 4 rated current again within 60 sec., the counting time reduces and is less than P14.83)
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Reduce the load. 2) Increase the setting value for P01.12–P01.19 (accel./decel. time) 3) Adjust the settings for P01.62–P01.70 (V/F curve), especially the setting value for the mid-point voltage (if the mid-point voltage is set too low, the load capacity decreases at low speed). Refer to the V/F curve selection of P01.43. 4) If the EoL4 only occurs during low-speed operations: a) Replaced the drive with a dedicated VFD model. b) Increase the motor capacity. 5) If using a VFD dedicated motor, verify P14.82=1: Standard motor (motor with fan on the shaft). 6) Verify motor rated current and reset if needed. 7) Verify motor rated frequency and reset if needed. 8) If using one drive to run multiple motors, set P14.82=2: Disable, and install thermal relay on each motor. 9) Set stall prevention to the proper value. 10) Adjust P07.75 torque compensation gain until the current reduces and the motor does not stall. 11) Check the status of the fan, or replace the fan. 12) Replace the motor.

(continued next page)

Fault Codes (continued)				
Display on GS20(X) Keypad	**ID No.**	**Fault Name and Description**	**Action, Reset, and Corrective Action**	
Hd6	140	oc hardware error (Hd6) GFF hardware protection error when power is ON.	Action Level	Hardware detection
			Action Time	Immediately act when the fault is detected
			Fault setting parameter	N/A
			Reset method	Power-off
			Reset condition	N/A
			Record	Yes
			Corrective Actions	Cycle the power. If Hd6 still exists, contact AutomationDirect Technical Support.
b49FF	141	GFF occurs before run (b4GFF) The ground short circuit detected when the output wiring detection is performed before the drive runs.	Action Level	250% of the rated current
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Reset in five seconds after the fault is cleared
			Record	Yes
			Corrective Actions	1) Check if the motor's internal wiring and the UVW wiring of the drive output terminal are correct. 2) Check the motor cable and remove causes of any short circuits, or replace the cable before turning on the power. 3) Check the motor insulation value with megger. Replace the motor if the insulation is poor.
AUE 1	142	Auto-tune error 1 (AuE1) No feedback current error when the motor parameter automatically detects	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Verify the motor is wired correctly. 2) If a contactor is used as an open state on the output side of the drive (U/V/W), check if the contactor coil is closed.
AUE2	143	Auto-tune error 2 (AuE2) Motor phase loss error when the motor parameter automatically detects	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Verify that the motor is wired correctly and no wires are broken. 2) Confirm that the motor works normally outside of auto-tuning. 3) If an electromagnetic contactor is used as an open state on the output side of the drive (U/V/W), verify that the three phases of the electromagnetic valve are all closed.
AUE3	144	Auto-tune error 3 (AuE3) No load current I_0 measurement error when the motor parameter automatically detects.	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediately reset
			Record	Yes
			Corrective Actions	1) Check the settings for P05.01 / P05.13 / P05.34. 2) Confirm that the motor works normally outside of auto-tuning.
AUE5	149	Auto-tune error 5 (AuE5) The rotor resistance measuring error when the motor parameter automatically detects	Action Level	Software detection
			Action Time	Immediately act
			Fault setting parameter	N/A
			Reset method	Manual reset
			Reset condition	Immediate reset
			Record	Yes
			Corrective Actions	1) Verify that the motor is wired correctly and no wires are broken. 2) Confirm that the motor works normally outside of auto-tuning. Possibly test with standard across-the-line starter."

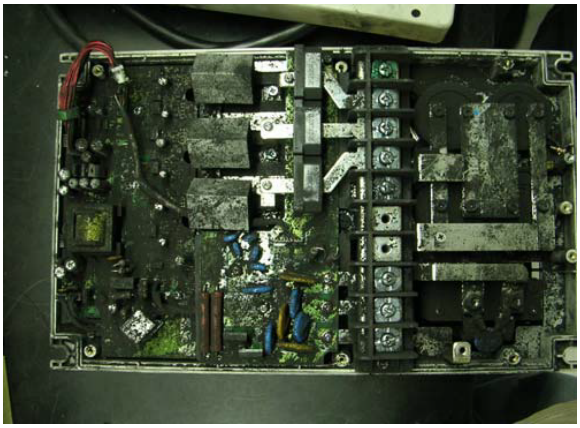
Typical AC Drive Problems and Solutions

Grease and Dirt Problems

In those industries where grease and dirt are common. Please be aware of the possible damage that grease, oil, and dirt, may cause to your GS20(X) drive:

1) *Electronic components that silt up with greasy oil may cause the drive to burn out or even explode.*
2) *Most greasy dirt contains corrosive substances that may damage the drive.*

Solution:
Install the GS20(X) drive in a suitable enclosure to protect it from grease and dirt. Clean and remove grease and dirt regularly to prevent damage of the drive.



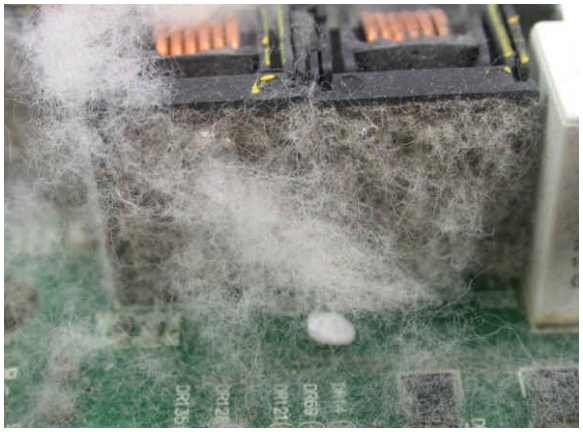
Fiber Dust Problem

Problems related to fiber dust are typical in the textile industry. Please be aware of the possible damage that fiber dust may cause to your GS20(X) drive:

1) *Fiber dust that accumulates or adheres to the fans will result in poor ventilation and cause overheating problems.*
2) *Textile plant environments with high humidity levels may experience GS20(X) drive failure or damage as a result of wet fiber dust adhering to components within the drive.*

Solution:

Install the GS20(X) drive in a suitable enclosure to protect it from fiber dust. Clean and remove fiber dust regularly to prevent damage to the drive.

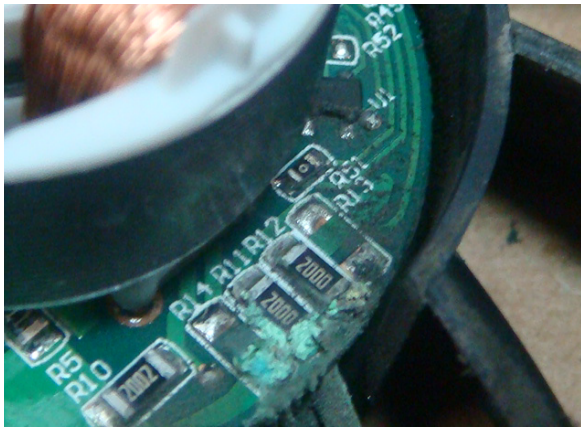


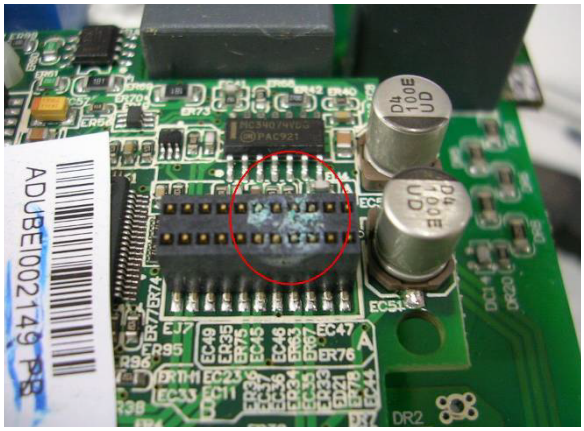
Corrosion Problem

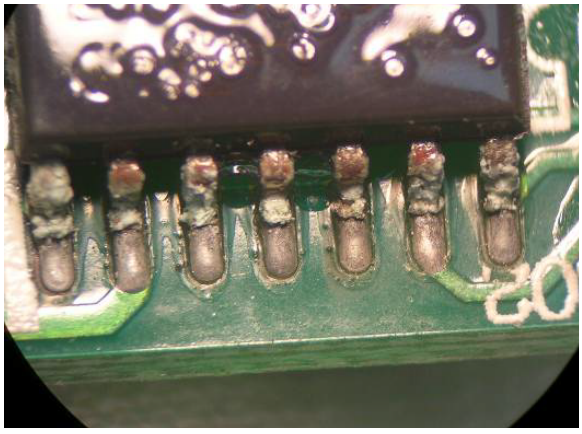
Corrosion problems may occur if any fluids or liquid in vapor form flows into the GS20(X) drive. Please be aware of the damage that corrosion may cause to your drive.

- *Corrosion of internal components may cause the GS20(X) drive to malfunction and possibly explode.*

Solution:
Install the GS20(X) drive in a suitable enclosure to protect it from fluids. Clean the drive regularly to prevent corrosion.





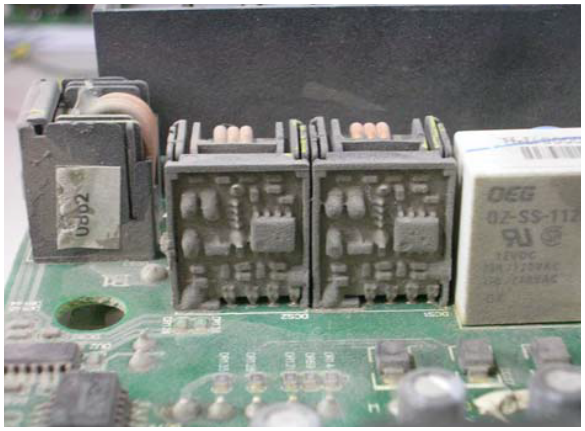


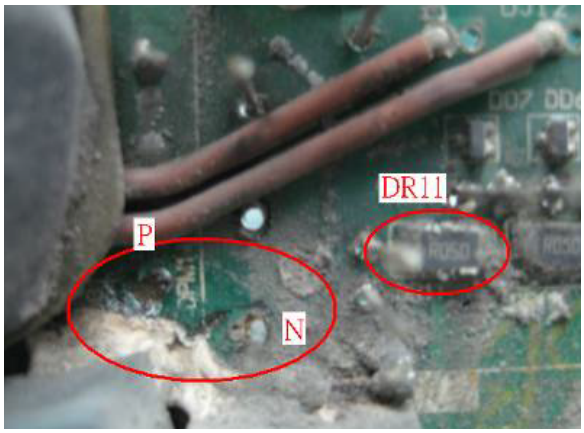
Industrial Dust Problem

Serious industrial dust pollution frequently occurs in stone processing plants, flour mills, cement plants, and so on. Please be particularly aware of any metal dust, filings or if metalized vapor is present as these may cause damage to your drives:

1) *Dust accumulating on electronic components may cause overheating problems and shorten the service life of the drive.*
2) *Conductive dust may damage the circuit board and may cause the drive to explode.*

Solution:
Install the GS20(X) drive in a suitable enclosure and protect it from dust. Clean the cabinet and ventilation filter regularly for good ventilation.





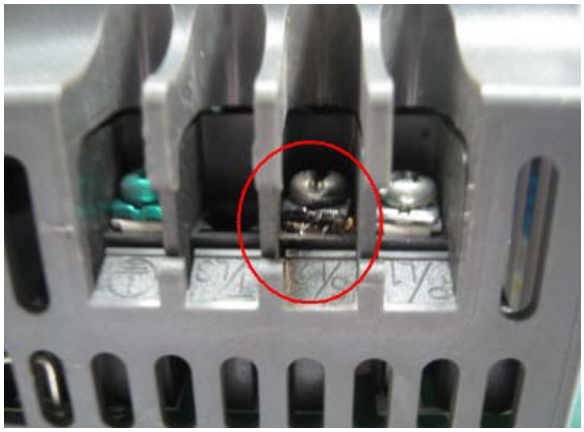
Wiring and Installation Problem

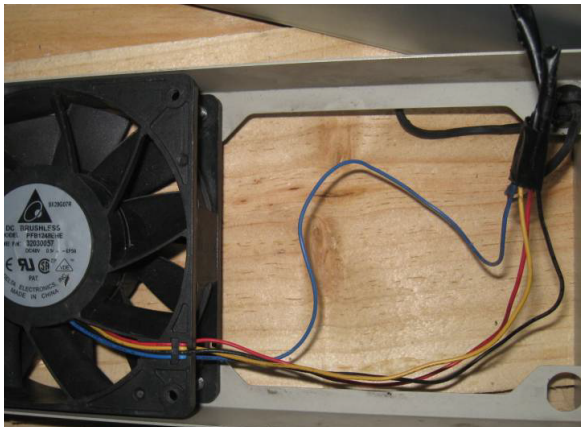
When wiring the GS20(X) drive, the most common problems are connection to the wrong terminal or poor wiring practice. Please be aware of the possible damage that poor wiring practice may cause to your GS20(X) drive:

1) *Screw terminals where the wire is not fully inserted or the terminal screw is not adequately tightened may result in sparking or high temperature due to a high resistance connection.*
2) *If circuit boards in the GS20(X) drive have been modified, components on the affected boards may have been damaged.*

Solution:

Inspect all power and control terminal connections in the GS20(X) drive to ensure adequate wire insertion. Do not attempt to disassemble or repair control boards in the GS20(X) drive.





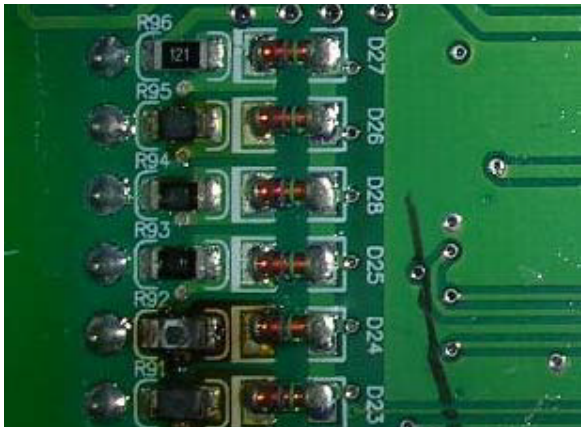
Digital Input/Output Terminal Problems

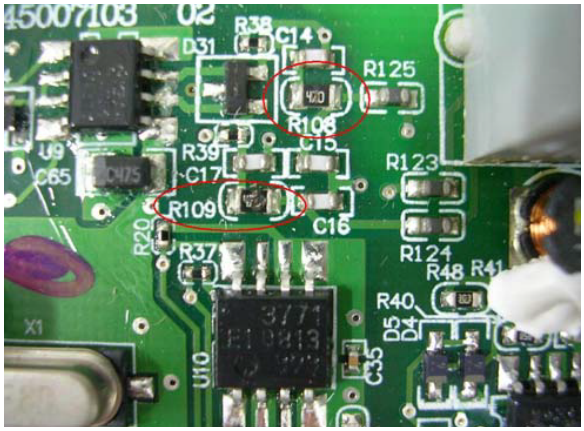
Problems with digital I/O are usually the result of improper termination, or failure to segregate control wiring from power wiring. This may result in errant signals due to induced voltage, capacitive coupling or electrical noise. Incorrect voltage levels applied to the digital I/O terminals can damage the I/O circuitry of the drive.

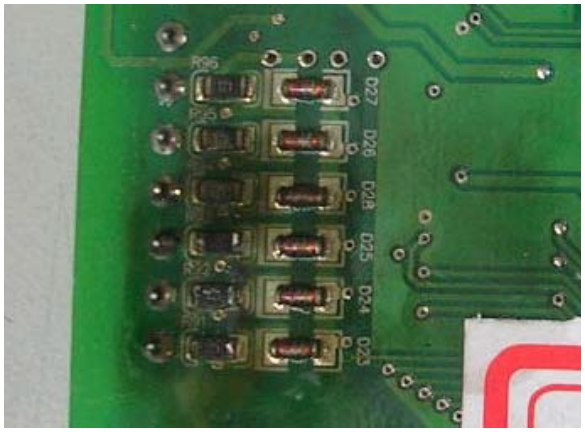
- *Input/Output circuit may burn out when the terminal usage exceeds its limit.*

Solution:

Refer to the user manual for multi-function input output terminals usage and follow the specified voltage and current. DO NOT exceed the specification limits.







GSoft2 – Getting Started

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GS20(X) Drive Configuration Software

GSoft2 is the configuration software for the Automation Direct GS4 and GS20(X) family of drives. It is designed to allow you to connect a personal computer to drives in the GS4 and GS20(X) family, and perform a variety of functions:

- *Create new drive configurations*
- *Upload/download drive configurations*
- *Edit drive configurations*
- *Archive/store multiple drive configurations on your PC*
- *Trend drive operation parameters*
- *Tune the drive PID loop*
- *View real time key operating parameters*
- *Start/Stop drive and switch directions, provided drive is set up for remote operation*
- *View drive faults*

GSoft2 includes an integral help file with software instructions. GSoft2 can be downloaded for free or purchased on USB card from AutomationDirect.com (search for GSoft2). Use version 2.0 or higher for use with GS20(X).

System Requirements

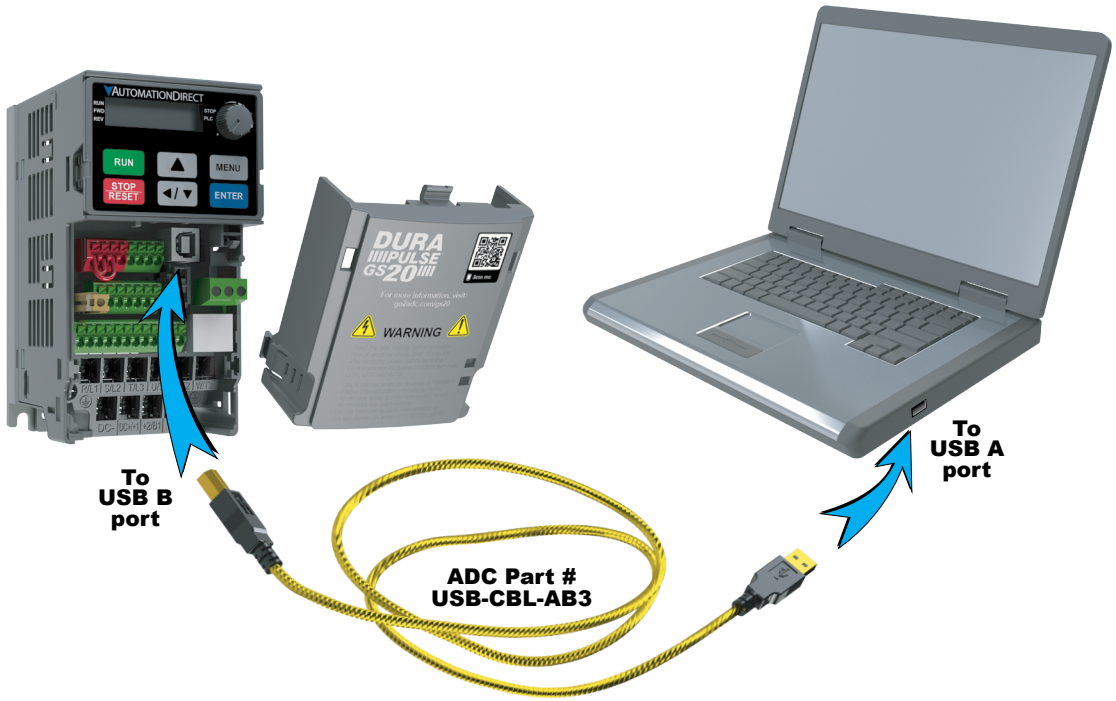
GSoft2 will run on PCs that meet the following requirements:

- *Windows OS: 7: 32 & 64 bit, 8: 32 & 64 bit, 8.1: 32 & 64 bit, 10: 64 bit*
- *Internet Explorer 9.0 or higher (for HTML help support)*
- *32 Mb of available memory*
- *10 Mb hard drive space*
- *Available USB port (for USB Type A to USB Type B cable)*

Installation Guide

System Requirement Configuration

Verify the GS20(X) drive connection to a PC/Laptop computer by connecting the PC's USB type A port to the GS20(X) drive's USB type B connector. The GS20(X) RS485 port is for connecting to an RS485 network only and can not be used to connect to GSoft2. See Chapter 5 for further information on GS20(X) drive communications.



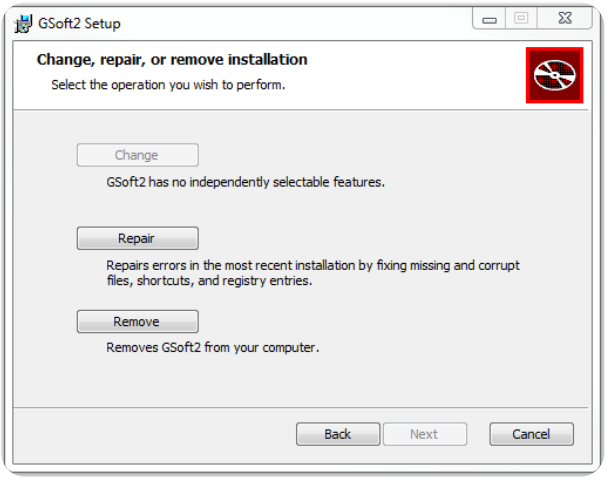
Ethernet connectivity for EtherNet/IP communication is possible with optional communication card # GS20-CM-ENETIP. Refer to "Appendix B: Optional I/O and Communication Cards" for details. Note that GSoft2 will not connect through ethernet.

Software Installation

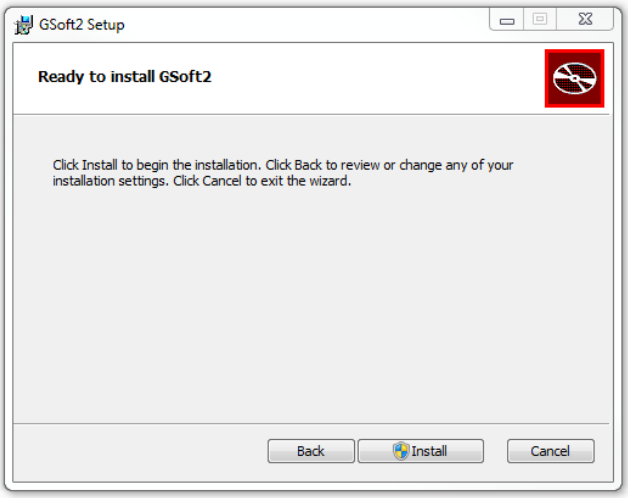
Step 1: Download the installation file from AutomationDirect.com or place the GSoft2 USB into your PC. If Autoplay is not enabled, doubleclick Setup.msi to start the installation process.

Step 2: Proceed with installation. At the welcome dialogue box select NEXT to continue installation process.

Step 3: If GSoft2 was previously installed then the Change, repair, or remove installation window allows you to effect changes to your installation, repair corrupt files or fix other issues with the current installation. Should you choose the GSoft2 file can be removed as well.



Step 4: If this is a new installation, click "Install" to continue the installation process. Follow the prompts to complete software installation.



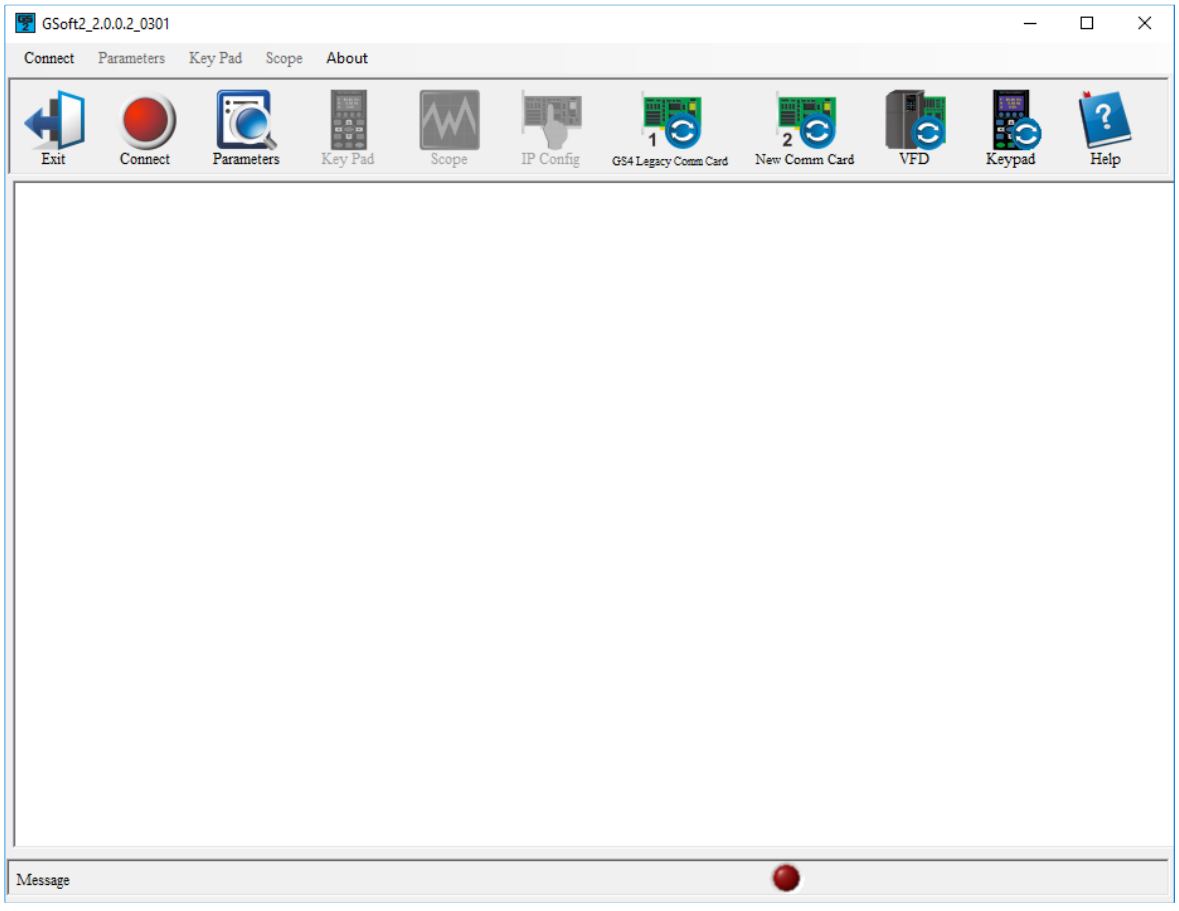
Opening GSoft2 Software Program

GSoft2 includes an integral help file with software instructions.

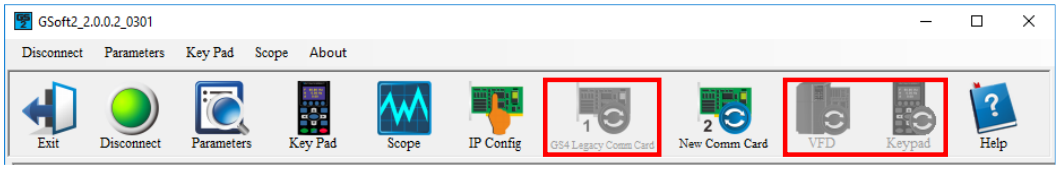
GSoft2 offers the user a PC based software configuration tool for creating and editing a GS20(X) Drive configuration. The configuration tool provides access to GS20(X) Drive parameters in a table format. Each parameter can be adjusted for your specific drive application. Once the selected parameters have been changed, the file can be downloaded to the GS20(X) Drive as well as saved to your project folder for future use on other drives. Once created and saved, subsequent editing is done using the GSoft2 software.

Double click the GSoft2 shortcut to open the program; OR click in the search box in the lower left corner of Desktop and type GSoft2.

GSoft2 Graphic User Interface (GUI) will open. You will notice that only one menu command is in bold (Connect), while the others are grayed out. Some icons on the toolbar are initially grayed out as well. At this point, the GUI includes seven Icons that are available as shown in the screencap. "Connect" is bold as shown upper left.

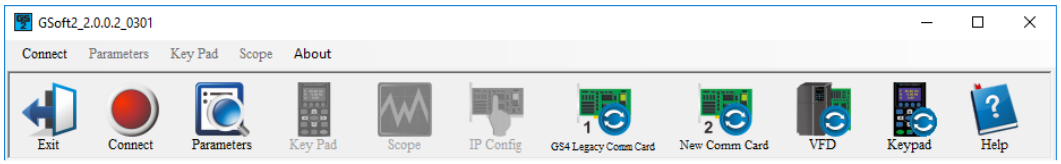


Icons within the red rectangles below will be grayed out after successfully connecting to the drive. Menu Bar commands will now appear in bold text (available).

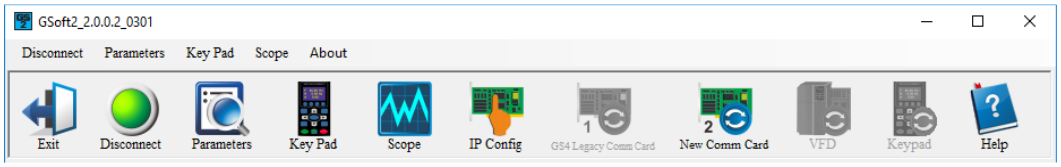


Software Functions

Icon Appearance Before Connecting to Drive



Icon Appearance After Connecting to Drive

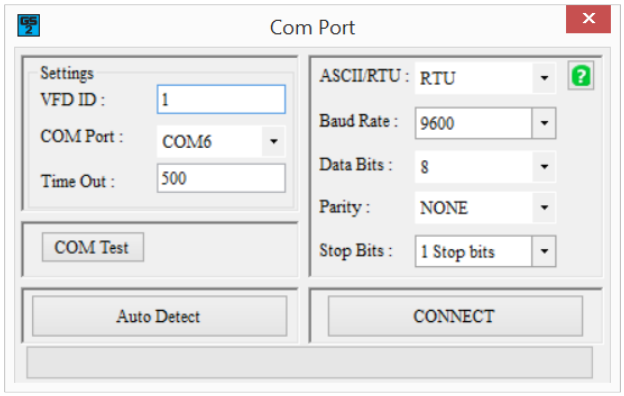


Icon Functions

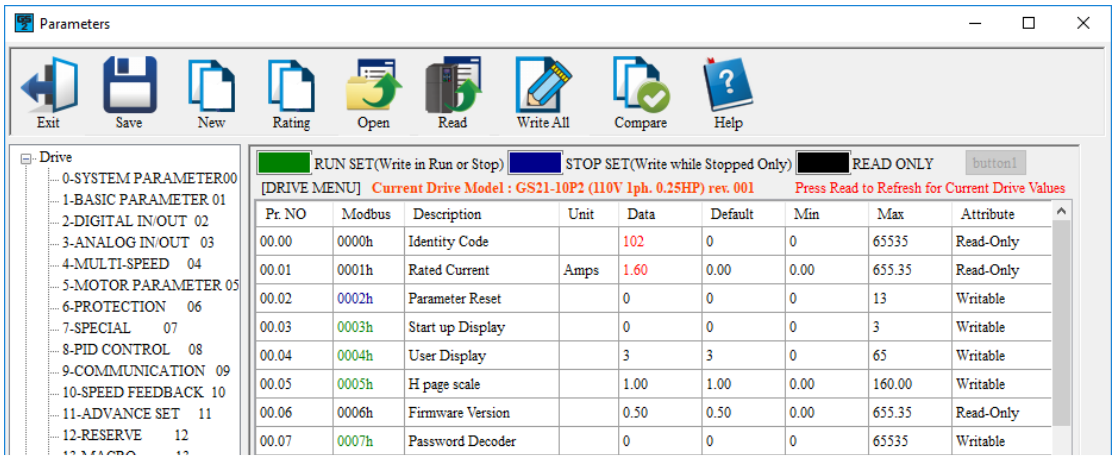
EXIT: Shuts down the GSoft2 software. (A pop-up "Are you sure" window will appear).

CONNECT: Opens Com Port dialog box (Same as “Connect” on the menu bar). This allows you to configure the settings to establish serial communication to your drive. If several COM ports are installed on your PC, you will need to go to Device Manager to determine which COM port is the correct one. For GS20(X) it is not necessary to modify the communication settings (ASCII/RTU, Baud Rate, Data bits, etc.) for the drive. The GS20(X) drive USB port is hard coded to communicate with GSoft2.

1) Choose the COM port.
2) Press the "COM Test" to verify the connection (a green "OK" should appear)., If Red Fault appears, then press "Auto Detect".
3) Click "CONNECT" to interface with the drive.



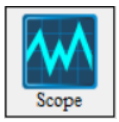
PARAMETERS: Opens GSoft2 drive parameters table. The Parameters screen allows the user to upload and download entire configurations to and from the drive. Individual parameters can be changed "live" as well. There is also the ability to Open and Save files on the PC's hard drive, and the ability to Compare parameter information to a drive's default values. See the online help file for more information.



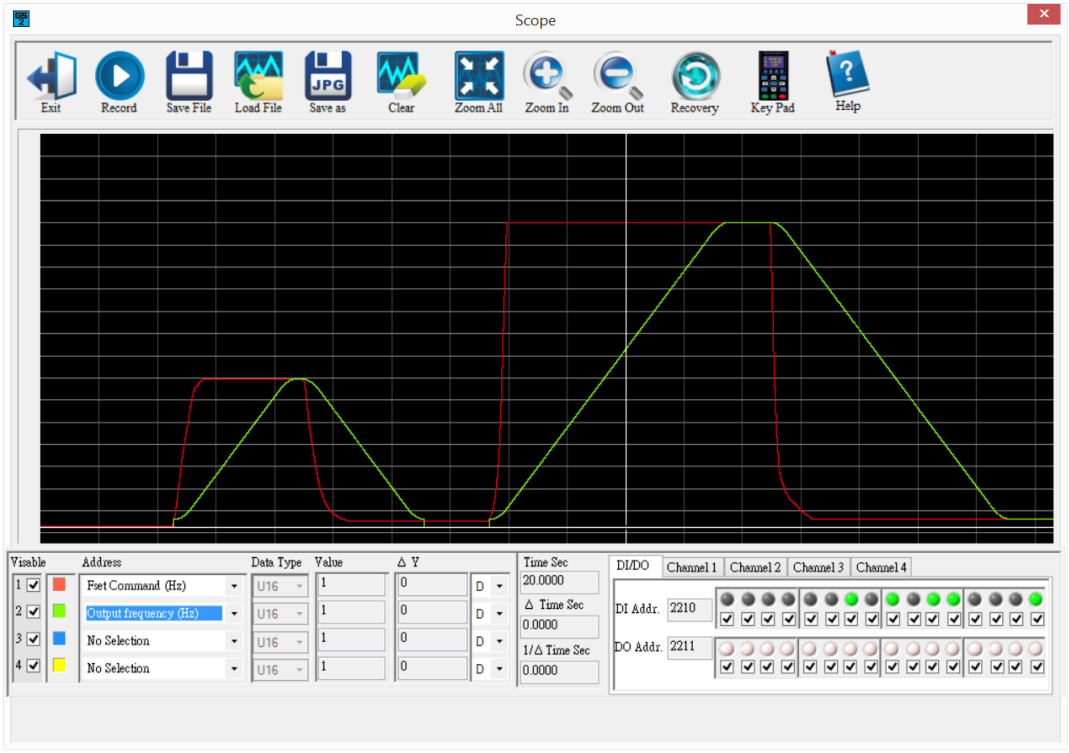
KEYPAD: Opens an advanced software keypad for use with your drive. Several buttons will be grayed-out (ESC, MENU, and several other keys are non-functional).

Operational Instructions:

To enable the Jog (F1), RUN, FWD/REV, and STOP/RESET buttons and to allow changes to the drive's speed, please see the GSoft2 online help file (must set P00.20/P00.21 (remote) and P00.30/P00.31 (local) for the drive to accept commands from RS485).

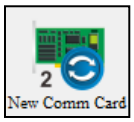


SCOPE: Opens a functional graphic interface for testing and viewing selected drive parameter data values (See the GSoft2 online helpfile for further detailed description).



IP Config: Allows manual configuration of an optional Ethernet card's IP address. GSoft2 uses the serial USB connection to communicate to the GS20(X) Drive ethernet communication card. Gsoft2 does not communicate via ethernet.

GS4 Legacy Comm Card: Use this feature when upgrading the GS4 Legacy ethernet communication cards (no J2 jumper is on the card). Icon is "grayed out" and not accessible after drive connection has been initiated. Press "Disconnect" to resume functionality. This is not used with GS20(X).



New Comm Card: Use when upgrading firmware to any newer GS4 Network card with J2 jumper or any GS20(X) Ethernet comm card.

Please read the important "Firmware Upgrade Notes" on page 7–10.

See the GSoft2 Helpfile for details on how to upgrade communication card firmware.

VFD: Use when upgrading GS drive firmware. Icon is "grayed out" and not accessible after drive connection has been initiated. Press "Disconnect" to resume functionality.

Please read the important "Firmware Upgrade Notes" on page 7–10.

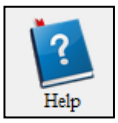
See the GSoft2 Helpfile for details on how to upgrade firmware.

NOTE: 500mA is required from the USB port of the sending PC. If unsure of the available current supplied by the PC, please use a powered USB hub.

KEYPAD: Use when upgrading KEYPAD firmware. Icon is "grayed out" and not accessible after drive connection has been initiated. Press "Disconnect" to resume functionality.

Please read the important "Firmware Upgrade Notes" on page 7–10.

See the GSoft2 Helpfile for details on how to upgrade keypad firmware.



Help: Use the icon to show the help file which provides detailed instructions on all features and detailed procedures.

Firmware Upgrade Notes

When upgrading firmware, the drive should be disconnected from all power sources (incoming AC power and control-level DC power).

All unnecessary USB peripherals should be disconnected from the host PC; Especially any USB to serial converters (USB-485M, USB-RS232, etc.) (drivers may conflict with the USB FW upgrade driver).

The host PC must be connected to the upgrade port of the GS20(X) via a standard USB A-to-B cable (USB-CBL-AB6 or similar).

Once the PC is connected to the GS20(X), the drive will be recognized as a USB serial device COM port. Open Device Manager to determine which port number has been assigned.

Follow the software's instructions to upgrade the GS20(X) firmware. More detailed firmware upgrade instructions are available in the GSoft2 online help file.

GSoft2 Help File Note

To get the most use out of GSoft2 for the GS20(X) AC Drive and to learn what powerful features and tools exist within GSoft2, we highly recommend that you use the internally available Help File. There are a couple of ways to access this Help File within the GSoft2 software:

• The easiest way to access the Help File information is to click the Help (Help File) icon in the far right of the Toolbox above the viewing pain.

• Alternately, you can access specific topics within the Help File by clicking "?" marks within the GSoft2 software. Those links bring up specific Help File information applicable to the particular GSoft2 topic.

Various data that exists within the User Manual also exists within the Help File, e.g., explanations of "how to" accomplish various tasks. Other information is found only within the Help File, such as more detailed information for using GSoft2 and for upgrading the GS20(X) drive firmware. The help File also contains detailed information concerning the GS20(X) AC drive parameters and information for understanding and using the PID process.

Make use of the Help File, and the Help File will live up to its name.

GSLogic Introduction

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Purpose of This Chapter

This chapter is intended as an overview and quick-start guide to get your first GS20(X) GSLogic PLC program quickly up and running.

For More Detailed Information

For further explanation of the GS20(X) PLC user interface, instruction set, and PLC implementation, please refer to the GSLogic Help File. The Help File can be accessed under the "Help" menu or anywhere you see the "?" symbol. Help on all of the following is located in the GSLogic Help file:

- *Full descriptions of the user interface, menu items, windows, and toolbars*
- *Basics of the GS20(X) PLC*
- *Special Function registers*
- *All GS20(X) PLC instructions*
- *Memory addressing and data types*
- *Using the digital and analog I/O*
- *Communication with the PLC and MODBUS addresses*

GSLogic Introduction

GSLogic is the PLC programming software for the built in GSLogic PLCs included on specified AutomationDirect Durapulse series of AC drives. This software can be used on any Durapulse drive series that includes the built-in GSLogic PLC: currently GS4, GS20/20X, and higher. The software is designed to enable you to perform a variety of PLC programming functions. Windows editing functions like cut, copy, paste, multiple windows, etc., are supported. GSLogic also provides for register editing, settings, file reading, saving, online monitoring settings, and other convenience functions, such as:

- *Upload/download of PLC program files to the on board PLC*
- *Editing of PLC programs*
- *Archive/store multiple PLC programs on your PC or on the GS4-KPD drive keypad*
- *Control PLC PID loops (FPID instructions)*
- *View in real time all PLC registers*
- *Print PLC program files*

GSLogic includes an integral help file that includes software instructions, how to use GSLogic, and how to use the GS20(X) PLC.

GS20(X) PLC Summary

Introduction

The GS20(X) drive includes a built-in PLC. Programmed in ladder logic, the GS20(X) PLC provides a comprehensive set of basic and application-specific instructions. This chapter is intended to provide an overview of the GS20(X) PLC, and to help you get started using it. For those unfamiliar with the onboard PLC, the Help File included with GSLogic includes all the detailed information needed to use the PLC.

The PLC functionality is included with every GS20(X) drive, and can be accessed over communications by external PLCs (over serial Modbus) or the drive (using built-in PLC instructions). The purpose and scope of the onboard PLC is to provide the user with solutions that a simple PLC can provide. The GS20(X) PLC is perfectly suited for simple PLC applications, where digital and analog I/O requirements are small. For applications with complex PLC programming or large I/O requirements, please consider Click, Productivity, or Do-More/BRX. All of these PLCs can be easily integrated with the GS20(X) drive or PLC. The optional GS4-KPD keypad of the GS20(X) is capable of storing multiple PLC programs (PLC must be disabled to perform a keypad copy).

There are *two methods* for communicating with the GS20(X) PLC. The *first method* is to use the *WPR* (write to parameters) *and RPR* (read parameters) *instructions* available in the PLC's library. These two instructions can read from or write to any GS20(X) AC drive parameter in the same physical drive, but not to other GS20(X) drives. The *second method* is to use *Modbus RTU*. The PLC is a Serial Modbus slave only. A Modbus RTU master can communicate with the PLC via serial only; the GS20(X) Modbus TCP/EtherNet/IP communication card cannot address the PLC. If the Modbus TCP/EtherNet/IP card is the desired method of communication, then parameters P09.11~P09.26 (PLC Buffers) can be used. Simply write the needed information from the PLC into the drive's PLC buffer parameters using the WPR instruction. The Modbus TCP/EtherNet/IP card can then read the VFD parameters.

For more detailed serial communication parameter information, refer to Chapter 5: Serial Communications. For more detailed Modbus TCP/EtherNet/IP communication card parameter information, refer to Appendix B.

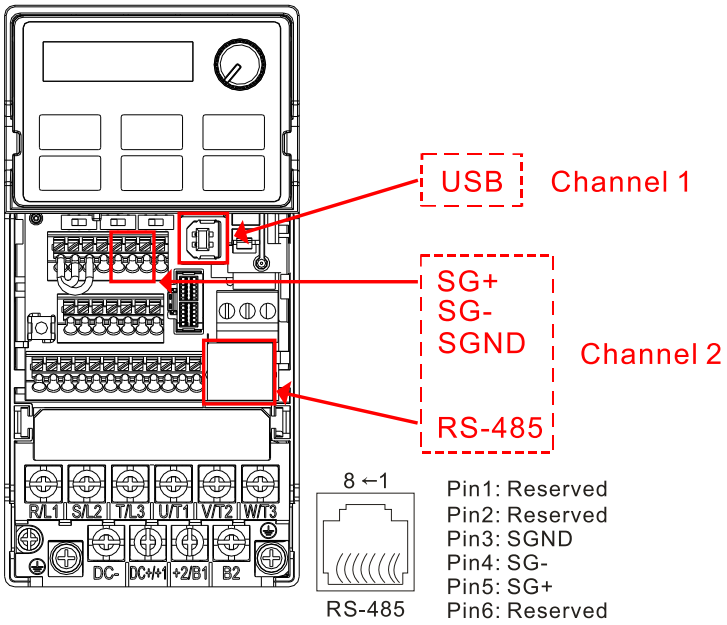
CAUTION: IF THE PLC IS IN CONTROL OF SPECIFIC INPUTS AND OUTPUTS, ONCE THE PLC IS DISABLED THE BEHAVIOR OF THE INPUTS AND OUTPUTS ARE NOW CONTROLLED BY P02.01–P02.07 / P02.13–P02.17. IT IS GOOD PRACTICE TO SET THE I/O THAT IS USED IN THE PLC TO "NO FUNCTION," SO WHEN THE PLC IS DISABLED THERE IS NOT SUDDEN OR UNEXPECTED MOTION.

Notes on Using GSLogic, the GS20(X) PLC, and the GS20(X) Drive

1) The GS20(X) PLC default node address is 2. The PLC node address can be changed in parameter P09.35, but this address cannot be the same as the GS20(X) drive node address of P09.00, which has a default node of 1. If multiple GS20(X) drives and PLCs will be connected to a third-party Modbus Master, *be sure to avoid duplicate node numbers*.
2) The GS20(X) drive provides one RJ45 port and one set of terminals (SG+ & SG-) for serial RS-485 communications, internally wired in parallel, that can be used to connect to RS485 networks. The GS20(X) drive provides one Type B Serial port that can be used to connect to a PC and download PLC programs using GSLogic (see figure below).

   Channel 1 (Type B USB Serial for PC communication only) has a fixed communications format, and can only be used to connect the drive with GSlogic software on a PC. Ensure GSlogic Communication serial RTU/ASCII setting match the Drive Parameter P09.04 setting. All other settings are hard coded for this channel.

   Channel 2 is the serial interface to Modbus-capable PLCs, HMIs, and PCs for programming and reading/writing data. Channel 2 can be accessed via the built-in RJ45 connector (ideal for connecting multiple drives together with standard RJ45 cables) or via the SG+, SG-, and SGND terminals. Channel 2 has a default communications setting of 9600, 8, O, 1 Modbus RTU (one RJ45 port and one set of terminals for RS-485). If communication settings in P09.01 and P09.04 are changed, this also changes the PLC comm settings. The Drive node and PLC node will always have the same serial baud rate and protocol. The communication settings are the same for the PLC and Drive communications, programming, and configurations. P09.01 and P09.04 are used to set up the serial communication rate and protocol.



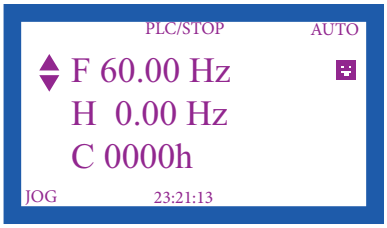
Note: If using both Modbus connection points (Terminal block and RS-485 Port), ensure you have the same ground reference. Non-equivalent grounding, or grounding from different references, can introduce noise issues that interfere with communications.

4) A client can simultaneously access data from the GS20(X) drive and the internal PLC. This is performed by using the two node numbers. For instance, if the GS20(X) drive node is 1 and the internal PLC node is 2, then the client command will be: 01 (node) 03 (read) 0400 (address) 0001 (1 data item), indicating that it must read the data from the GS20(X) drive parameter P04.00. Or the client will select the PLC: 02 (node) 02 (read) 0800 (address) 0001 (1 data item), indicating that it must read the data from the internal PLC which is the address to internal bit M0.
5) The PLC program will be disabled from running when uploading/downloading programs.
6) Please note when using WPR (Write to Drive Parameters) commands, values may be modified up to a maximum of 10^6 times. More than this number of writes will result in a memory write error. The calculation of modifications is based on whether the entered value has been changed. If the entered value is left unchanged, the modification count will not increase. But if the entered value is different from before, the modification count will increase by one.
The parameters in the following table are exceptions, and can be written to an unlimited number of times. The FREQ instruction is also an exception to this.

Parameter	***Description***
P00.10	Control Mode (Speed or Torque)
P00.11	(Speed) Control Mode
P00.27	User-defined value
P01.12~P1.19	1st~4th Acc/Dec Time
P02.12	Multi-Function Input Contact Selection
P02.18	Multi-Function Output Contact Selection
P04.50–P04.69	PLC buffer 1~20
P08.04	Upper Limit for Integral Time
P08.05	PID Output Frequency Limit
P10.17	Electronic gear A
P10.18	Electronic gear B
P11.34	Torque command

7) When parameter P00.04 is set to 28 (User Display = PLC D1043 Value), the GS20(X) keypad displayed value will be the value of PLC register D1043.

Optional Digital Keypad GS4-KPD Can Display 0~FFFF (hex). (See the 3rd line in the figure below)



8) In the PLC Run and PLC Stop modes, the parameter P00.02 cannot be set to 9 or 10 (cannot be reset to factory defaults). PLC must be in Disable mode (PLC0) for this. A power cycle is needed after resetting to defaults.

9) The PLC memory will be cleared and the program erased from the PLC when parameter P00.02 is set to 6. The PLC must be in Disable mode before resetting the PLC.
10) When the PLC controls the GS20(X) drive operation, control commands will be entirely controlled by the PLC, and will *not* be affected by the setting of parameter P00.21 or P00.31.
11) When the PLC controls the GS20(X) drive frequency commands, the commanded frequency will *not* be affected by parameter P00.20, P00.30, or the P00.29 Hand ON/OFF configuration.
12) The use of certain registers will disable the drive's control of the drive output frequency. The instructions and registers that transfer control of the drive output to the PLC are: FREQ, M1040, M1025, M1026, and M1027. See P00.19 or P09.33 for details about what the PLC controls.
13) GS20(X) PLC is limited to 2,000 Steps. Steps in the PLC program are not directly proportional to rungs. See GSLogic Help inside the GSLogic software for additional information.
14) When the PLC controls the drive operation, if the keypad STOP (P00.32) setting is valid, this triggers an FStP error and causes the drive to stop.
15) The corresponding drive parameter Multi-Function Inputs and Outputs will be disabled when the PLC ladder program contains external terminal usage X and Y registers. (*See GS20(X) AC Drive to PLC Input/Output Cross Reference tables, page 8–9 & page 8–9.)*
16) Several parameters in the GS20(X) drive are directly related to the GS20(X) PLC operation, monitoring, or control.

GS20(X) AC Drive Parameters Related to GS20(X) PLC	
Parameter/Setting Number	***Parameter/Setting Description***
P02.01~P02.07 = 51	Multi-Function Inputs = PLC Mode Select bit 0
P02.01~P02.07 = 52	Multi-Function Inputs = PLC Mode Select bit 1
P02.52	PLC Digital Input Mask
P02.53	PLC Digital Output Mask
P03.30	PLC Analog Output Mask
P00.04 = 28	User Display = PLC D1043 Value (displayed only in hexadecimal)
P09.11~P09.26	PLC Buffers
P09.01 = 9.6	Modbus Baud Rate = 9.6k
P09.04 = 13	Modbus Protocol = 8,N,2 (RTU)
P00.02 = 6	Parameter Reset = Reset PLC (clear PLC)
P00.19	PLC Command Mask
P09.35 = 2	PLC Address = 2 (Cannot be the same as the address of the drive (P9.00))
P09.33	PLC Frequency Command Force to 0

Getting Started

The GS20(X) automatically switches to PLC mode when the external multi-function input terminals (DI1–DI7) are in PLC Mode selection bit 0 (51) or PLC Mode selection bit1 (52), and the terminal contact is closed or open. In this case, keypad switching is invalid. The corresponding actions are listed below:

PLC mode		PLC Mode selection bit1 (52)	PLC Mode selection bit0 (51)
Using GS4-KPD (optional)	Using GS20(X) Keypad		
Disable	PLC 0	OFF	OFF
PLC Run	PLC 1	OFF	ON
PLC Stop	PLC 2	ON	OFF
Maintain previous state	Maintain previous state	ON	ON

- *When the PLC screen from the keypad is set to PLC0 (or "Disable" on GS4-KPD), the built-in PLC is disabled and you cannot use GSLogic to connect to it.*
- *When the PLC screen from the keypad is set to PLC1 (or "PLC Run" on GS4-KPD), the built-in PLC is enabled and you can use GSLogic to connect to it through Modbus.*
- *When the PLC screen from the keypad is set to PLC2 (or "PLC Stop" on GS4-KPD), the built-in PLC is enabled and you can use GSLogic to connect to it. However, the programs in the built-in PLC do not work.*
- *When the built-in PLC is enabled (PLC1 or PLC2), you can switch between PLC Run or PLC Stop through GSLogic.*
- *The external terminal control method is the same as shown in the table above.*

NOTE: When the input/output terminals (DI1-DI7, R1, and DO) are included in the PLC program, these input/output terminals are used only by the PLC. For example, when the PLC program controls Y0 during PLC operation (PLC1 or PLC2), the corresponding output terminal relay (R1) operates according to the program. At this time, the multifunctional input/output terminal setting has no effect. Because these terminal functions are already being used by the PLC, you can determine the DI/DO/AO in use by the PLC by looking at P02.52, P02.53, and P03.30.

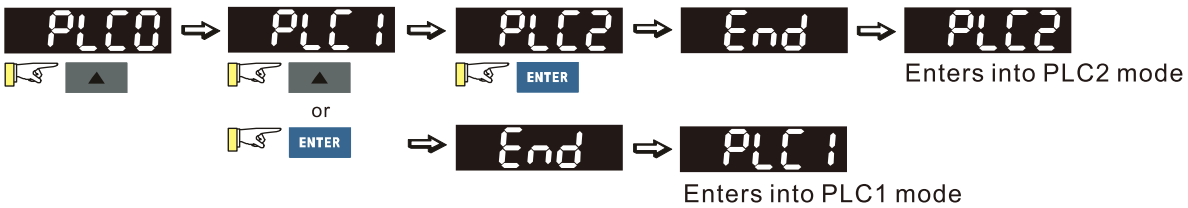
NOTE: When the PLC program uses special register D1040, the corresponding AO contact AO1 is occupied.

NOTE: P03.30 monitors the action state of the PLC function analog output terminals; bit 0 corresponds to the AO1 action state.

Connect to PLC

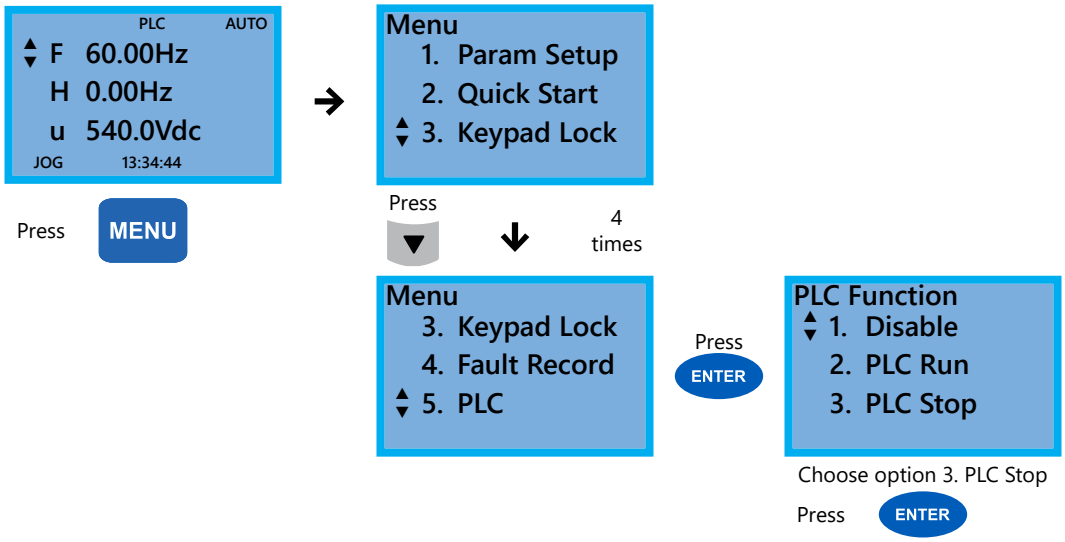
Start operation of PLC functions in accordance with the following steps from the GS20(X) drive keypad.

1) Press the MENU button on the keypad until PLC0 appears.
2) Press the UP arrow key to navigate to PLC1 or PLC2 as desired.
3) Press ENTER to start the selected PLC mode.



If using the optional GS4-KPD, follow the four steps below instead:

1) Using the Menu key on the GS20(X) digital keypad, select 5: PLC, press Enter key (see figure below).
The PLC can be connected to only when in Run or Stop modes. When it is in Disable mode the communications to the PLC will be terminated.

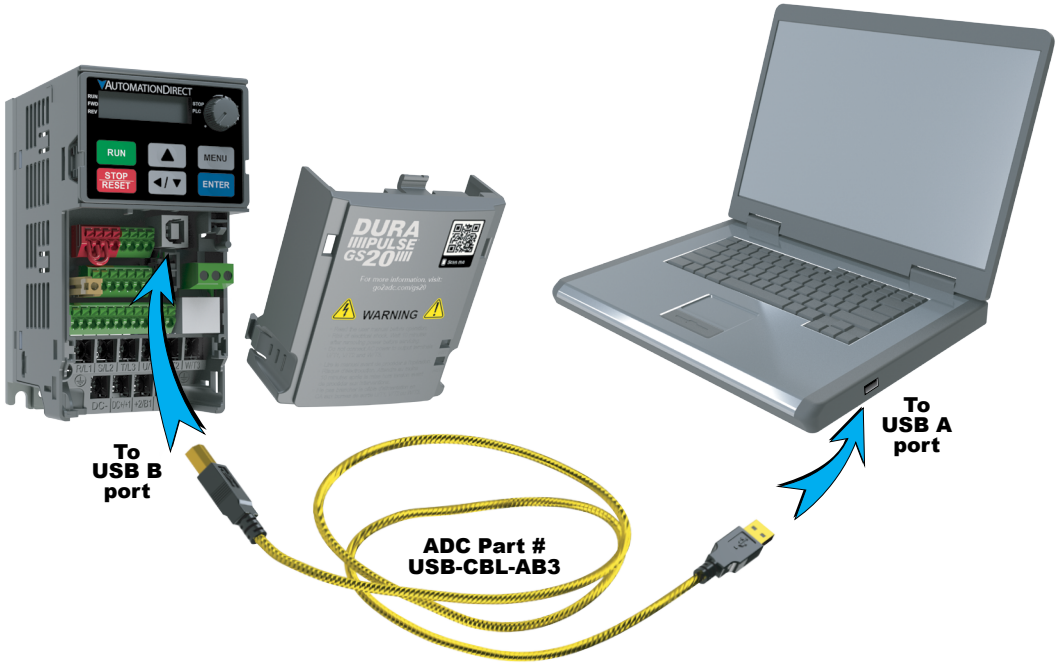


PLC functions are as shown in the lower right menu of the figure above; options 2 or 3 will enable the PLC communication connection. Choose 3 (stop) for now, or if you do not know what the PLC might do if placed into Run mode.

1: PLC0 - Disable: No function
2: PLC1 - PLC Run: Enable PLC functions
3: PLC2 - PLC Stop: Stop PLC functions

Important: When the PLC is Disabled, the PLC Modbus RTU node does not exist, and no communications to the PLC can occur. The PLC must be in Run or Stop for GSLogic or a Modbus device to be able to connect.

2) Wiring: Connect the GS20(X) drive USB serial communication interface port to a PC USB port. Then you are ready to install and connect to GSLogic software.



Controlling Drive IO with the PLC

When the external Multi-Functional Input terminals (DI1 to DI7, P02.01 to P02.07) are set to function 51 or 52 (PLC Mode select bit0 or bit1), the digital inputs have priority and the keypad will not be able to change PLC modes.

PLC Mode	Select Bit1 (52)	Select Bit0 (51)
PLC0 - Disable	OFF	OFF
PLC1 - PLC Run	OFF	ON
PLC2 - PLC Stop	ON	OFF
Maintain Previous State	ON	ON

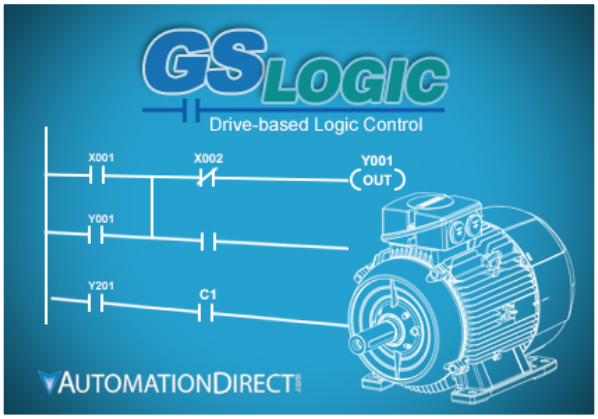
GS20(X) AC Drive to PLC *Input* Cross Reference			
GS20(X) Digital Input	PLC Address	GS20(X) Analog Input	PLC Address
FWD (DI1)	X0	AI1	D1028
REV (DI2)	X1	AI2	D1029
DI3	X2	–	
DI4	X3		
DI5	X4		
DI6	X5		
DI7	X6		

GS20(X) AC Drive to PLC *Output* Cross Reference			
GS20(X) Digital Output	PLC Address	GS20(X) Analog Output	PLC Address
R1-R1C-R1O	Y0	AO1	D1040
DO1	Y3	–	
DO2	Y4		
–			

NOTE 1: When X and Y addresses for the input and output terminals are included in the PLC program, these input/output terminals will only be used by the PLC. The DI and DO multifunction assignments are configured by parameters P02.01~P02.07 and will be overridden. As an example, when the PLC program controls Y0 during PLC operation, the corresponding output terminal relay (R1) will operate in accordance with the program. At this time, the Multi-Function Output terminal setting P02.13 will be ineffective because these terminal functions are already being used by the PLC.

NOTE 2: When the PLC uses the special registers D1040, the corresponding Analog Output AO1 will only be used by the PLC overriding the multifunction configuration. The AO multifunction assignments, when they are drive controlled, are configured by parameter P03.20.

Installation of GSLogic Programming Software



System Requirements

GSLogic Windows-based programming software environment. Please check the following requirements when choosing your PC configuration:

- *Windows OS: 7: 32 & 64 bit, 8: 32 & 64 bit, 8.1: 32 & 64 bit, 10: 64 bit*
- *SVGA 1024x768 pixels resolution (1280x1024 pixels resolution recommended)*
- *300MB free hard-disk space*
- *RAM: Windows 7, 8, 10*
  - *with GUI version 2.0.0.x or higher, RAM = 2GB memory (4GB recommended)*
  - *with GUI version 1.10 or lower, RAM = 512MB free RAM (1GB recommended)*
- *USB Port for project transfer to GS20(X)*

About Getting Started

If you are familiar with Programmable Logic Controllers in general, then following the simple steps in this chapter may be all you require to start being productive using a GS20(X) PLC system. After you have completed the steps, your GS20(X) controller will be running the ladder logic project that you programmed.

Software and Online Help Files

The GSLogic programming software is available as a download from our website:

www.automationdirect.com/pn/gslogic

The GSLogic software includes searchable online help topics covering all aspects of the software, instruction set, setup, and communications.

Technical Support

We strive to make our manuals the best in the industry. We rely on your feedback to let us know if we are reaching our goal. The feedback section of the Help File can be used to send a comment to Technical Support. If you cannot find the solution to your particular application, or if for any reason you need technical assistance, please call us at:

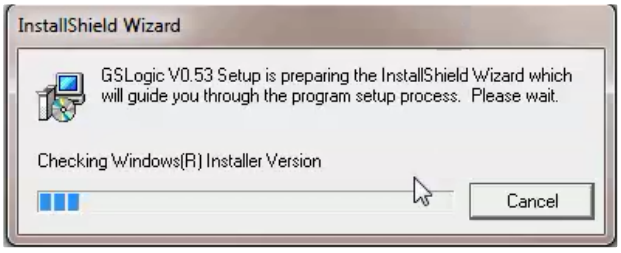
1–770–844–4200

Our technical support group will work with you to answer your questions. They are available Monday through Friday from 9:00 A.M. to 6:00 P.M. Eastern Time. We also encourage you to visit our web site where you can find information about our company and specific technical information about a wide array of our products.

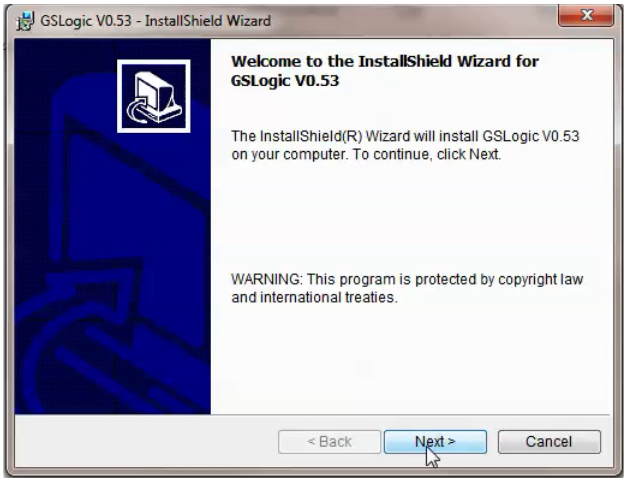
https://www.automationdirect.com

Installing GSLogic Programming Software

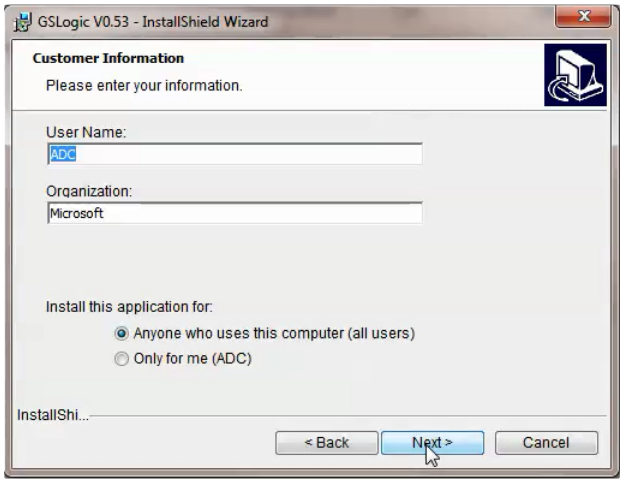
1) Download the latest version of the GSLogic Software, (See ADC's website for GSLogic editing software: www.automationdirect.com/pn/gslogic). Or, if the GSLogic USB drive is available, insert it into your PC USB port. Open the GSLogic setup.exe file.
2) The "InstallShield Wizard" popup (shown below) will appear briefly while the software is checking for previous installs.



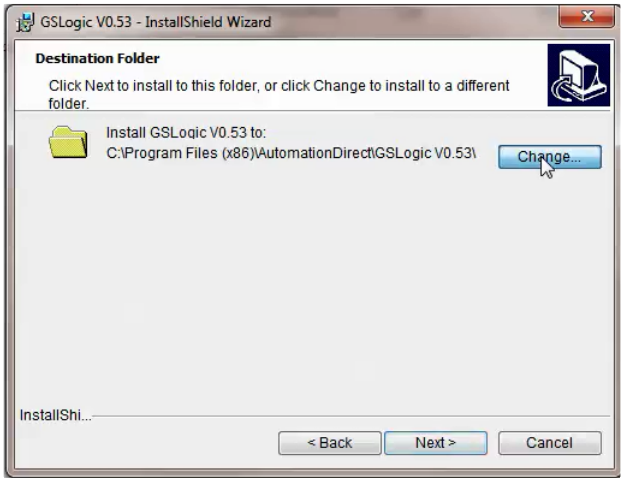
3) The Welcome popup will appear, allowing you to choose to proceed or not. Click the "Next" button to install.



4) The "Customer Information" window will open next. Enter a User Name and Organization name, then click "Next."

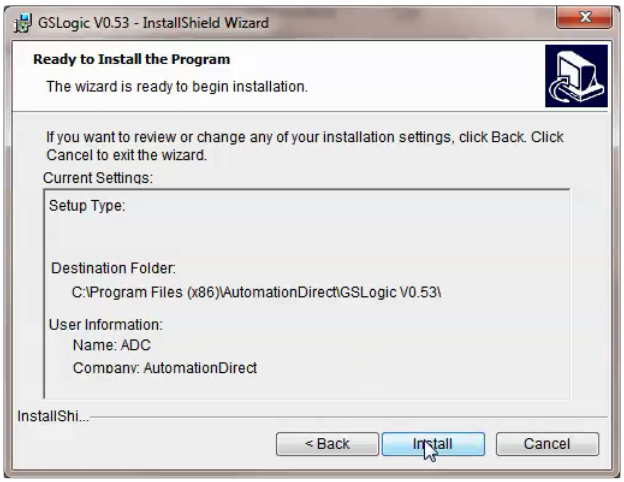


5) The Destination Folder popup will appear, showing the default path to the destination file; click “Next” to continue. Should you want to change to another destination, Click “Change” and another dialog box will appear, allowing entry of a new file path.

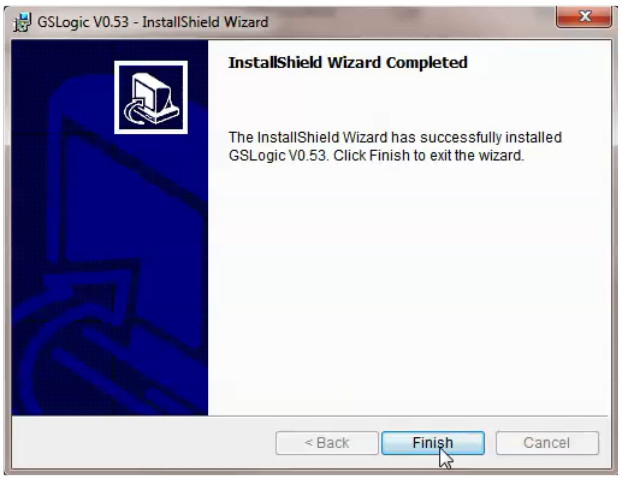


The default installation folder is:
C:\Program Files (x86)\
AutomationDirect\GSLogic Vx.xx

6) Once you have selected the install folder (default or new path), the “Destination Folder” window will appear. Click “Next” to continue the installation process. Click “Install” when ready to install the software.



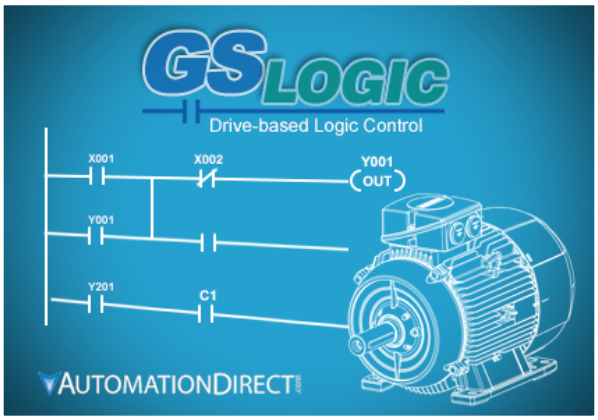
7) The Installation is now complete. Click “Finish.” Double-click on the GSLogic icon or navigate to the AutomationDirect folder in the start menu to open the GSLogic programming environment.



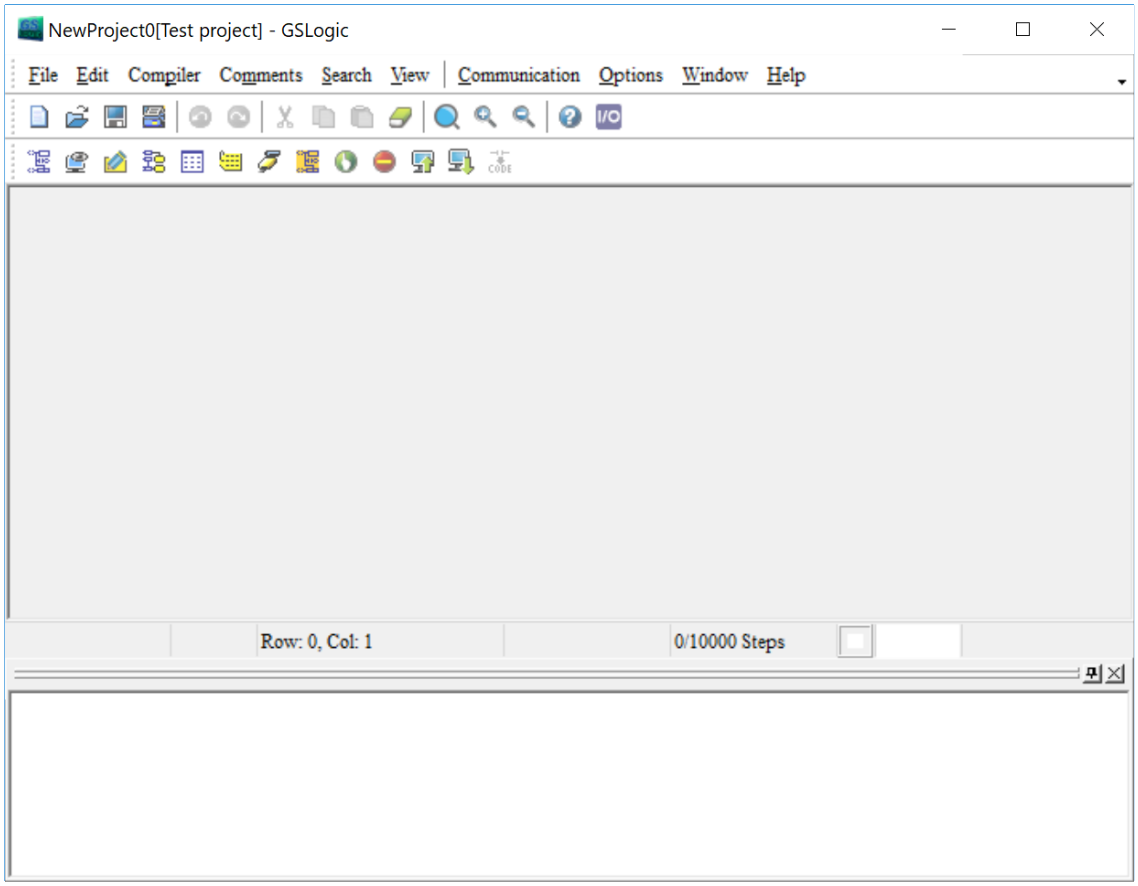
Program Writing

Connecting GSLogic PC to GS20(X) PLC

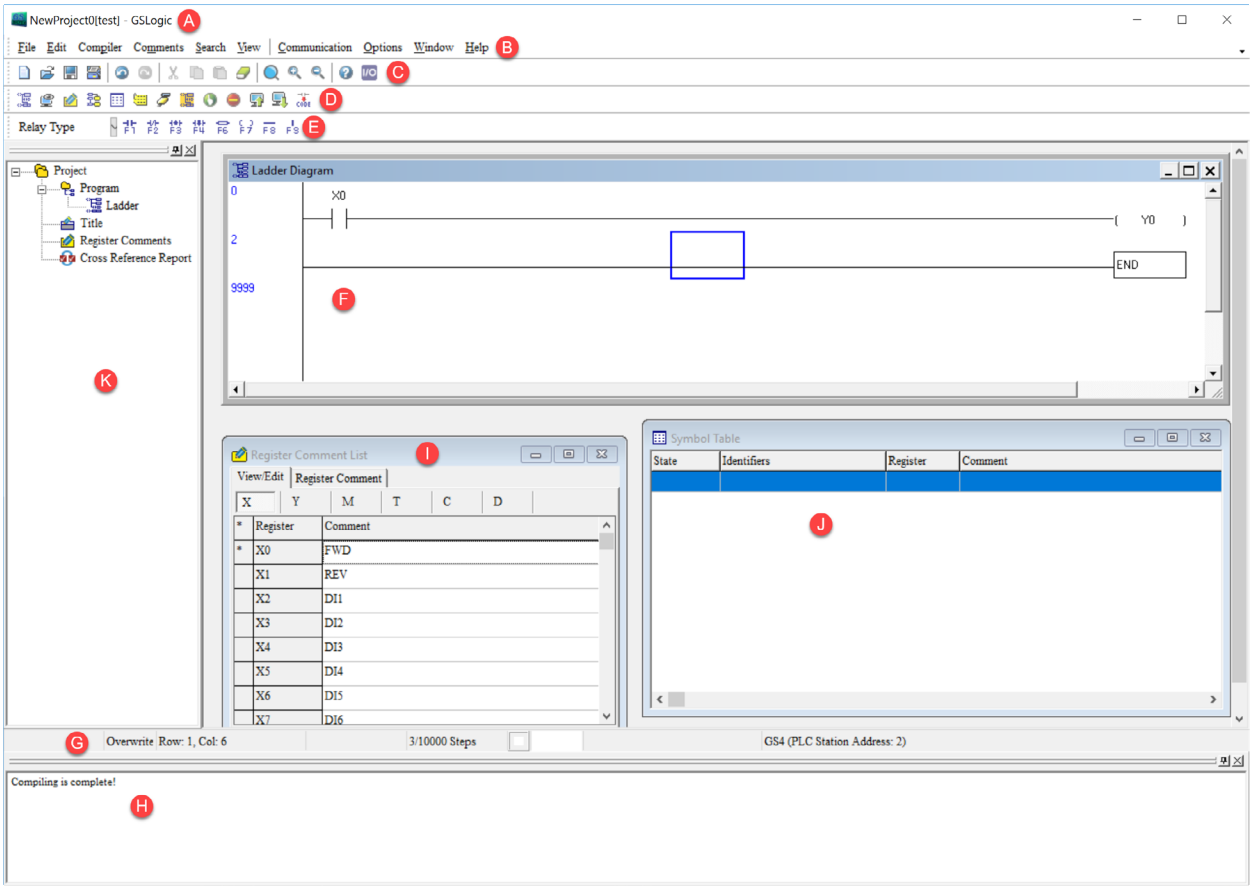
In order to connect to the PLC with GSLogic, the PLC must be enabled by either selecting PLC1 or PLC2 on the GS20(X) keypad, or PLC Run or PLC Stop in the optional GS4-KPD keypad. Also, no other Modbus master can be connected to the GS20(X) drive; *this includes GSOFT2*.



When running GSLogic for the first time, before a "New file" has been used, only the "File (F)," View (V)," "Communications (C)," "Options (O)," and "Help (H)" functions will appear on the function toolbar.

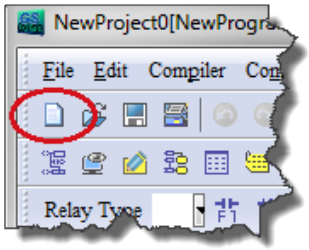


After running GSLogic for the second time, the last file edited will open and be displayed in the editing window.

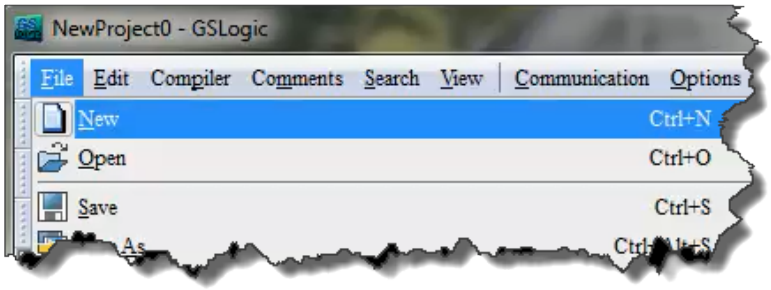


Following is a brief description of the various areas in the GSLogic editing software window shown above.

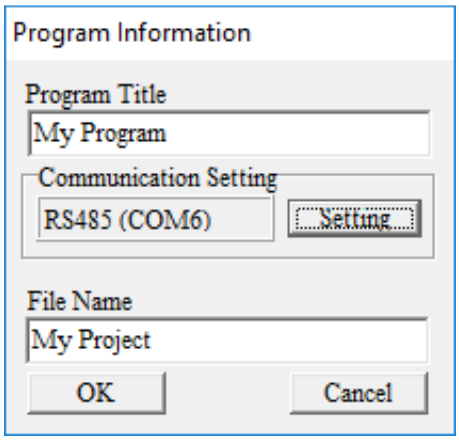
Symbol	Name	Description
A	Project Title Toolbar	Project File Name and Project Title shown here (File Name [Project Title])
B	Menu Toolbar	Individual drop-down menu options
C	Standard Editing Toolbar	Contains standard Windows application features
D	PLC Quick Access Toolbar	Allows easy access to the most commonly used GSLogic tasks
E	Ladder Editing Toolbar	Provides quick access to the most common devices used in creating ladder code
F	Ladder Diagram Window	Where the program ladder code is entered and edited
G	Status Toolbar	Displays messages regarding PLC and program status
H	Output Window	Shows compiling status and error messages
I & J	Auxiliary Window	The Symbol Table and Register Comment List Window are shown in order to demonstrate how multiple windows can be placed in the workspace.
K	Reveals or hides the Project Workspace Window	From here, you can open the Ladder Diagram window, change the project title and description, Register Comments, and view the Cross Reference table.



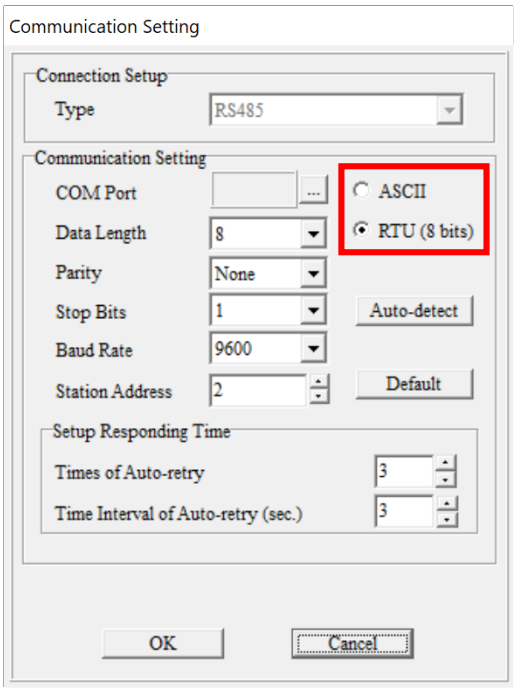
Click the “NEW FILE” icon on the toolbar to open a new file (Ctrl+N).
You can also use “File (F)”=>New file (N) (Ctrl+N).



The “Program Information” window will appear after opening a new file.
Enter the Program Title and File Name. These will appear at the top of the project window.



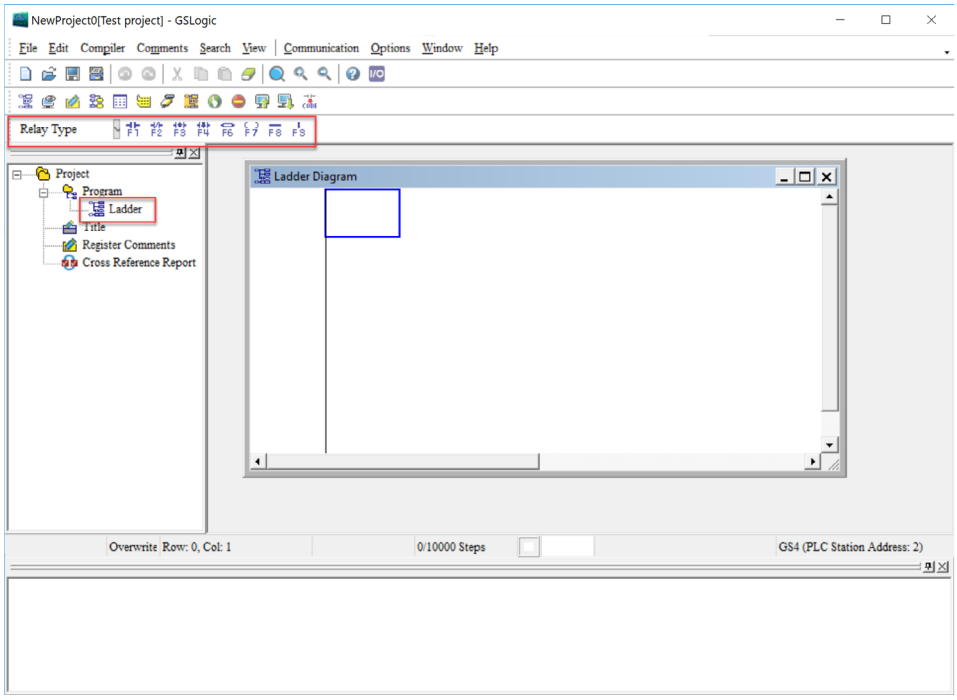
Select “Setting” to choose the communication settings to be used. To adjust communication settings on an existing project, go to the Communication menu and select “Communication Settings.” Choose the correct COM Port and ASCII/RTU setting. Only the GSLogic communication settings selection for ASCII or RTU must be the same as the Drive’s ASCII/RTU setting found in P09.04. All other settings on this window can be left at default. These values are hard coded in the GS20(X) drive to communicate with GSLogic.



Communication Setting: Perform settings in accordance with the desired communications method. The Default Station Address for the PLC is 2. (The Modbus station address must be different from the GS20(X) Drive’s station address. The Drive’s default address =1.)

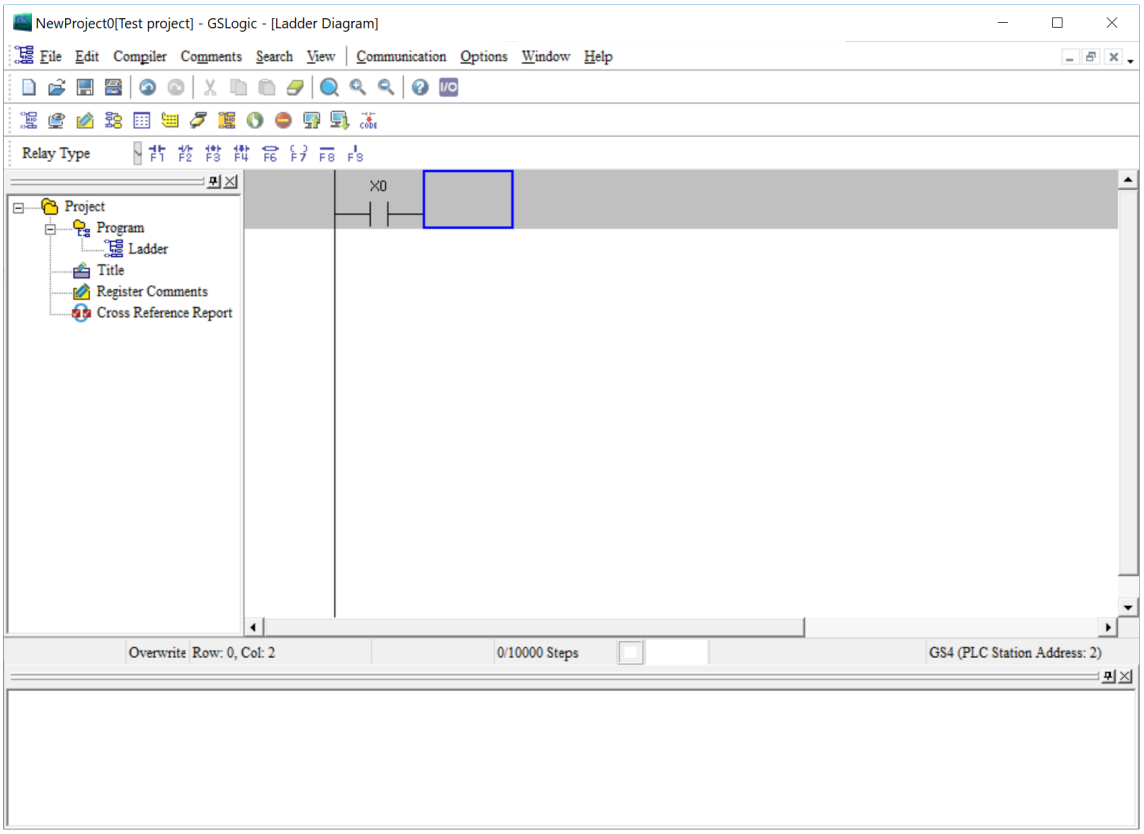
Click “OK” after completing settings to return to program editing in ladder diagram mode.

In ladder diagram mode, you can perform program editing using the buttons on the Ladder Diagram Toolbar.

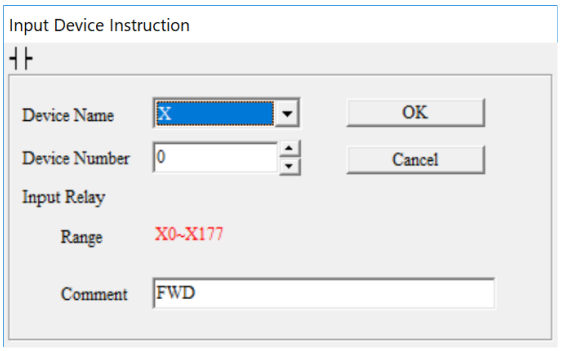


Basic Ladder Program Example

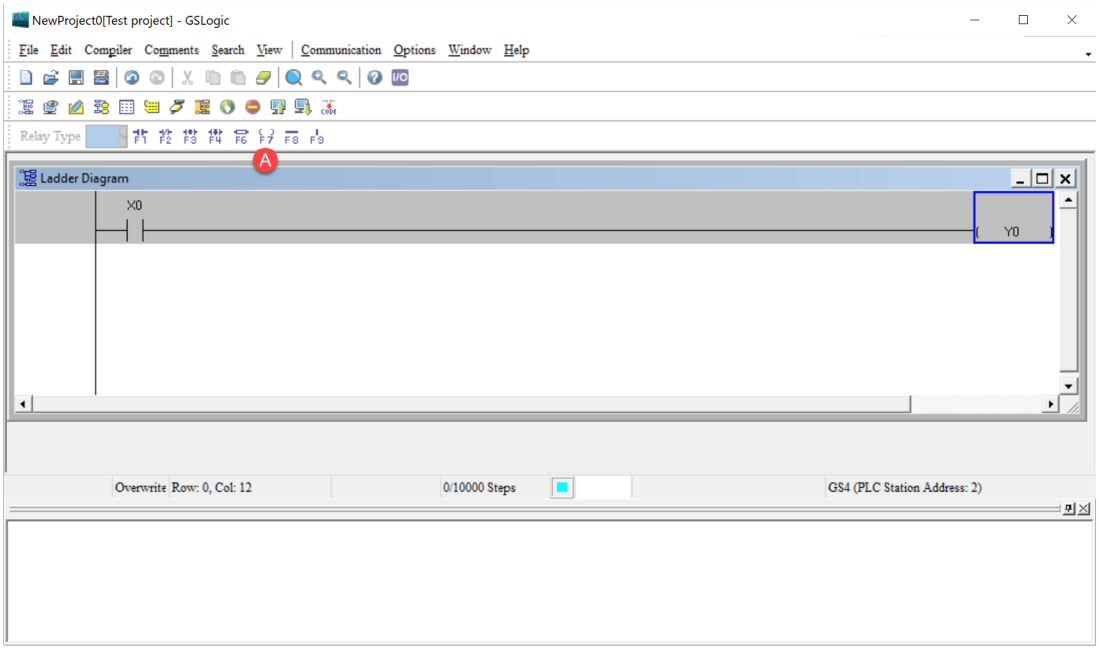
1) With the cursor in the ladder diagram editor window, select a "Normally Open" contact icon from the Ladder Editing Tool Bar, or use keyboard function key (F1) operation.



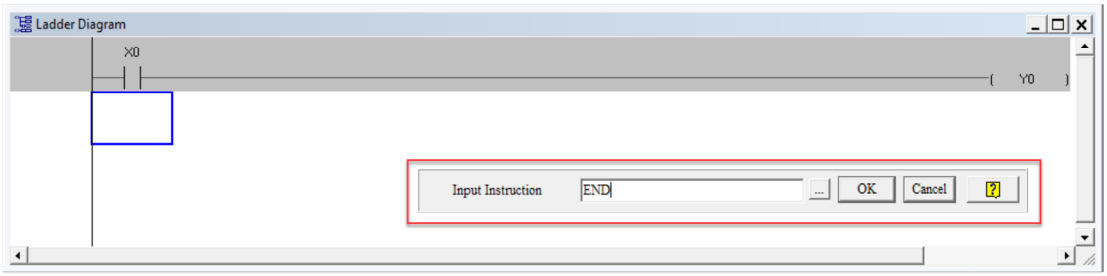
2) The Input Device Instruction dialog box will appear. Select the device name (such as "M" or "X"), the device number (such as "10" or "0"), and input comments (such as "Enable Pushbutton") can be selected; click the OK button when finished. X0 is a digital input which is tied to the FWD terminal of the drive. Any preconfigured behavior of the terminal is void now that the input is being used in the PLC code. Once the PLC is in Disable Mode, the control of the digital input terminal will belong to the drive again.



3) Click on the output coil icon (a) or press function key F7. In the Input Device Instruction dialog box choose device name (such as "M"), device number (such as "0"), and input comments (such as "Enable Light"). Click the OK button when finished.



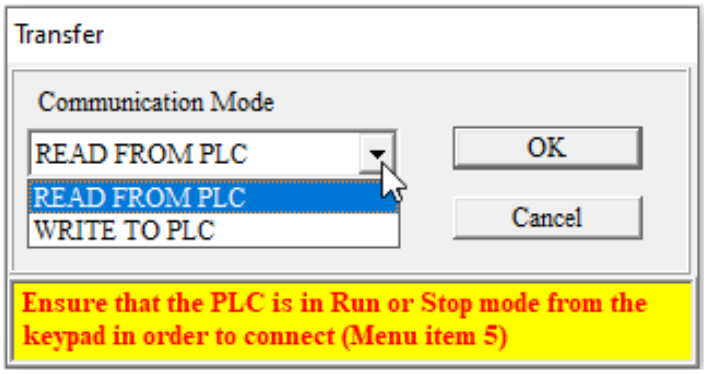
4) While the cursor edit box is on the next row, double-click in the cursor box to bring up the Input Instruction text box (or press F6 to invoke the Instruction List dialogue box). Type in "End" and click OK to add the end instruction rung to the ladder program. This signals the end of the ladder program.



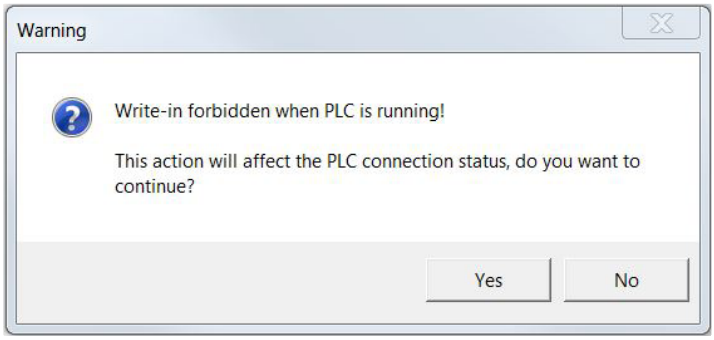
5) Click on the compile (CODE) icon on the tools ribbon. After compiling, the number of steps will appear on the left side of the editor window. The PLC can only accept 2,000 steps.
Note:
Steps in the PLC program are not proportionally related to rungs. One rung of code with a single contact and a single coil would have two steps for that one rung. A rung with one contact and the FREQ instruction would have eight steps.

Program Download

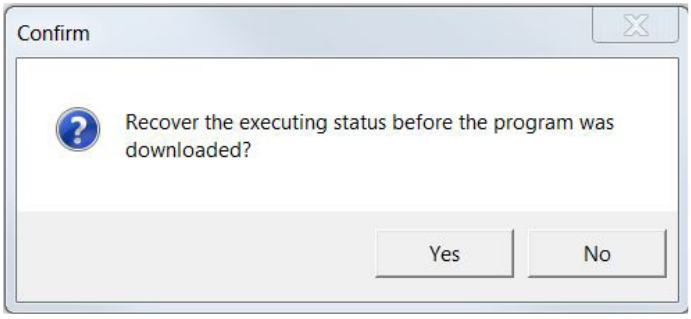
Be sure the PLC is NOT in Disabled mode (PLC0) on the GS20(X) keypad. After creating and compiling a program using GSLogic, select the Write to PLC icon on the tool ribbon ( ). When the Transfer Setup window appears, make sure that the Communication Mode is set to "Write to PLC," which will download the program to the PLC. GSLogic will perform program download with the GS20(X) drive PLC in the communications format specified in previously set up communications settings dialog box.



If the PLC is in Run mode, a warning will appear asking if you want to continue. Press Yes if you want to proceed with the download.



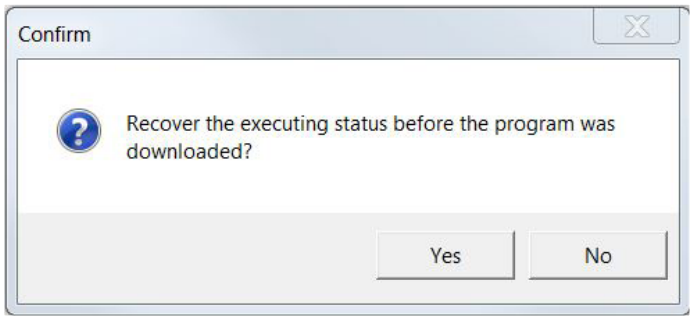
After the program has downloaded, GSLogic will ask you to confirm that you want to put the PLC back in the previous run/stop state it was in before the download. Click Yes if you would like to recover this state.

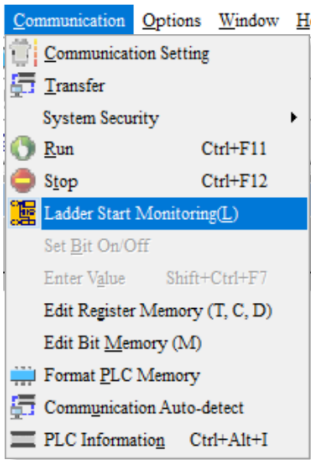


If the PLC is in Run mode, then the ladder code is now running on the GS20(X) PLC.

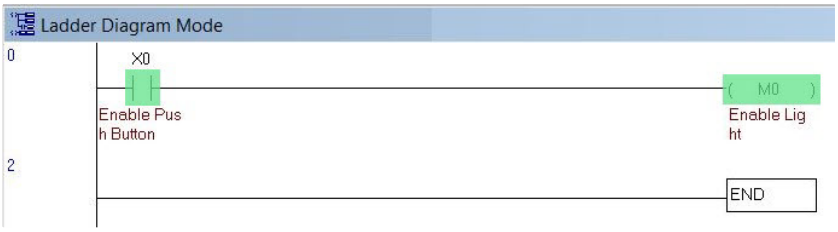
Program Monitoring

Press the Online Mode icon ( ) to go online with the PLC and the current ladder code, and confirm the PLC is in Run Mode at the bottom of the screen. While confirming that the PLC is in the Run Mode after downloading a program, click on the Ladder Start Monitoring icon ( ) in the Communication menu drop-down, or on the tools ribbon (see figures below).

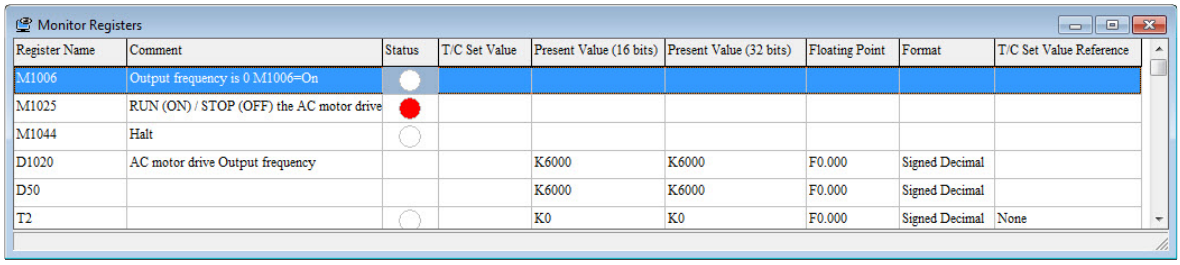




If you select the Ladder Start Monitoring icon, a live view of the ladder diagram can be viewed similar to the image below. A contact, coil, or instruction highlighted in *green* indicates that it is *conducting* if it is a *contact*, and it is *activated* if it is a *coil or instruction*.



Press the Edit Monitored Registers icon ( ) to monitor and edit values live in the PLC code. In order to monitor a specific register either double click or right click on a row in the window and type in the register you wish to monitor. To change the value of the register right click on the row and enter the desired value.



Register Name	Comment	Status	T/C Set Value	Present Value (16 bits)	Present Value (32 bits)	Floating Point	Format	T/C Set Value Reference
M1006	Output frequency is 0 M1006=On							
M1025	RUN (ON) / STOP (OFF) the AC motor drive							
M1044	Halt							
D1020	AC motor drive Output frequency			K6000	K6000	F0.000	Signed Decimal	
D50				K6000	K6000	F0.000	Signed Decimal	
T2				K0	K0	F0.000	Signed Decimal	None

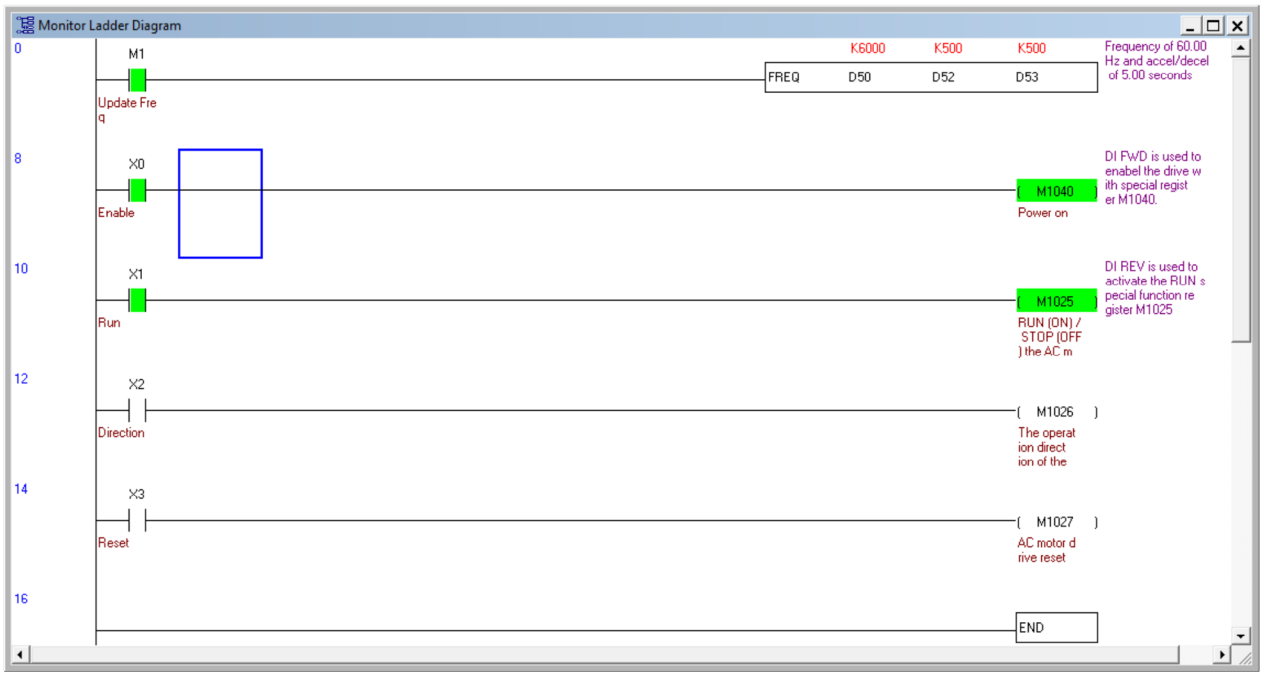
This chapter is designed to be an overview and quick-start guide to get you quickly up and running your first PLC program. For more details and further explanation of the user interface, instruction set, and implementing the PLC, please refer to the GSLogic Help File. This Help File can be accessed under the "Help" menu or anywhere you see the "?" symbol.
Help on all of the following is located in the GSLogic Help file: Full description of the user interface, menu items, windows, and tool bars; Basics of the PLC; Special Function registers; Full set of PLC Instructions; Memory locations and data types; Using the digital and analog I/O; Communication with the PLC and MODBUS addresses.

GS20(X) GSLogic Program Examples

Ex 1: GS20(X) Drive Control from GS20(X) PLC

Below is an example in which the drive PLC has control of the drive run, stop, direction, reset, and speed controls. After GSLogic installation, example programs can be found in \Documents\ AutomationDirect\GSLogicV100\.

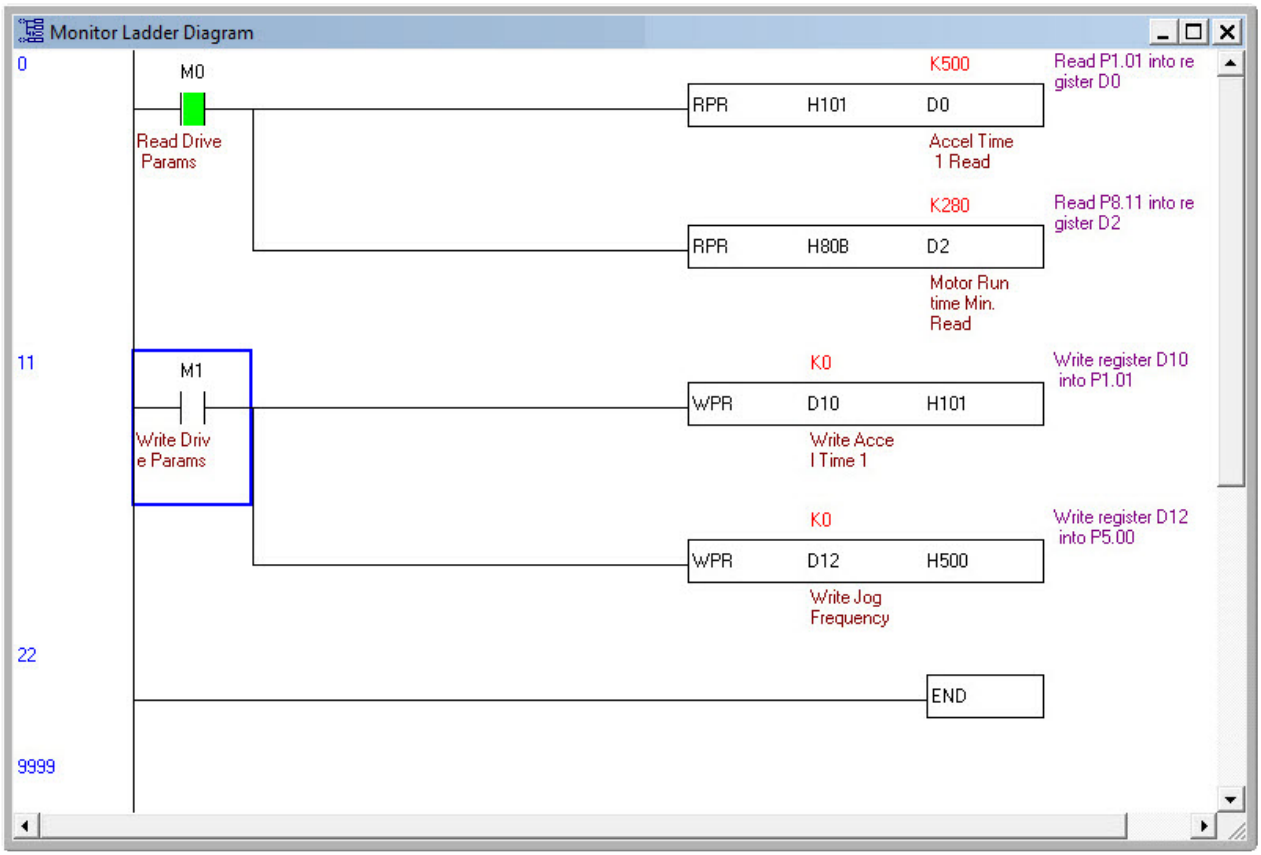
- *Rung 1: When bit M1 is on the FREQ instruction will write the values in D50, D52, and D53 to the drive. This instruction will not cause the drive to run on its own. M1 can be turned on either via Modbus or through GSLogic. The values of D50, D52, and D53 are populated using GSLogic by modifying the register.*
- *Rung 2: X0 (Digital input FWD) will turn on the output relay and allow power to the output of the drive.*
- *Rung 3: X1 (Digital input REV) will tell the drive to run at profile assigned in the FREQ command in rung 1.*
- *Rung 4: X2 (Digital input 3) will change the direction of rotation of the motor.*
- *Rung 5: X3 (Digital input 4) will reset any resettable faults in the drive, if they occur.*



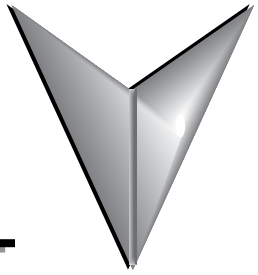
Ex 2: Drive Intercommunications

Below is an example of using the PLC to read and write to the VFD parameters using the RPR and WPR instructions. The WPR (Write Parameter) follows the same rules as when entering new values through the keypad. Even when using the WPR instruction, a Stop-Mode-Only writable parameter can still be written to only when the drive output is stopped.

The comments on the right side of each rung describes what each RPR and WPR does in the following example.



ACCESSORIES



APPENDIX

A

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Fuses/Circuit Breakers

Protection devices are essential to prevent damage to your GS20(X) drive and application equipment. Please use the fuse specification chart below to select fuses that are applicable to your GS20(X) drive. Only use UL-certified fuses which comply with your local regulations.

Fuse Specification Chart GS20(X) *DURAPULSE* Drives									
Drive Model	**HP**	**Input Power**			**Input Fuse**			**Circuit Breaker**	
		Ø	**Volts**	**GS20(X) Input Amps**	**Fuse Amps**	**Fast Acting Class T**	**Edison Class J***	**Size**	**Note**
GS21-10P2	1/4	1	120	6.8	10	TJN10	JHL10	20	G3P-020
GS21-10P5	1/2	1	120	10.1	10	TJN10	JHL10	25	G3P-025
GS21-11P0	1	1	120	20.6	25	TJN25	JHL25	50	G3P-050
GS21-20P2	1/4	1	230	5.8	10	TJN10	JHL10	15	G3P-015
GS21-20P5	1/2	1	230	8.3	15	TJN15	JHL15	20	G3P-020
GS21-21P0	1	1	230	11.3	20	TJN20	JHL20	30	G3P-030
GS21-22P0	2	1	230	18.5	35	TJN35	JHL35	45	G3P-040
GS21-23P0	3	1	230	27.5	50	TJN50	JHL50	70	G3P-070
GS23-20P2	1/4	3	230	2.2	10	TJN10	JHL10	15	G3P-015
GS23-20P5	1/2	3	230	3.8	15	TJN15	JHL15	15	G3P-015
GS23-21P0	1	3	230	6	20	TJN20	JHL20	15	G3P-015
GS23-22P0	2	3	230	9.6	35	TJN35	JHL35	25	G3P-025
GS23-23P0	3	3	230	15	50	TJN50	JHL50	40	G3P-040
GS23-25P0	5	3	230	23.4	80	TJN80	JHL80	60	G3P-060
GS23-27P5	7 1/2	3	230	32.4	60	TJN60	JHL60	63	G3P-060
GS23-2010	10	3	230	43.2	80	TJN80	JHL80	90	G3P-090
GS23-2015	15	3	230	61.2	110	TJN110	JHL110	125	F3P-125
GS23-2020	20	3	230	82.8	150	TJN150	JHL150	160	BW250JAGU-3P160SB
GS23-40P5	1/2	3	460	2	10	TJS10	JHL10	15	G3P-015
GS23-41P0	1	3	460	3.3	15	TJS15	JHL15	15	G3P-015
GS23-42P0	2	3	460	5.1	20	TJS20	JHL20	15	G3P-015
GS23-43P0	3	3	460	7.2	25	TJS25	JHL25	20	G3P-020
GS23-45P0	5	3	460	11.6	45	TJS45	JHL45	30	G3P-030
GS23-47P5	7 1/2	3	460	17.3	35	TJS35	JHL35	32	G3P-030
GS23-4010	10	3	460	22.6	45	TJS45	JHL45	45	G3P-040
GS23-4015	15	3	460	30.8	60	TJS60	JHL60	60	G3P-060
GS23-4020	20	3	460	39.6	80	TJS80	JHL80	80	G3P-080
GS23-4025	25	3	460	45.7	90	TJS90	JHL90	90	G3P-090
GS23-4030	30	3	460	53.9	110	TJS110	JHL110	100	G3P-100
GS23-51P0	1	3	575	2.4	6	TJS6	JHL6	6	n/a
GS23-52P0	2	3	575	4.2	10	TJS10	JHL10	10	n/a
GS23-53P0	3	3	575	5.8	10	TJS10	JHL10	15	BW125JAGU-3P015SB
GS23-55P0	5	3	575	9.3	20	TJS20	JHL20	30	BW125JAGU-3P030SB
GS23-57P5	7 1/2	3	575	13.4	25	TJS25	JHL25	30	BW125JAGU-3P030SB
GS23-5010	10	3	575	17.5	30	TJS30	JHL30	30	BW125JAGU-3P030SB
GS21X-20P5	1/2	1	230	8.3	15	TJN15	JHL15	16	G3P-015
GS21X-21P0	1	1	230	11.3	20	TJN20	JHL20	25	G3P-025
GS21X-22P0	2	1	230	18.5	35	TJN35	JHL35	45	G3P-040
GS21X-23P0	3	1	230	27.5	50	TJN50	JHL50	63	G3P-060
GS23X-20P5	1/2	3	230	3.8	15	TJN15	JHL15	10	FAZ-C10-3-NA
GS23X-21P0	1	3	230	6	20	TJN20	JHL20	15	G3P-015
GS23X-22P0	2	3	230	9.6	35	TJN35	JHL35	25	G3P-025
GS23X-23P0	3	3	230	15	50	TJN50	JHL50	40	G3P-040
GS23X-25P0	5	3	230	23.4	80	TJN80	JHL80	60	G3P-060
(table continued next page)									

Fuse Specification Chart GS20(X) *DURAPULSE* Drives - continued									
Drive Model	**HP**	**Input Power**			**Input Fuse**			**Circuit Breaker**	
		Ø	**Volts**	**GS20(X) Input Amps**	**Fuse Amps**	**Fast Acting Class T**	**Edison Class J***	**Size**	**Note**
GS23X-27P5	7 1/2	3	230	32.4	60	TJN60	JHL60	63	G3P-060
GS23X-40P5	1/2	3	460	2.5	10	TJS10	JHL10	6	FAZ-C5-3-NA
GS23X-41P0	1	3	460	4.2	15	TJS15	JHL15	10	FAZ-C10-3-NA
GS23X-42P0	2	3	460	6.4	20	TJS20	JHL20	16	G3P-015
GS23X-43P0	3	3	460	7.2	25	TJS25	JHL25	16	G3P-015
GS23X-45P0	5	3	460	11.6	35	TJS35	JHL35	30	G3P-030
GS23X-47P5	7 1/2	3	460	17.3	35	TJS35	JHL35	30	G3P-030
GS23X-4010	10	3	460	22.6	45	TJS45	JHL45	45	G3P-040

** High-speed Class J.*

Note: JHL fuses can be used with GS and DURAPULSE drives in non-UL applications. Fuse the drive according to NEC guidelines (NEC Article 430). For UL applications, GS, and DURAPULSE drives require Class T fuses (refer to the drive's user manual for details).

Recommended Fuse Specifications for the DC-side of Common DC-Bus

These fuses are applicable only when connecting input power directly to the DC bus with terminals DC+ and DC-.

- *The fuse current specifications in table below are based on overloading. If there is no possibility of overloading during use then fuses with a lower rating than the table below are allowed. The DC-side current calculation method described in Chapter 3.1 DC Power Supply Applications can be used to calculate a suitable fuse rating for drive with DC current. Special cases such as overload or emergency stop must be considered however.*
- *For the DC-side fuse, please select a DC fuse or refer to the DC voltage specifications from the fuse parameters. The DC voltage rating must be higher than the operating voltage.*
- *Fuse selection should take into account operating class (e.g. High-speed or general purpose) and overloading.*
  a) If the drive is subject to overloading and high-speed fuse is used: Due to the speed of response the chosen fuse should be rated double that of the calculated maximum instantaneous DC current.
  b) If the drive is subject to overloading and normal fuse is used: Fuse selection should be based on the calculated maximum instantaneous current during overloading.
  c) If drive is not subject to overloading: Select a fuse with a current rating close to that of the calculated DC current.
- *UL-listed fuse suitable for short-circuit protection of inputs. "In the United States, branch circuits must comply with the US National Electrical Code (NEC) and its local directives." Please select a UL-listed fuse to comply with local regulations.*
- *"In Canada, branch circuits must comply with the Canadian Electrical Code and its local directives." Please select a UL-listed fuse to comply with local regulations.*

GS20(X) - DC Bus Fusing				
Requirement	**Drive Model**	**230V Drives**	**460V Drives**	**575V Drives**
DC Bus Voltage Level	all models	350	700	875
DC Bus Fuse Voltage Rating	all models	690	1250	1250
DC Bus Fuse (amps)	1P2 (1/4HP)	10	-	-
	1P5 (1/2HP)	10	10	-
	1P0 (1HP)	16	10	6
	2P0 (2HP)	25	16	10
	3P0 (3HP)	40	20	16
	5P0 (5HP)	63	30	20
	7P5 (7.5HP)	80	40	30
	010 (10HP)	100	55	40
	015 (15HP)	160	80	-
	020 (20HP)	200	100	-
	025 (25HP)	-	125	-
	030 (30HP)	-	160	-

DC Side Current Calculation

Different motors and loads will produce different DC current values. When the motor power and efficiency parameters are known, use the following formula to calculate the DC current:

$$I_{dc} = P_{motor} / (1.35 * V_{Line} * n_{motor})$$

Where V_{Line}= Output voltage, n_{motor}= motor efficiency, P_{motor}=Motor power.

If the input DC voltage, output load, and output power factor are known then the following formulation can be used as well:

$$I_{dc} = V_{line} * \sqrt{3} * Io * \cos\boldsymbol{\theta} / 0.95 / VDC$$

For example:

V_{line}=220V, motor power factor cos$\boldsymbol{\theta}$=0.8, drive efficiency 0.95 (generally 0.94~0.98), output current I_o=11A, VDC=360V

$$I_{dc} = (220V * \sqrt{3} * 11 * 0.8 / 0.95) / 360$$

$$I_{dc} = 9.8A$$

Standard Footprint EMC Filter and Zero Phase Reactor

Use EMC filters to enhance the EMC performance for the environment and machines and to comply with EMC regulations, further reducing EMC problems. If you purchase a motor drive without a built-in EMC filter, we recommend that you select an EMC filter as shown below. GS20 drives will mount on top of these footprint filters for Frames A–D. GS20X drives can use the filters, but the filter must be mounted remotely in a panel. For some motor drive models, you need to work with zero phase reactors to be compliant with EMC regulations. Refer to the table and figure below for the recommended model, setting method, and maximum motor cable length of the EMC filter and zero phase reactor.

GS20(X) EMC Filter and Zero Phase Reactor												
Frame	*Drive Model*	*Input Current (A)*	*Footprint Filter Model #*	*Recommended Zero Phase Reactor*	*Conducted Emission*				*Radiated Emission*		
					C1-motor cable length-30m			C2-motor cable length-100m	C2-motor cable length-100m		
					Position to Install a Zero Phase Reactor						
					1	*2*	*3*	*n/a*	*1*	*2*	*3*
A	***GS21-10P2***	6.8	EMF11AM21A	Delta P/N RF008X00A Note: Not available from Automation Direct				N/A			
	GS21-20P2	3.8	EMF11AM21A			✓	✓	N/A		✓	✓
	GS21-20P5	6.7	EMF11AM21A			✓	✓	N/A		✓	✓
	GS23-20P2	2.2	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23-20P5	3.8	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23-21P0	6	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23-40P5	2.5	EMF6A0M43A				✓	N/A			✓
	GS23-41P0	4.2	EMF6A0M43A				✓	N/A			✓
	GS23-51P0	2.4	EMF6A0M63B					N/A*			
	GS21-10P5	10.1	EMF11AM21A					N/A			
	GS21X-20P5	8.3	EMF11AM21A			✓	✓	N/A		✓	✓
	GS21X-21P0	11.3	EMF11AM21A			✓	✓	N/A		✓	✓
	GS21X-22P0	18.5	EMF27AM21B				✓	N/A			✓
	GS23X-20P5	3.8	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23X-21P0	6	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23X-22P0	9.6	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23X-40P5	2.5	EMF6A0M43A				✓	N/A			✓
	GS23X-41P0	4.2	EMF6A0M43A				✓	N/A			✓
	GS23X-42P0	6.4	EMF6A0M43A				✓	N/A			✓
	GS23X-43P0	7.2	EMF12AM43B					N/A			
B	***GS21-21P0***	10.5	EMF11AM21A	Delta P/N RF008X00A Note: Not available from Automation Direct		✓	✓	N/A		✓	✓
	GS23-22P0	9.6	EMF10AM23A			✓	✓	N/A		✓	✓
	GS23-52P0	4.2	EMF6A0M63B					N/A*			
	GS23-42P0	6.4	EMF6A0M43A				✓	N/A			✓
	GS21X-23P0	27.5	EMF27AM21B				✓	N/A			✓
	GS23X-23P0	15	EMF24AM23B			✓	✓	N/A		✓	✓
	GS23X-25P0	23.4	EMF24AM23B			✓	✓	N/A		✓	✓
	GS23X-45P0	11.6	EMF12AM43B			✓	✓	N/A		✓	✓

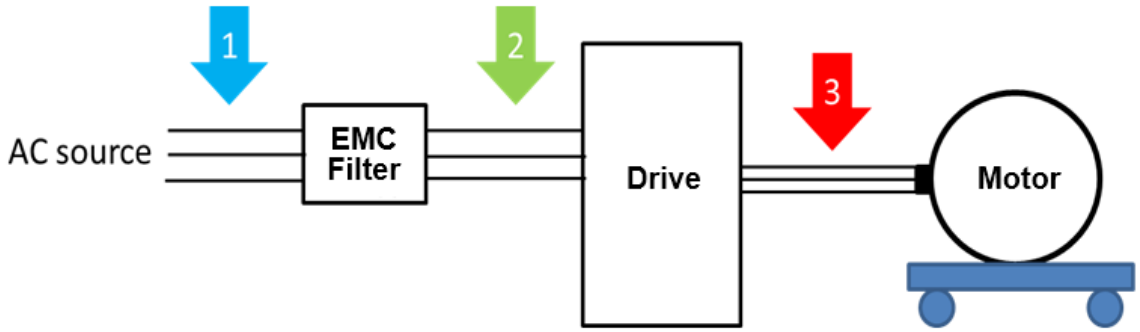
GS20(X) EMC Filter and Zero Phase Reactor (continued)												
					Conducted Emission				Radiated Emission		
					C1-motor cable length-30m			C2-motor cable length-100m*	C2-motor cable length-100m		
					Position to Install a Zero Phase Reactor**						
Frame	Drive Model	Input Current (A)	Footprint Filter Model #	Recommended Zero Phase Reactor	1	2	3	n/a	1	2	3
C	GS21-11P0	20.6	EMF27AM21B	Delta P/N RF008X00A Note: Not available from Automation Direct				N/A			
	GS21-22P0	17.9	EMF27AM21B				✓	N/A			✓
	GS21-23P0	26.3	EMF27AM21B				✓	N/A			✓
	GS23-23P0	15	EMF24AM23B			✓	✓	N/A		✓	✓
	GS23-25P0	23.4	EMF24AM23B			✓	✓	N/A		✓	✓
	GS23-43P0	7.2	EMF12AM43B					N/A			
	GS23-53P0	5.8	EMF16AM63B					N/A*			
	GS23-55P0	9.3	EMF16AM63B					N/A			
	GS23-45P0	11.6	EMF12AM43B			✓	✓	N/A		✓	✓
	GS23X-27P5	32.4	EMF33AM23B		✓	✓		N/A	✓	✓	
C	GS23X-47P5	17.3	EMF23AM43B	Delta P/N RF008X00A Note: Not available from Automation Direct	✓	✓	✓	N/A	✓	✓	✓
	GS23X-4010	22.6	EMF23AM43B		✓	✓	✓	N/A	✓	✓	✓
D	GS23-27P5	32.4	EMF33AM23B		✓	✓		N/A	✓	✓	
	GS23-47P5	17.3	EMF23AM43B		✓	✓	✓	N/A	✓	✓	✓
	GS23-57P5	13.4	EMF16AM63B					N/A			
	GS23-5010	17.5	EMF16AM63B					N/A			
	GS23-4010	22.6	EMF23AM43B		✓	✓	✓	N/A	✓	✓	✓
E	GS23-2010	43.2	n/a			✓	✓	N/A		✓	✓
	GS23-2015	61.2	n/a			✓	✓	N/A		✓	✓
	GS23-4015	30.8	n/a					N/A			
	GS23-4020	39.6	n/a			✓	✓	N/A		✓	✓
F	GS23-2020	82.8	n/a			✓	✓	N/A		✓	✓
	GS23-4025	45.7	n/a			✓	✓	N/A		✓	✓
	GS23-4030	53.9	n/a			✓	✓	N/A		✓	✓

Note: It is not necessary to add a zero phase reactor for passing the C2 conducted emission test.

** The maximum motor cable length of the conducted emission C2 class for GS23-51P0, GS23-52P0, and GS23-53P0 is 75 meters. All others are 100 meters.*

*** See diagram below for installation positions.*

Zero phase reactor installation position diagram:

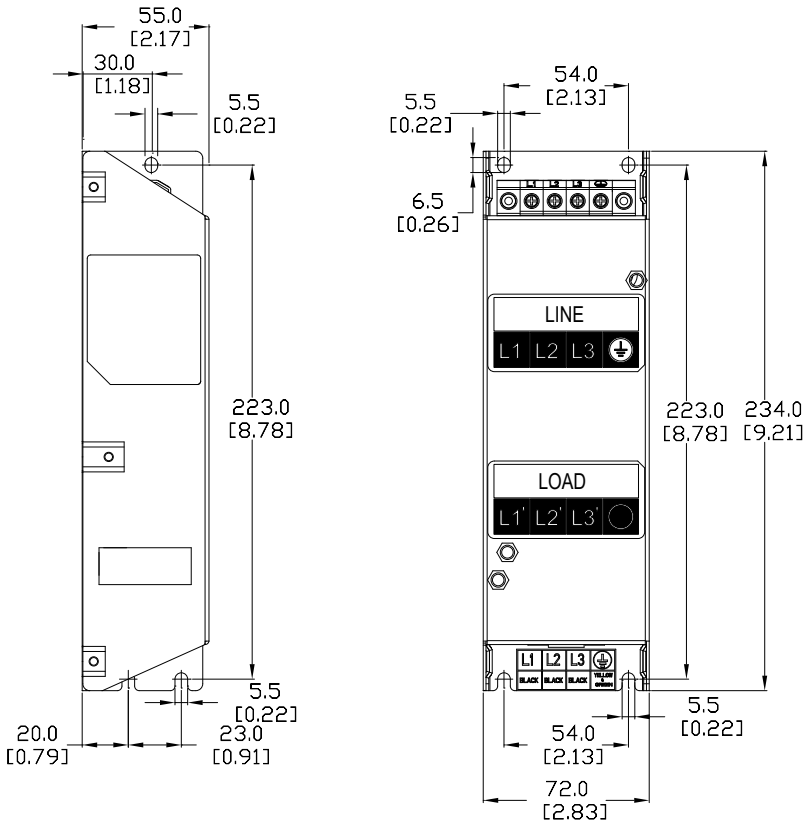


1: Install at the cable between the power supply and the EMC filter.

2: Install at the cable between the EMC filter and the drive.

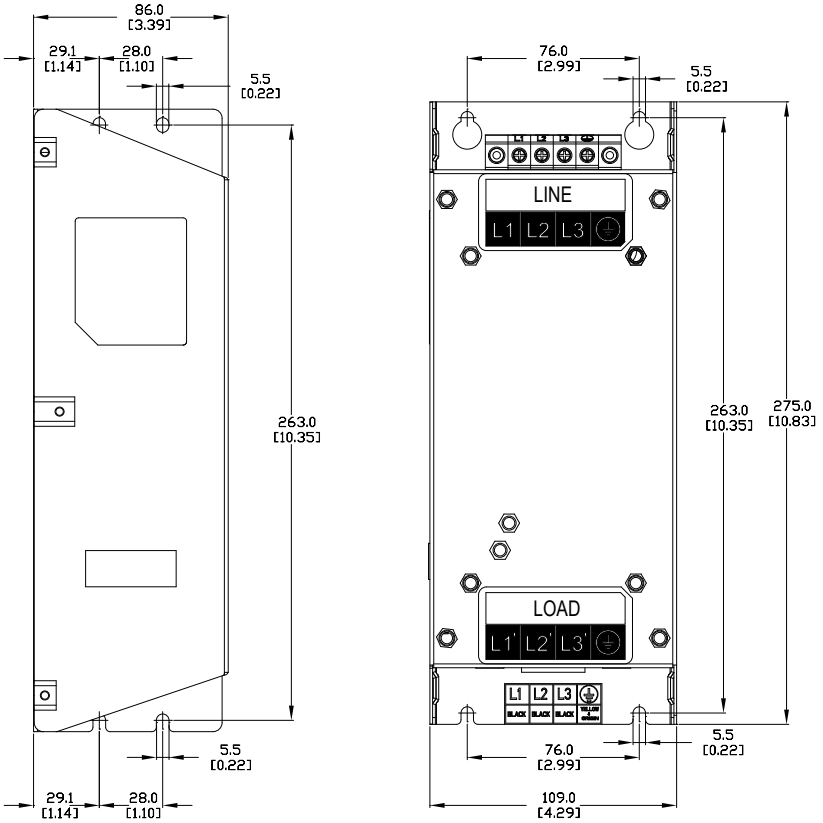
3: Install at the cable between the drive and the motor.

Filter Dimensions



EMF11AM21A
EMF10AM23A
EMF6A0M43A

Screw	Torque
M5 x 2	16–20 kg-cm / 13.9–17.3 lb-in / 1.56–1.96 N•m
M4 x 2	14–16 kg-cm / 12.2–13.8 lb-in. / 1.38–1.56 N•m



EMF27AM21B; EMF24AM23B
EMF33AM23B; EMF12AM43B
EMF23AM43B; EMF6A0M63B;
EMF16AM63B

Screw	Torque
M5 x 4	16–20 kg-cm / 13.9–17.3 lb-in. / 1.56–1.96 N•m

High Performance EMI Input Filters

The optional accessories listed in this chapter are available for use with the GS20(X) drive. Selection of these accessories is application specific and may improve drive performance. Additional information regarding filter installation and operation is available in the AutomationDirect white paper, "Applied EMI/RFI Techniques Overview."

EMI Filters Selection			
Model	**Description**	**EMI Filter***	
		Roxburgh Filters Chassis 1ph	**Roxburgh Filters C2 Rated**
GS21-10P2	120V 1ph 0.25 hp	**RES90F10**	**MIF10**
GS21-10P5	120V 1ph 0.5 hp	**RES90F16**	**MIF16**
GS21-11P0	120V 1ph 1.0 hp	**RES90S30**	**MIF23**
GS21-20P2	230V 1ph 0.25 hp	**RES90F06**	**MIF06**
GS21-20P5	230V 1ph 0.5 hp	**RES90F10**	**MIF10**
GS21-21P0	230V 1ph 1.0 hp	**RES90F16**	**MIF16**
GS21-22P0	230V 1ph 2.0 hp	**RES90S20**	**MIF23**
GS21-23P0	230V 1ph 3.0 hp	**RES90S30**	**MIF330B**
GS23-20P2	230V 3ph 0.25 hp	-	**KMF306A**
GS23-20P5	230V 3ph 0.5 hp	-	**KMF306A**
GS23-21P0	230V 3ph 1.0 hp	-	**KMF306A**
GS23-22P0	230V 3ph 2.0 hp	-	**KMF318A**
GS23-23P0	230V 3ph 3.0 hp	-	**KMF318A**
GS23-25P0	230V 3ph 5.0 hp	-	**KMF325A**
GS23-27P5	230V 3ph 7.5 hp	-	**KMF336A**
GS23-2010	230V 3ph 10hp	-	**KMF350A**
GS23-2015	230V 3ph 15hp	-	**KMF370A**
GS23-2020	230V 3ph 20hp	-	**KMF3100A**
GS23-40P5	460V 3ph 0.5 hp	-	**KMF306A**
GS23-41P0	460V 3ph 1.0 hp	-	**KMF306A**
GS23-42P0	460V 3ph 2.0 hp	-	**KMF306A**
GS23-43P0	460V 3ph 3.0 hp	-	**KMF310A**
GS23-45P0	460V 3ph 5.0 hp	-	**KMF318A**
GS23-47P5	460V 3ph 7.5 hp	-	**KMF318A**
GS23-4010	460V 3ph 10hp	-	**KMF325A**
GS23-4015	460V 3ph 15hp	-	**KMF336A**
GS23-4020	460V 3ph 20hp	-	**KMF350A**
GS23-4025	460V 3ph 25hp	-	**KMF350A**
GS23-4030	460V 3ph 30hp	-	**KMF370A**
GS23-51P0	575V 3ph 1.0 hp	-	**KMF306V**
GS23-52P0	575V 3ph 2.0 hp	-	**KMF306V**
GS23-53P0	575V 3ph 3.0 hp	-	**KMF306V**
GS23-55P0	575V 3ph 5.0 hp	-	**KMF310V**
GS23-57P5	575V 3ph 7.5 hp	-	**KMF318V**
GS23-5010	575V 3ph 10hp	-	**KMF318V**
GS21X-20P5	230V 1ph 0.5 hp	**RES90F10**	**MIF10**
GS21X-21P0	230V 1ph 1.0 hp	**RES90F16**	**MIF16**
GS21X-22P0	230V 1ph 2.0 hp	**RES90S20**	**MIF23**
GS21X-23P0	230V 1ph 3.0 hp	**RES90S30**	**MIF330B**
GS23X-20P5	230V 3ph 0.5 hp	-	**KMF306A**
GS23X-21P0	230V 3ph 1.0 hp	-	**KMF306A**
GS23X-22P0	230V 3ph 2.0 hp	-	**KMF310A**
GS23X-23P0	230V 3ph 3.0 hp	-	**KMF318A**
GS23X-25P0	230V 3ph 5.0 hp	-	**KMF325A**
GS23X-27P5	230V 3ph 7.5 hp	-	**KMF336A**
GS23X-40P5	460V 3ph 0.5 hp	-	**KMF306A**
GS23X-41P0	460V 3ph 1.0 hp	-	**KMF306A**
GS23X-42P0	460V 3ph 2.0 hp	-	**KMF306A**
GS23X-43P0	460V 3ph 3.0 hp	-	**KMF310A**

EMI Filters Selection (continued)			
Model	**Description**	**EMI Filter**	
		Roxburgh Filters Chassis 1ph	**Roxburgh Filters C2 Rated**
GS23X-45P0	460V 3ph 5.0 hp	-	**KMF318A**
GS23X-47P5	460V 3ph 7.5 hp	-	**KMF318A**
GS23X-4010	460V 3ph 10hp	-	**KMF325A**
** All specs for the EMI filters can be found at www.automationdirect.com or by clicking the following links: -KMF Series Filters -MIF Series Filters -RES90 Series Filters*			

EMI Filter Installation

Electrical equipment like the GS20(X) drive, will generate electrical noise when in operation and may interfere with the normal operation of peripheral equipment. The use of an EMI filter will mitigate this type of power supply interference. Other measures may be required for reduction or mitigation of radiated emissions. Roxburgh EMI filters have been tested with the GS20(X) family of drives and are recommended for the mitigation of interference and the highest performance When the GS20(X) drive and Roxburgh EMI filter are installed and wired according to the user manual, the installation will conform to the following rules:

- *EN61000-6-4*
- *EN61800-3: 1996*
- *EN55011 (1991) Class A Group 1 (1st Environment, restricted distribution)*

General precaution

1) *Install the EMI filter and GS20(X) drive on the same subpanel or metal plate.*
2) *Install the EMI filter as close as possible to the GS20(X) drive.*
3) *Keep wiring between the EMI filter and GS20(X) drive as short as possible.*
4) *The subpanel or metal plate used to support the EMI filter and GS20(X) drive should be well grounded (minimal resistance to ground is typically less then 1Ω).*
5) *To insure that the EMI filter and GS20(X) drive are adequately grounded, insure that both are securely attached to the subpanel or plate.*

Choose suitable motor cable and precautions

Proper installation and the the choice of good motor cable will positively affect the performance of the filter. When selecting motor cable, please observe the following precautions.

1) *Cable shielding (double shielding is best).*
2) *Ground the shield on both ends of the motor cable. Maintain minimum length and employ strong mechanical connection to ground.*
3) *Remove paint on the metal saddle, subpanel or plate to insure good contact to ground.*

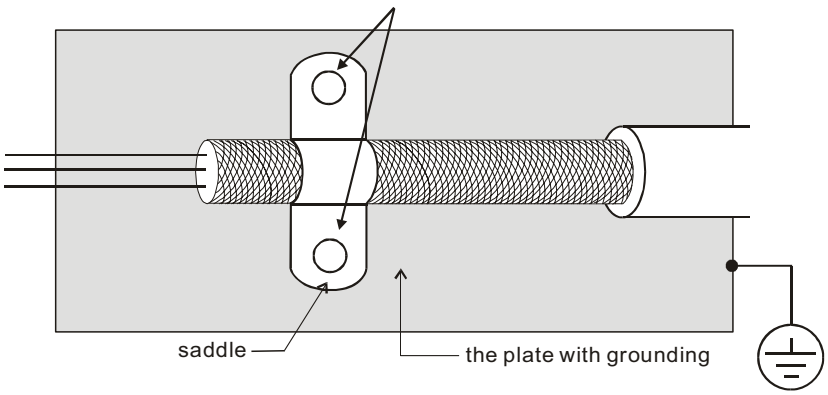


Figure 1

EMI Filter Installation (continued)

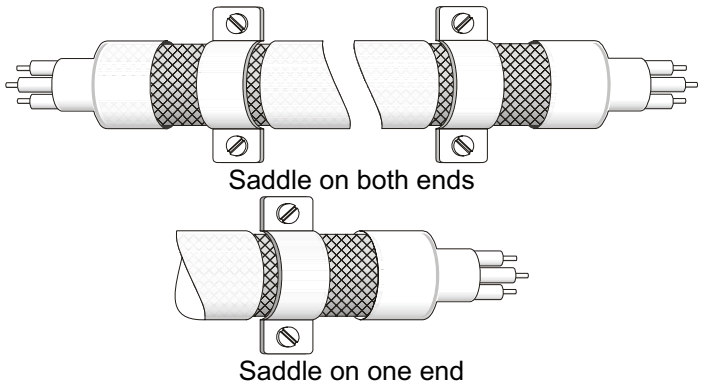


Figure 2

Reflective Wave Phenomenon

The inverter section of a PWM drive like the GS20(X) does not produce sinusoidal output voltage wave forms. Rather, the output voltage produced is a continuous train of width modulated pulses, sent to the motor terminals via the motor cable.

Peak pulse voltage at the GS20(X) drive is equal to the drive DC bus voltage and contains steep rise and fall times, the result of the IGBT switching device used in the drive inverter section.

Peak pulse voltage at the motor terminals may exceed the drive DC bus voltage and is dependent on the dynamics of the drive output voltage rise time, cable transmission line characteristics, cable length and motor impedance.

The voltage pulse train at the motor terminals experiences momentary transient over voltage as the IGBT transistors switch. The result being voltage levels at the motor terminals double that of the drive bus voltage.

Over voltage of this type has the potential to stress the motor insulation, damaging the motor.

Recommended Motor Cable Length

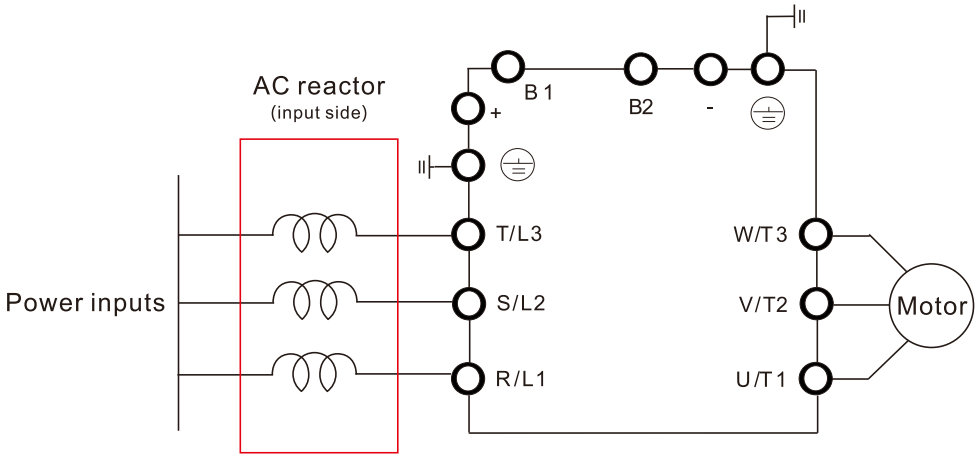
1) Never connect phase lead capacitors or surge absorbers to the output terminals of the drive.
2) As cable length increases, capacitance between cables will increase and may result in leakage current and over current faults with the possibility of damage to the GS20(X) drive.
3) If more than one motor is connected to the drive, the total cable length is the sum of the cable lengths from the GS20(X) drive to each motor.
4) Should an overload relay malfunction occur, lower the GS20(X) drive carrier frequency (P2.10) or install an output reactor.
5) When operating an AC motor with a PWM drive like the GS20(X), the motor may experience reflective wave as described above. To prevent this situation, please observe the recommendations below:
   a) Use a motor with enhanced insulation. (1000V, 1200V, 1600V, higher is better)
   b) Connect an output reactor (optional) to the output terminals of the drive.
   c) Keep motor cable length as short as possible. (65ft, 20m, or less)
   d) Where motor cable lengths will exceed 65ft (20m), refer to "Maximum Recommended Cable Length - GS20(X)" on page A–18.

Line Reactors / Voltage Time Filters

Line Reactor

Installing an AC reactor on the input side of an AC motor drive can increase line impedance, improve the power factor, reduce input current, increase system capacity, and reduce interference generated from the motor drive. It also reduces momentary voltage surges or abnormal current spikes from the mains power, further protecting the drive. For example, when the main power capacity is higher than 500 kVA, or when using a phase-compensation capacitor, momentary voltage and current spikes may damage the AC motor drive's internal circuit. An AC reactor on the input side of the AC motor drive protects it by suppressing surges.

Install an AC input reactor in series between the main power and the three input phases R S T, as shown in the figure below:

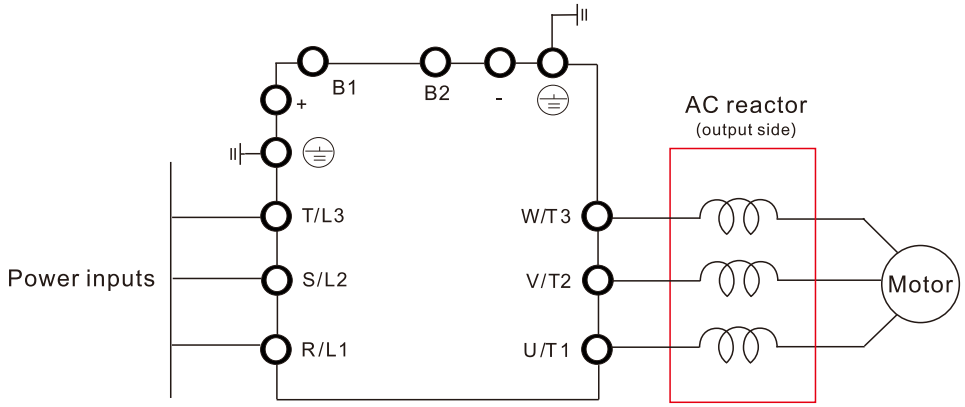


Load Reactor/Voltage Time Filter

When using drives in long wiring output application, ground fault (GFF), over-current (OC) and motor over-voltage (OV) often occur. GFF and OC cause errors due to the drive's self-protective mechanism; over-voltage damages motor insulation.

The excessive length of the output wires makes the grounded stray capacitance too large, increases the three-phase output common mode current, and the reflected wave of the long wires makes the motor dv / dt and the motor terminal voltage too high. Thus, installing a reactor on the drive's output side can increase the high-frequency impedance to reduce the dv / dt and terminal voltage to protect the motor. For distances greater than 100 feet, a dV/dT filter (VTF Series) is recommended for best performance.

Install an AC output reactor or voltage time filter in series between the three output phases U V W and the motor, as shown in the figure below:

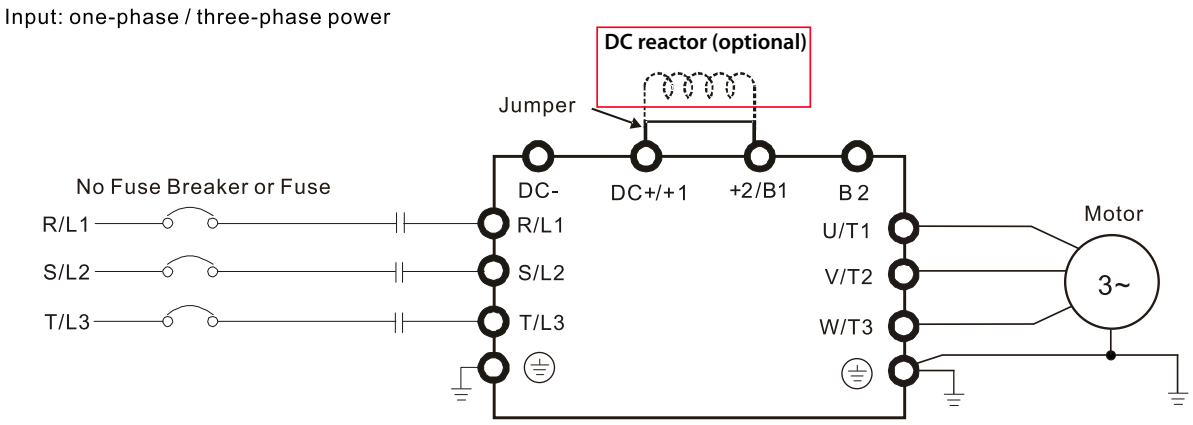


DC Reactor

A DC reactor can also increase line impedance, improve the power factor, reduce input current, increase system power, and reduce interference generated from the motor drive. A DC reactor stabilizes the DC bus voltage. Compared with an AC input reactor, a DC reactor is in smaller size, lower price, and lower voltage drop (lower power dissipation).

Install a DC reactor between terminals +1 and +2. Remove the jumper, as shown in the figure below, before installing a DC reactor.

Note: 120V models have no DC reactor/choke terminals.



When the GS20(X) drive is connected directly to a large-capacity power transformer (600kVA or above) or when a power correction capacitor is switched on, excessive peak currents may occur in the input power circuit resulting in damage to the GS20(X) drive.

To avoid this, install a line reactor in series with the GS20(X) drive on the input side. The installation of a line reactor will reduce input current peaks and improve the output power efficiency.

Line (load) reactors installed on the output side protect the motor insulation against AC drive short circuits and IGBT reflective wave damage, and also allow the motor to run cooler by "smoothing" the motor current waveform. They are recommended for operating "non-inverter-duty" motors, and for any motors where the length of wiring between the AC drive and motor is less than or equal to 100 feet. For AC drive-to-motor wiring distances over 100 feet, use of the VTF series output filter is recommended.

Line/Load Reactors Selection Charts

GS20(X) Line/Load Reactor, AC Output Filter, & DC Reactor Selections							
GS20(X) Model	CT Output Amps (rms)	Saturation Amps (rms)	Motor HP	Line Reactor (LR2)**	Load Reactor (LR2)**	AC Output Filter (VTF)**	DC Reactor Delta P/N*
GS21-10P2	1.6	3.2	1/4	LR2-10P2-1PH	LR2-20P2	VTF-46-DE	DR008D0366
GS21-10P5	2.5	5	1/2	LR2-10P5-1PH	LR2-20P5	VTF-246-CFG	DR011D0266
GS21-11P0	5	9.6	1	LR2-11P5-1PH	LR2-21P0	VTF-24-FH	DR025D0117
GS21-20P2	1.6	3.2	1/4	LR2-20P5-1PH	LR2-20P2	VTF-46-DE	DR005D0585
GS21-20P5	2.8	5.6	1/2	LR2-20P5-1PH	LR2-20P5	VTF-246-CFG	DR008D0366
GS21-21P0	4.8	9.6	1	LR-23P0	LR2-21P0	VTF-24-FH	DR011D0266
GS21-22P0	7.5	15	2	LR2-22P0-1PH	LR-22P0	VTF-246-HKL	DR017D0172
GS21-23P0	11	22	3	LR-27P5	LR-25P0	VTF-24-JL	DR025D0117
GS23-20P2	1.6	3.2	1/4	LR2-20P2	LR2-20P2	VTF-46-DE	DR005D0585
GS23-20P5	2.8	5.6	1/2	LR2-20P5	LR2-20P5	VTF-246-DGH	DR005D0585
GS23-21P0	4.8	9.6	1	LR2-20P7	LR2-20P7	VTF-24-FH	DR005D0585
GS23-22P0	7.5	15	2	LR-22P0	LR-22P0	VTF-246-HKL	DR008D0366
GS23-23P0	11	22	3	LR-25P0	LR-25P0	VTF-24-JL	DR011D0266
GS23-25P0	17	34	5	LR-27P5	LR-25P0	VTF-46-LM	DR017D0172
GS23-27P5	25	50	7 1/2	LR-2010	LR-2010	VTF-46-NP	DR025D0117
GS23-2010	33	66	10	LR-2015	LR-2010	VTF-246-LPQ	DR033DP851
GS23-2015	46	92	15	LR-2020	LR-2020	VTF-246-NRS	DR049DP574
GS23-2020	65	130	20	LR-2025	LR-2025	VTF-246-PSU	DR065DP432
GS23-40P5	1.5	3	1/2	LR2-40P5	LR2-40P5	VTF-46-DE	DR003D1870
GS23-41P0	2.7	5.4	1	LR2-41P0	LR2-41P0	VTF-246-CFG	DR003D1870
GS23-42P0	4.2	8.4	2	LR2-43P0	LR2-42P0	VTF-24-FH	DR004D1403
GS23-43P0	5.5	11	3	LR2-45P0	LR2-43P0	VTF-24-FH	DR006D0935
GS23-45P0	9	18	5	LR2-47P5	LR2-45P0	VTF-246-HKL	DR009D0623
GS23-47P5	13	26	7 1/2	LR-4010	LR2-47P5	VTF-24-JL	DR012D0467
GS23-4010	17	34	10	LR-4015	LR-4010	VTF-24-JL	DR018D0311
GS23-4015	25	50	15	LR-4015	LR-4015	VTF-246-LPQ	DR024D0233
GS23-4020	32	64	20	LR-4020	LR-4020	VTF-246-LPQ	DR032D0175
GS23-4025	38	76	25	LR-4025	LR-4025	VTF-246-MQR	DR038D0147
GS23-4030	45	90	30	LR-4030	LR-4030	VTF-246-NRS	DR045D0124
GS23-51P0	1.7	3.4	1	LR2-51P0	LR2-51P0	VTF-46-DE	n/a
GS23-52P0	3	6	2	LR2-52P0	LR2-52P0	VTF-246-CFG	n/a
GS23-53P0	4.2	8.4	3	LR2-53P0	LR2-53P0	VTF-246-DGH	n/a
GS23-55P0	6.6	13.2	5	LR2-55P0	LR2-55P0	VTF-246-GJJ	n/a
GS23-57P5	9.9	19.8	7 1/2	LR-5010	LR2-57P5	VTF-246-HKL	n/a
GS23-5010	12.2	24.4	10	LR-4010	LR-5010	VTF-246-HKL	n/a
GS21X-20P5	2.8	5.6	1/2	LR2-20P5-1PH	LR2-20P2	VTF-246-DGH	DR005D0585
GS21X-21P0	4.8	9.6	1	LR2-21P0-1PH	LR2-20P7	VTF-24-FH	DR008D0366
GS21X-22P0	7.5	15.0	2	LR2-22P0-1PH	LR2-22P0	VTF-246-HKL	DR011D0266
GS21X-23P0	11.0	22.0	3	LR-27P5	LR-25P0	VTF-24-JL	DR017D0172
GS23X-20P5	2.8	5.6	1/2	LR2-20P2	LR2-20P2	VTF-246-DGH	DR005D0585
GS23X-21P0	4.8	9.6	1	LR2-21P5	LR2-21P0	VTF-24-FH	DR005D0585
GS23X-22P0	7.5	15.0	2	LR2-22P0	LR2-22P0	VTF-246-GJJ	DR008D0366
GS23X-23P0	11.0	22.0	3	LR-25P0	LR-25P0	VTF-24-JL	DR011D0266
GS23X-25P0	17.0	34.0	5	LR-27P5	LR-27P5	VTF-4-M	DR017D0172
GS23X-27P5	25.0	50.0	7 1/2	LR-2010	LR-2010	VTF-246-KMN	DR025D0117
GS23X-40P5	1.5	3.0	1/2	LR2-40P5	LR2-40P5	VTF-46-DE	DR003D1870
GS23X-41P0	2.7	5.4	1	LR2-41P5	LR2-41P0	VTF-246-CFG	DR003D1870
GS23X-42P0	4.2	8.4	2	LR2-43P0	LR2-42P0	VTF-24-FH	DR004D1403
GS23X-43P0	5.5	11.0	3	LR2-44P0	LR2-43P0	VTF-24-FH	DR006D0935
GS23X-45P0	9.0	18.0	5	LR2-47P5	LR2-45P0	VTF-246-HKL	DR009D0623
GS23X-47P5	13.0	26.0	7 1/2	LR-4010	LR2-47P5	VTF-24-JL	DR012D0467
GS23X-4010	17.0	34.0	10	LR-4015	LR-4010	VTF-46-LM	DR018D0311

** Not available at AutomationDirect.com*

*** Reactor sizing is based on rated HP NEMA motor load, not drive output amp load. Size the reactor based on the motor nameplate current. All specs for the LR2 and VTF can be found at www.automationdirect.com or by clicking the following links::*

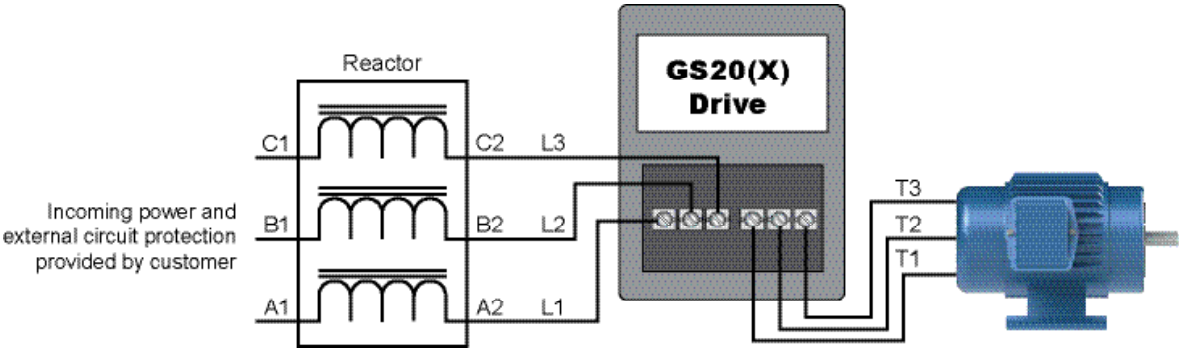
-LR2 Line Reactors

-VTF Output Filters

Line Reactor Applications and Wiring Connections

Input Side of AC Drive

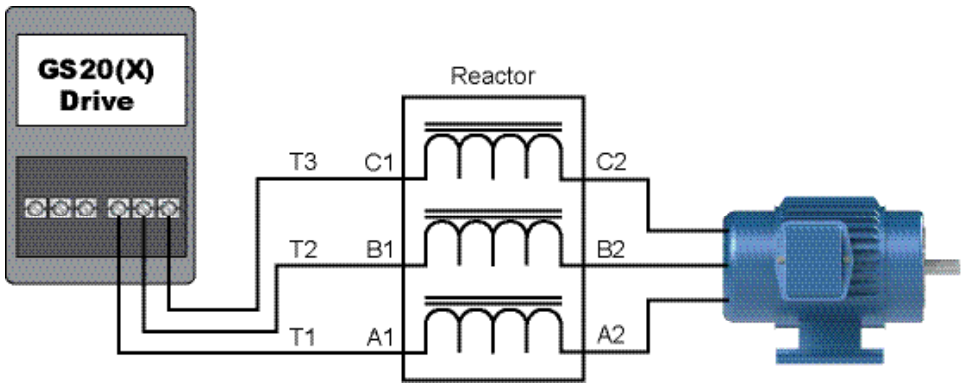
When installed on the input side of the GS20(X) drive, a line reactor will reduce line notching, current peaks, voltage spikes and surges from the incoming line, as well as reduce the available short circuit current. A line reactor will also reduce harmonic distortion from the GS20(X) drive onto the line. The line reactor is installed in front of the GS20(X) drive as shown.



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the GS20(X) drive.

Output Side of AC Drive

When installed on the output side of the GS20(X) drive, line (load) reactors help to protect the GS20(X) drive from short circuits at the load. Voltage and current waveforms from the GS20(X) drive are enhanced, reducing motor overheating and noise emissions.

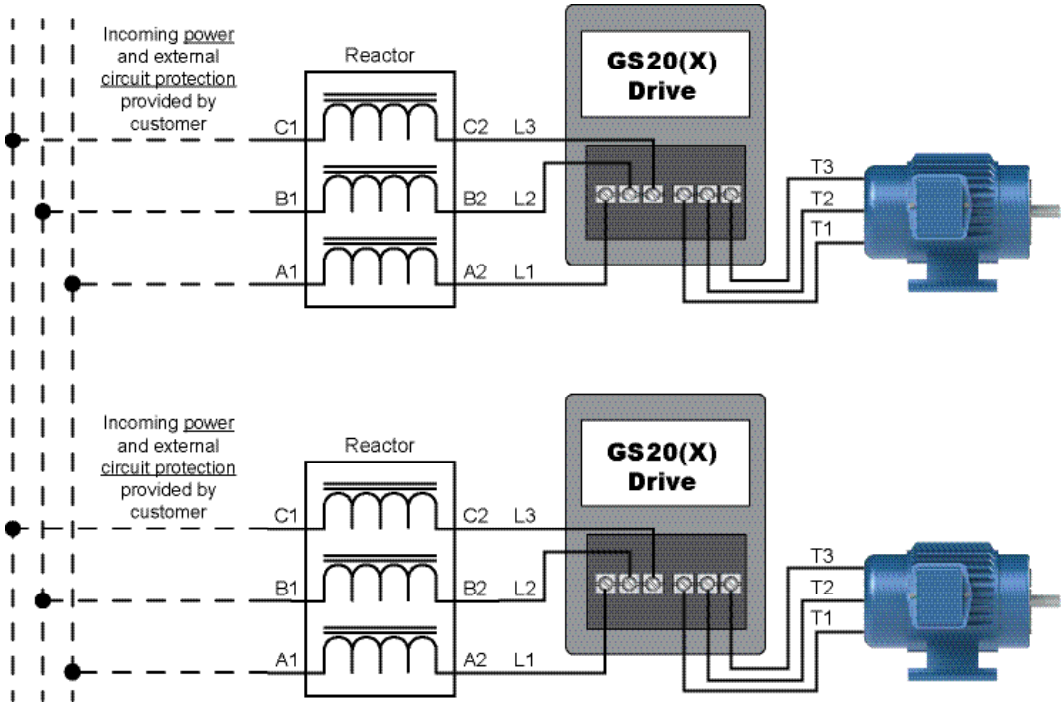


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the GS20(X) drive.

Single phase line reactors should NOT be installed on the output side of an AC Drive. Use only three-phase reactors on drive outputs, and only for three-phase motors.

Multiple AC Drives

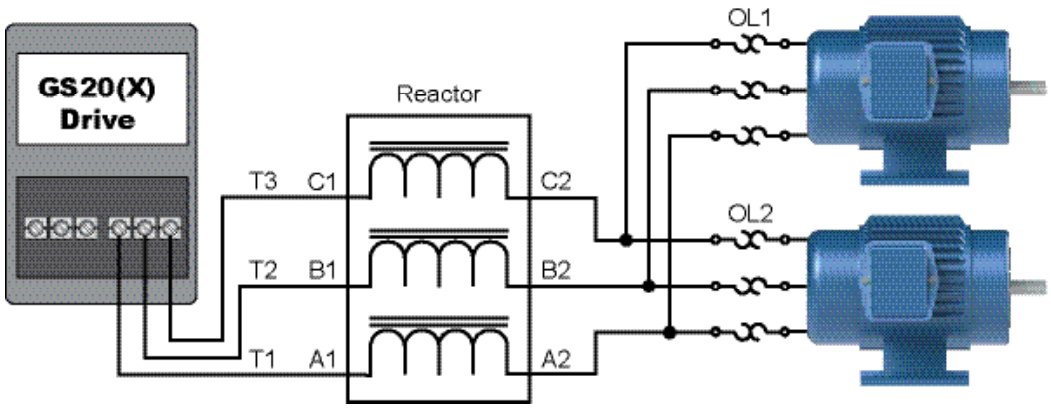
Individual line reactors are recommended when installing multiple GS20(X) drives on the same power line. Individual line reactors eliminate cross-talk between multiple GS20(X) drives and provide isolated protection for each GS20(X) drive for its own specific load.



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the GS20(X) drive.

Multiple Motors

A single output (load) reactor can be used with multiple motors on the same GS20(X) drive, but only if the motors operate simultaneously. Size the reactor based upon the total horsepower of all the motors, and select a reactor with a current rating greater than the sum of the motor full-load currents. Overload relays are required for use in multi-motor applications.

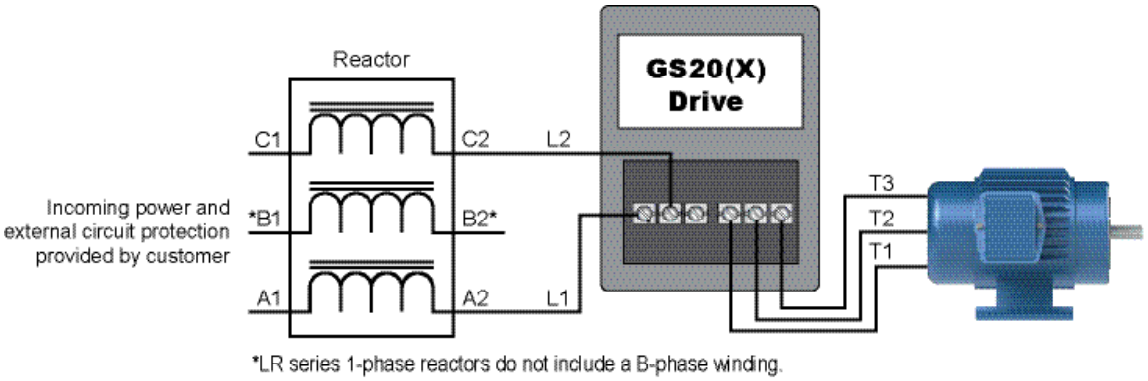


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the GS20(X) drive.

A single reactor should be used with multiple motors ONLY when the motors will operate simultaneously from a single AC drive. OVERLOAD RELAYS are required for use in multiple motor applications.

Single-Phase Applications

Some three-phase line reactors are listed for use with single-phase input power. Follow the connection diagram shown below. Make sure that terminals B1 and B2, if present, are properly insulated before any connections are made. If a 3-phase reactor is used on the line side of a single-phase input drive application, ensure that the actual single-phase current does not exceed the Line Reactor's current rating (example: a 3-phase, 5hp Line Reactor and 3-phase 5hp drive will not handle enough current to power a 5hp motor on a single-phase supply - both the drive and the Line Reactor will have to be upsized).



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the GS20(X) drive.

ENSURE THAT YOU PROPERLY INSULATE TERMINALS B1 AND B2 BEFORE MAKING ANY CONNECTIONS TO SINGLE-PHASE POWER.

Recommended Cable Length

Motor Leakage Current

If the cable length is too long, the stray capacitance between cables increases and may cause leakage current. This activates over-current protection, increases leakage current, or may affect the current display. In the worst case, it may damage the AC motor drive. If more than one motor is connected to one AC motor drive, the total wiring length should be the sum of the wiring length from AC motor drive to each motor.

For the 460V series AC motor drive, when you install an overload thermal relay between the drive and the motor to protect the motor from overheating, the connecting cable must be shorter than 50m; however, an overload thermal relay malfunction may still occur. To prevent the malfunction, install an output reactor (optional) to the drive or lower the carrier frequency setting (see P00.17 Carrier Frequency).

Motor Surge Voltage

When a motor is driven by a PWM-type AC drive, the motor terminals experience surge voltages (dv/dt) due to power transistor conversion of the drive. For very long motor cable (especially for the 460V series), surge voltages (dv/dt) may damage the motor insulation and bearing. To prevent this, follow these rules:

A) Use a motor with enhanced insulation.
B) Reduce the cable length between the AC drive and motor to suggested values.
C) Connect an output reactor (optional) to the output terminals of the AC drive.

Refer to the following tables for the suggested motor shielded cable length. For drive models < 480V, use a motor with a rated voltage ≤ 500 VAC and an insulation level ≥ 1.35 kVp-p in accordance with IEC 60034-17. For the 575V drive model, use a motor with a rated voltage ≤ 600 VAC and an insulation level ≥ 1.79 kVp-p in accordance with IEC 60034-25.

Maximum Recommended Cable Length - GS20(X)							
GS20(X) Model	Input Power		VT Rated Current (Arms)	Without Output AC Reactor (meters)		With Output AC Reactor (meters)	
	Ø	Volts		Shielded Cable	Unshielded Cable	Shielded Cable	Unshielded Cable
GS21-10P2	1	120	1.8	50	75	75	115
GS21-10P5			2.7				
GS21-11P0			5.5				
GS21-20P2		230	1.8				
GS21-20P5			3.2				
GS21-21P0			5				
GS21-22P0			8.5				
GS21-23P0			12.5				
GS23-20P2	3		1.8				
GS23-20P5			3.2				
GS23-21P0			5				
GS23-22P0			8				
GS23-23P0			12.5				
GS23-25P0			19.5				
GS23-27P5			27				
GS23-2010			36	100	150	150	225
GS23-2015			51				
GS23-2020			69				
GS23-40P5		460	1.8	35	50	50	90
GS23-41P0			3				
GS23-42P0			4.6				
GS23-43P0			6.5	50	75	75	115
GS23-45P0			10.5				
GS23-47P5			15.7				
GS23-4010			20.5	100	150	150	225
GS23-4015			28				
GS23-4020			36				
GS23-4025			41.5				
GS23-4030			49				
GS23-51P0		575	2.1	15	55	N/A	N/A
GS23-52P0			3.6	50	80		
GS23-53P0			5	65	120		
GS23-55P0			8.5		295		
GS23-57P5			11.5	145	320		
GS23-5010			15				
GS21X-20P5	1	230	3.2	50	75	75	115
GS21X-21P0			5				
GS21X-22P0			8.5				
GS21X-23P0			12.5				
GS23X-20P5	3		3.2				
GS23X-21P0			5				
GS23X-22P0			8				
GS23X-23P0			12.5				
GS23X-25P0			19.5				
GS23X-27P5			27				
GS23X-40P5		460	1.8	35	50	50	90
GS23X-41P0			3				
GS23X-42P0			4.6				
GS23X-43P0			6.5	50	75	75	15
GS23X-45P0			10.5				

Dynamic Braking

Dynamic braking absorbs the motor regeneration energy when the motor is decelerated faster than it would if it was allowed to coast to a stop. The regeneration energy is dissipated by braking resistors. GS series braking resistors provide the best braking results with GS20(X) drives. All drives have the braking function built-in and do not require a separate dynamic braking unit.

To avoid possible injury, please refer to the DURApulse Drives Dynamic Braking User Manual before wiring.

Braking Units

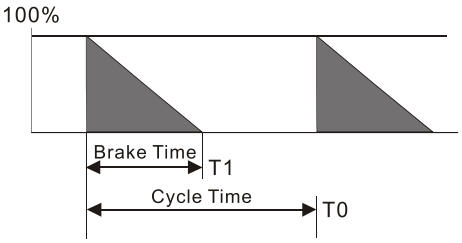
GS20(X) AC Drive Braking Component Selection										
Drive Voltage	Motor Power		Drive Model	125% Braking Torque @ 10% Duty Cycle*				Max Braking Torque		
				Braking Resistor		Brake Torque (kg•m)	Total Brake Current (A)	Min Resistor Value (Ω)	Max Total Brake Current (A)	Peak Power (kW)
	(hp)	(kW)		Quantity	Part #					
120V	1/4	0.2	GS21-10P2	1	GS-BR-080W750	0.1	0.5	190.0	2	0.8
	1/2	0.4	GS21-10P5	1	GS-BR-080W200	0.3	1.9	95.0	4	1.5
	1	0.75	GS21-11P0	1	GS-BR-080W200	0.5	1.9	63.3	6	2.3
230V	1/4	0.2	GS21-20P2	1	GS-BR-080W750	0.1	0.5	190.0	2	0.8
	1/2	0.4	GS21-20P5	1	GS-BR-080W200	0.3	1.9	95.0	4	1.5
	1	0.75	GS21-21P0	1	GS-BR-080W200	0.5	1.9	63.3	6	2.3
	2	1.5	GS21-22P0	1	GS-BR-200W091	1	4.2	47.5	8	3.0
	3	2.2	GS21-23P0	1	GS-BR-300W070	1.5	5.4	38.0	10	3.8
	1/4	0.2	GS23-20P2	1	GS-BR-080W750	0.1	0.5	190.0	2	0.8
	1/2	0.4	GS23-20P5	1	GS-BR-080W200	0.3	1.9	95.0	4	1.5
	1	0.75	GS23-21P0	1	GS-BR-080W200	0.5	1.9	63.3	6	2.3
	2	1.5	GS23-22P0	1	GS-BR-200W091	1	4.2	47.5	8	3.0
	3	2.2	GS23-23P0	1	GS-BR-300W070	1.5	5.4	38.0	10	3.8
	5	3.7	GS23-25P0	1	GS-BR-400W040	2.5	9.5	19.0	20	7.6
	7 1/2	5.5	GS23-27P5	1	GS-BR-1K0W020	3.7	19	16.5	23	8.7
	10	7.5	GS23-2010	1	GS-BR-1K0W020	5.1	19	14.6	26	9.9
	15	11	GS23-2015	1	GS-BR-1K5W013	7.4	29	12.6	29	11.0
	20	15	GS23-2020	2	GS-BR-1K0W4P3 (x2 series)	10.2	44	8.3	46	17.5
460V	1/2	0.4	GS23-40P5	1	GS-BR-080W750	0.3	1	380.0	2	1.5
	1	0.75	GS23-41P0	1	GS-BR-080W750	0.5	1	190.0	4	3.0
	2	1.5	GS23-42P0	1	GS-BR-200W360	1	2.1	126.7	6	4.6
	3	2.2	GS23-43P0	1	GS-BR-300W250	1.5	3	108.6	7	5.3
	5	3.7	GS23-45P0	1	GS-BR-400W150	2.5	5.1	84.4	9	6.8
	7 1/2	5.5	GS23-47P5	1	GS-BR-1K0W075	3.7	10.2	50.7	15	11.4
	10	7.5	GS23-4010	1	GS-BR-1K0W075	5.1	10.2	40.0	19	14.4
	15	11	GS23-4015	1	GS-BR-1K5W043	7.4	17.6	33.0	23	17.5
	20	15	GS23-4020	2	GS-BR-1K0W016 (x2 series)	10.2	24	26.2	29	22.0
	25	18	GS23-4025	2	GS-BR-1K0W016 (x2 series)	12.2	24	26.2	29	22.0
	30	22	GS23-4030	2	GS-BR-1K5W013 (x2 series)	14.9	29	23.0	33	25.1
575V	1	0.75	GS23-51P0	1	GS-BR-080W750	0.5	1.2	280.0	4	4.5
	2	1.5	GS23-52P0	1	GS-BR-200W360	1	2.6	186.7	6	6.7
	3	2.2	GS23-53P0	1	GS-42P0-BR	1.5	2.3	160.0	7	7.8
	5	3.7	GS23-55P0	1	GS-47P5-BR	2.5	9.2	93.3	12	13.4
	7 1/2	5.5	GS23-57P5	1	GS-47P5-BR (x2 series)	3.7	6.6	80.0	14	15.7
	10	7.5	GS23-5010	1	GS-BR-1K0W075	5.1	12.3	70.0	16	17.9

GS20(X) AC Drive Braking Component Selection (continued)										
Drive Voltage	Motor Power		Drive Model	125% Braking Torque # 10% Duty Cycle*				Max Braking Torque		
				Braking Resistor		Brake Torque (kg•m)	Total Brake Current (A)	Min Resistor Value (Ω)	Max Total Brake Current (A)	Peak Power (kW)
	(hp)	(kW)		Quantity	Part #					
230V	1/2	0.4	GS21X-20P5	1	GS-BR-080W200	0.3	1.9	95.0	4	1.5
	1	0.75	GS21X-21P0	1	GS-BR-080W200	0.5	1.9	63.3	6	2.3
	2	1.5	GS21X-22P0	1	GS-BR-200W091	1	4.2	47.5	8	3.0
	3	2.2	GS21X-23P0	1	GS-BR-300W070	1.5	5.4	38.0	10	3.8
	1/2	0.2	GS23X-20P5	1	GS-BR-080W200	0.1	0.5	190.0	2	0.8
	1	0.4	GS23X-21P0	1	GS-BR-080W200	0.3	1.9	95.0	4	1.5
	2	0.75	GS23X-22P0	1	GS-BR-200W091	0.5	1.9	63.3	6	2.3
	3	1.5	GS23X-23P0	1	GS-BR-300W070	1	4.2	47.5	8	3.0
	5	2.2	GS23X-25P0	1	GS-BR-400W040	1.5	5.4	38.0	10	3.8
	7 1/2	3.7	GS23X-27P5	1	GS-BR-1K0W020	2.5	9.5	19.0	20	7.6
460V	1/2	0.4	GS23X-40P5	1	GS-BR-080W750	0.3	1	380.0	2	1.5
	1	0.75	GS23X-41P0	1	GS-BR-080W750	0.5	1	190.0	4	3.0
	2	1.5	GS23X-42P0	1	GS-BR-200W360	1	2.1	126.7	6	4.6
	3	2.2	GS23X-43P0	1	GS-BR-300W250	1.5	3	108.6	7	5.3
	5	3.7	GS23X-45P0	1	GS-BR-400W150	2.5	5.1	84.4	9	6.8
	7 1/2	5.5	GS23X-47P5	1	GS-BR-1K0W075	3.7	10.2	50.7	15	11.4
	10	7.5	GS23X-4010	1	GS-BR-1K0W075	5.1	10.2	40.0	19	14.4
* 10% Duty Cycle with maximum ON (braking) time for 10 seconds.										

Please refer to DURAPULSE Dynamic Braking User Manual for more detailed information on braking resistors.

Choosing and Installing a Braking Resistor

1) Select the resistance value, power and brake usage (ED %).
Definition for Brake Usage ED%:



ED% = T1 / T0 x 100(%)

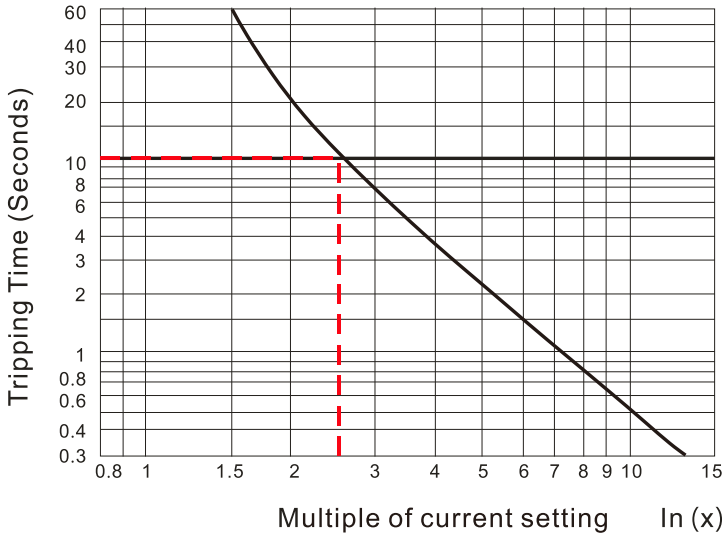
Explanation:
Brake usage ED (%) is the amount of time needed for the brake unit and brake resistor to dissipate heat generated by braking. When the brake resistor heats up, the resistance increases with temperature, and braking torque decreases accordingly.

For safety, install a thermal overload relay (O.L) between the brake unit and the brake resistor in conjunction with the magnetic contactor (MC) before the drive for additional protection. The thermal overload relay protects the brake resistor from damage due to frequent or continuous braking. Under such circumstances, turn off the power to prevent damage to the brake resistor and drive.

Note: Never use the thermal overload relay to disconnect the brake resistor.

2) Any damage to the drive or other equipment caused by using brake resistors and brake modules that are not provided by AutomationDirect voids the warranty.
3) Consider environmental safety factors when installing the brake resistors. If you use the minimum resistance value, consult AutomationDirect for the power calculation.

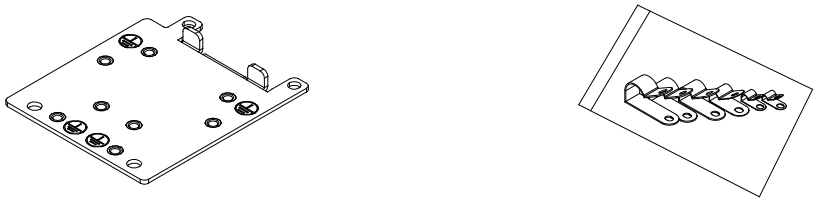
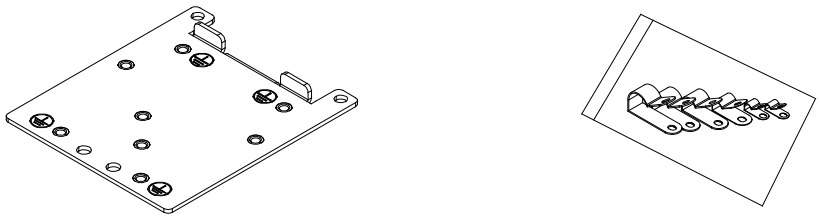
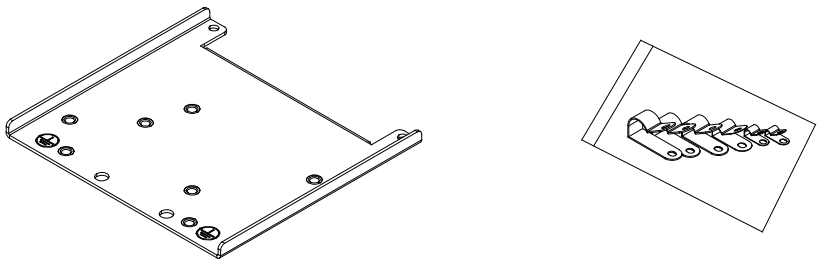
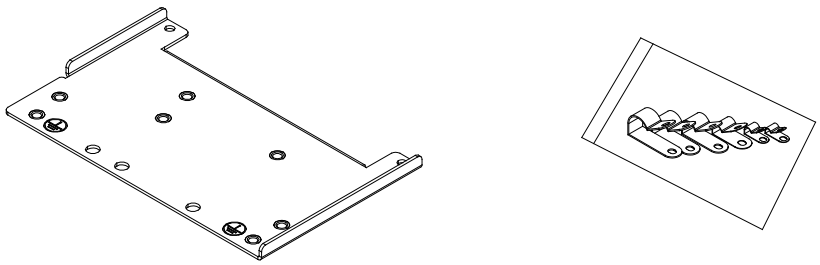
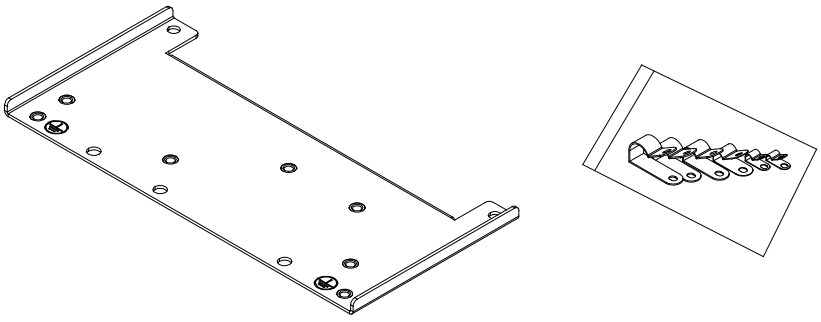
4) Refer to the ADC Dynamic Braking unit User Manual for more detail on braking resistors (https://cdn.automationdirect.com/static/manuals/gs3dbm/gs-db_ump.pdf)
5) The selection tables are for 10% duty cycle. If the AC motor drive requires frequent braking, increase the Watts by two to three times.
6) Thermal Overload Relay (TOR):
Thermal overload relay selection is based on its overload capacity. A standard braking capacity of the GS20(X) is 10% ED (Tripping time=10 s). As shown in the figure below, a 460V, 1kw GS20(X) required the thermal relay to take 260% overload capacity for 10 seconds (hot starting) and the braking current is 24A. In this case, select a thermal overload relay rated at 10A (10 * 260% = 26 A > 24 A). The property of each thermal relay may vary among different manufacturers. Carefully read the specification before using it.



EMC Shield & Earthing Plates

GS20 EMC Shield Plates

EMC shield plates are available for use with shielded cable and your GS20 drive. Find the frame type from the specification tables of your GS20 and reference the table below:

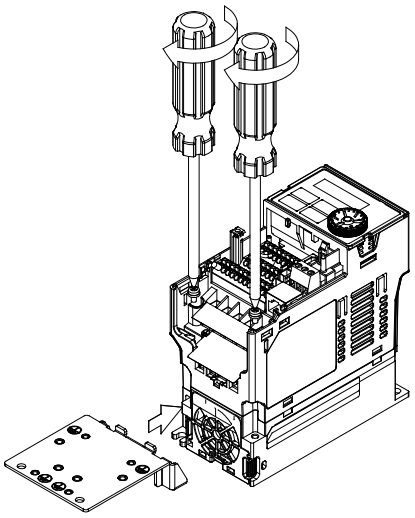
GS20 EMC Shield Plate Selection		
Frame	***EMC Shield Plate Model***	***Reference Drawing***
A	GS20A-ESP-A	
B	GS20A-ESP-B	
C	GS20A-ESP-C	
D	GS20A-ESP-D	
E	GS20A-ESP-E	
F	GS20A-ESP-F	

EMC Shield Plate Installation

The steps below show how to install the EMC shield plate on a GS20 drive. The diagram examples use an A frame model.

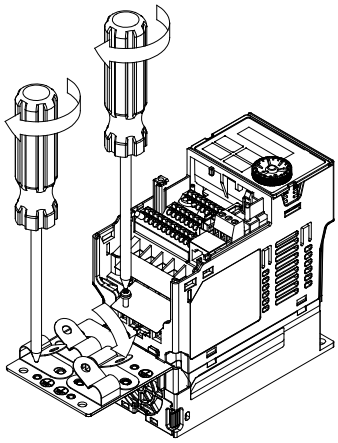
1) Attach the shield plate to the GS20 drive as shown in the diagram to the right.
Torque the screws per the table below:

Frame	Screw	Torque
A	M3.5	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]
B	M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]
C	M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]
D	M3	4–6 kg-cm (3.5–5.2 lb-in.) [0.39–0.59 N•m]
E	M3	4–6 kg-cm (3.5–5.2 lb-in.) [0.39–0.59 N•m]
F	M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]



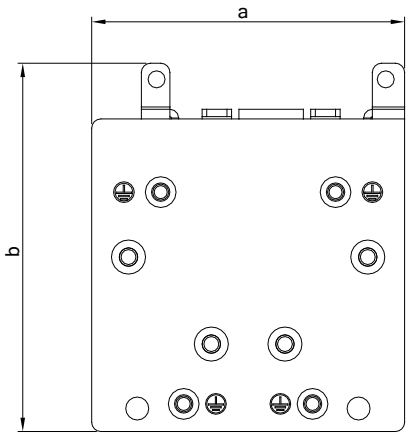
2) Select an R-clip suitable for the wire gauge used and then fix the R-clip to the shield plate as shown in the diagram to the right.
Torque the R-clip screws per the table below:

Screw	Torque
M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]



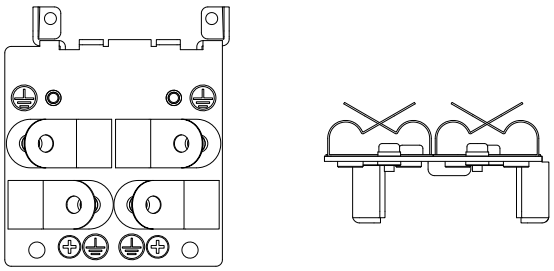
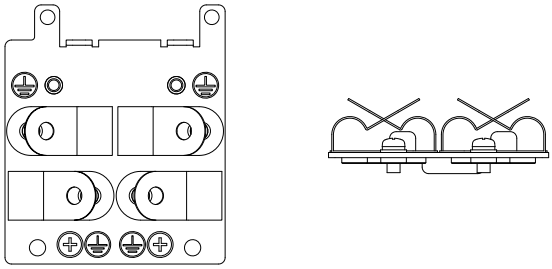
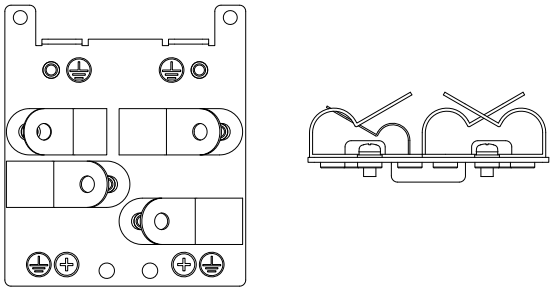
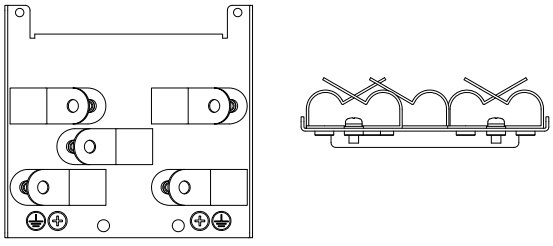
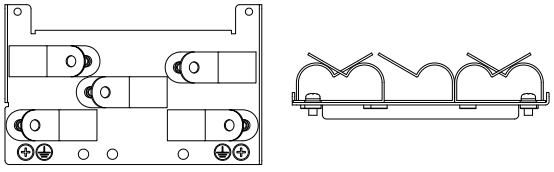
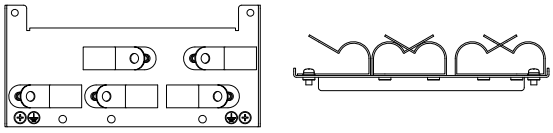
EMC Shield Plate Dimensions

EMC Shield Plate Dimensions		
Model	**Dimensions mm [inch]**	
	a	**b**
GS20-ESP-A	69.3 [2.73]	80.0 [3.15]
GS20-ESP-B	67.7 [2.67]	79.7 [3.14]
GS20-ESP-C	78.0 [3.07]	91.0 [3.58]
GS20-ESP-D	103.4 [4.07]	97.0 [3.82]
GS20-ESP-E	124.3 [4.89]	77.4 [3.05]
GS20-ESP-F	168.0 [6.61]	80.0 [3.15]



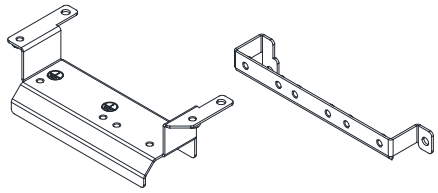
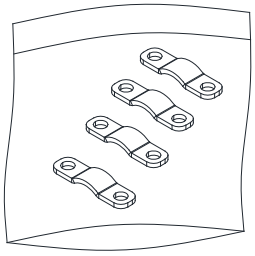
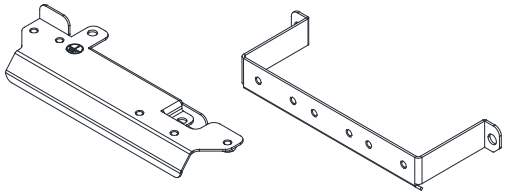
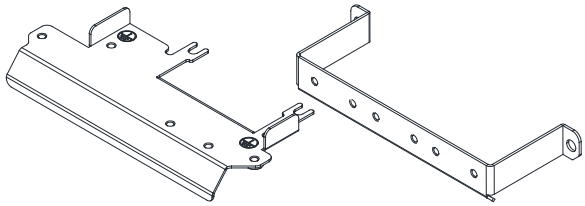
Recommended Wiring Method

The diagrams below show the recommended R-clip configuration for wiring shielded cable to each frame type/EMC shield plate model.

EMC Shield Plate Wiring Methods		
Frame	***EMC Shield Plate Model***	***Reference Drawing***
A	GS20A-ESP-A	
B	GS20A-ESP-B	
C	GS20A-ESP-C	
D	GS20A-ESP-D	
E	GS20A-ESP-E	
F	GS20A-ESP-F	

GS20X Earthing Plates

Earthing plates are available for use with shielded cable and your GS20X drive. Find the frame type of your GS20X from the specification tables and reference the table below:

GS20X Earthing Plate Selection			
Frame	***Earthing Plate Model***	***Reference Drawing***	
A	GS20XA-EPA		
B	GS20XA-EPB		
C	GS20XA-EPC		

Earthing Plate Installation

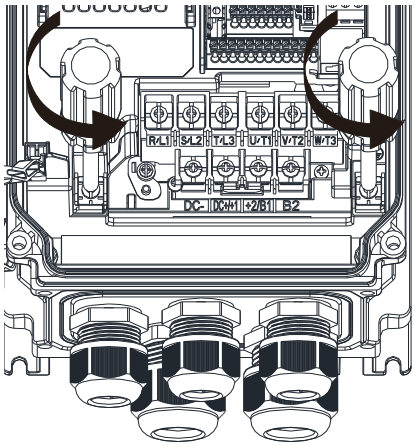
The steps below show how to install the earthing plate to your GS20X drive. The steps are fundamentally the same for each frame type, except Frame B has a different grounding screw configuration.

Torque all screws per the table below regardless of frame type.

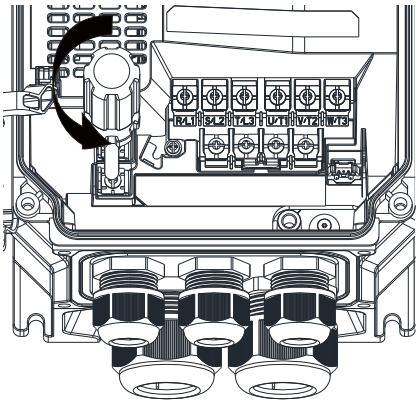
Screw	***Torque***
M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]

1) Frame A and C:
Loosen the ground screws on the right and left.

Frame B:
Loosen the ground screw on the left.



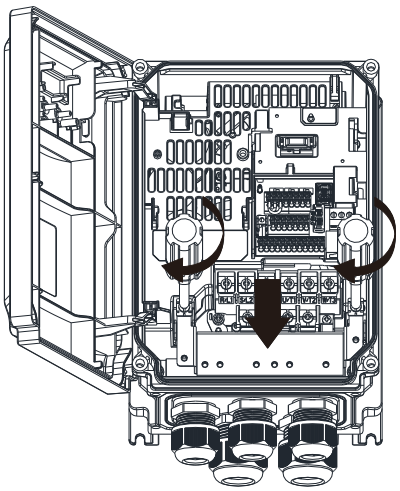
Frame A or C
(Frame A pictured)



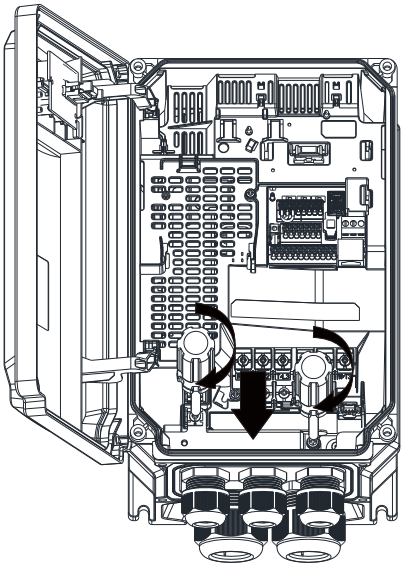
Frame B

2) Frame A and C:
Put the first earthing plate into the drive, then tighten the ground screws on the right and left again.

Frame B:
Put the first earthing palte into the drive, then tighten the ground screw on the left and the fixing screw on the right.

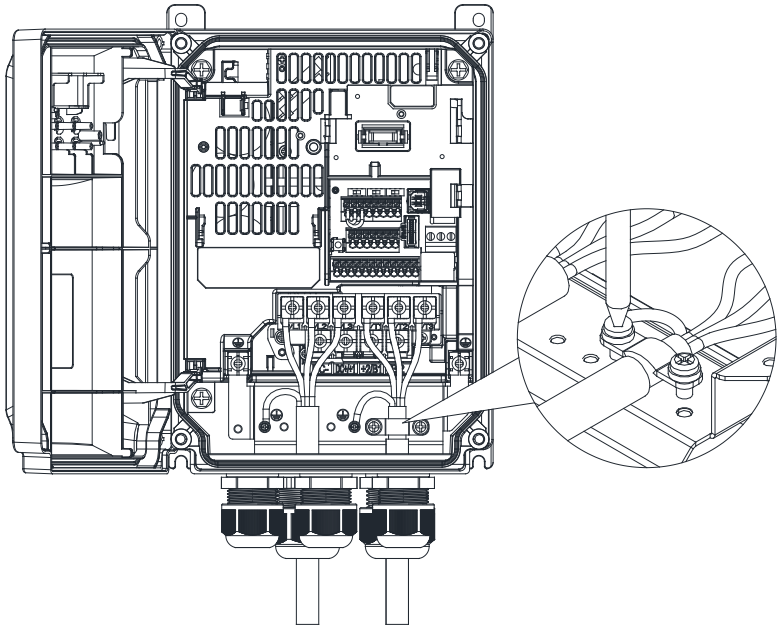


Frame A or C
(Frame A pictured)

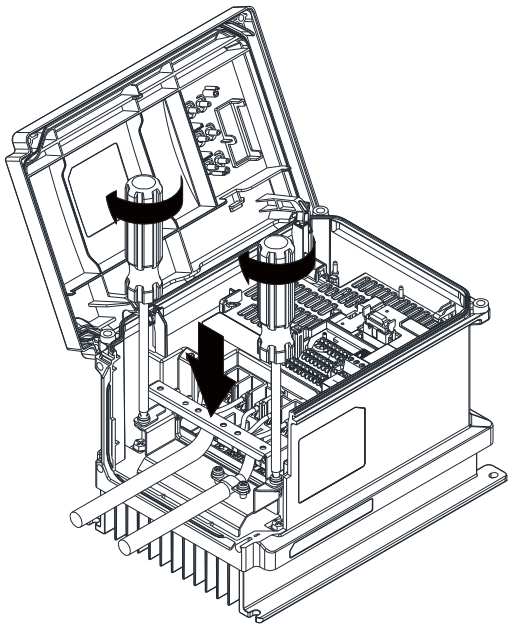


Frame B

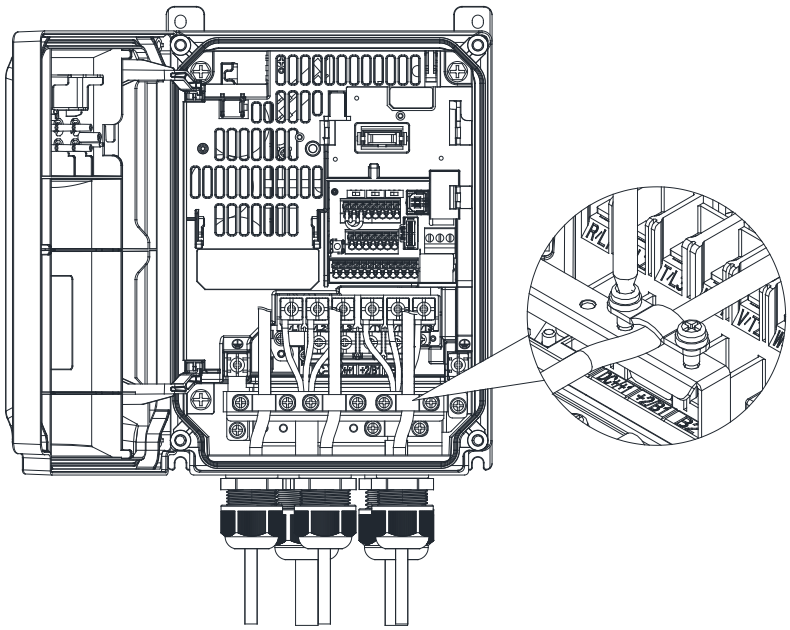
3) Before doing any wiring, strip part of the wire wraps, and then tighten the wires for the output terminals on the earthing plate (clamps must be fixed on the shielding).



4) Install the second earthing plate on top of the first one.



5) Tighten and fix the control wire with clamps.



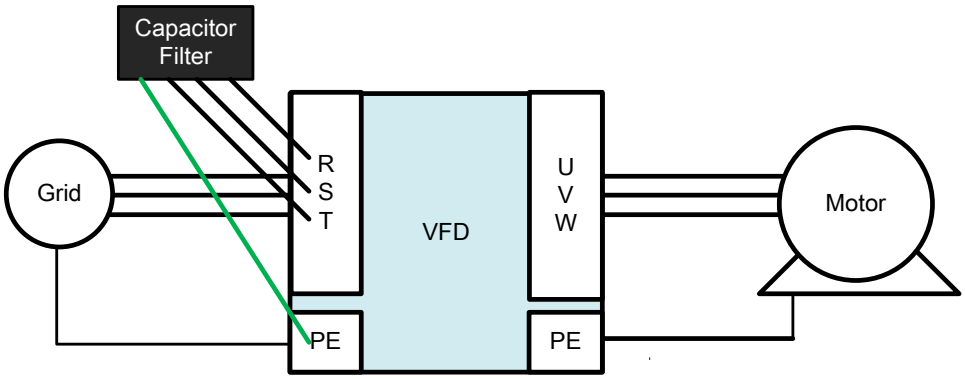
Capacitive Filter (GS20A-CAPF)

The GS20A-CAPF capacitive filter supports basic filtering and noise interference reduction for models 460V and below.

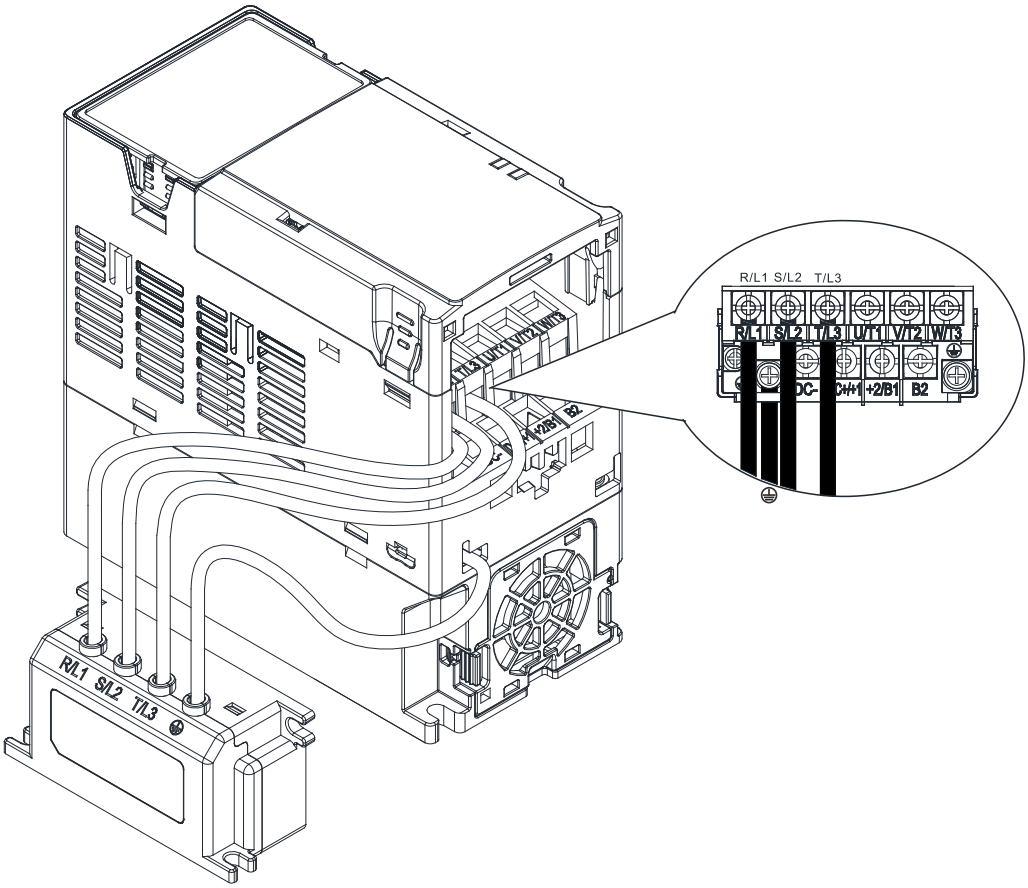
GS20A-CAPF Specifications			
Model	***Applicable Voltage***	***Temperature Range***	***Capacitance***
GS20A-CAPF	110–480 VAC	-40–85°C	Cx: 1uF ± 20% Cy: 0.1uF ± 20%

Note: GS20A-CAPF cannot be used with 575V GS20 models.

Installation diagram:

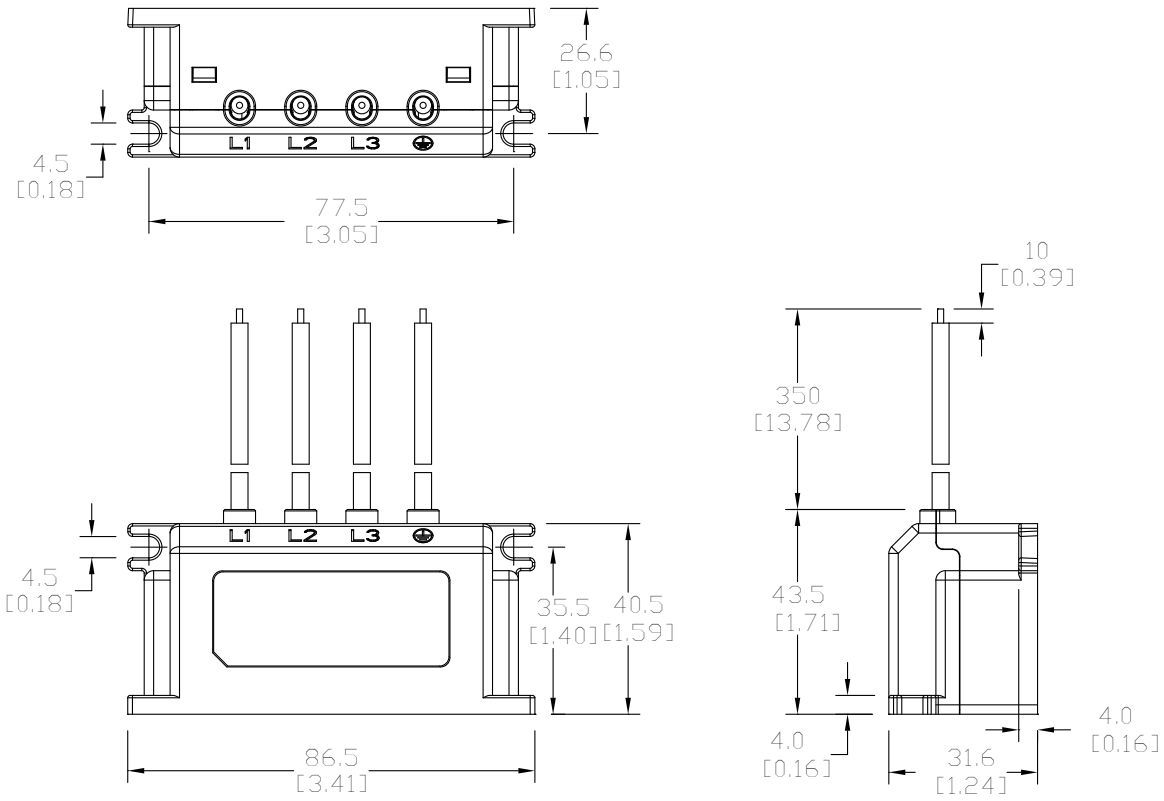


Filter and Drive Wiring



GS20A-CAPF Dimensions

Units = mm [inch]



Conduit Box

NEMA 1 / UL Type 1 compliant conduit boxes are available for all frame sizes (A–F).

Conduit Box Dimensions

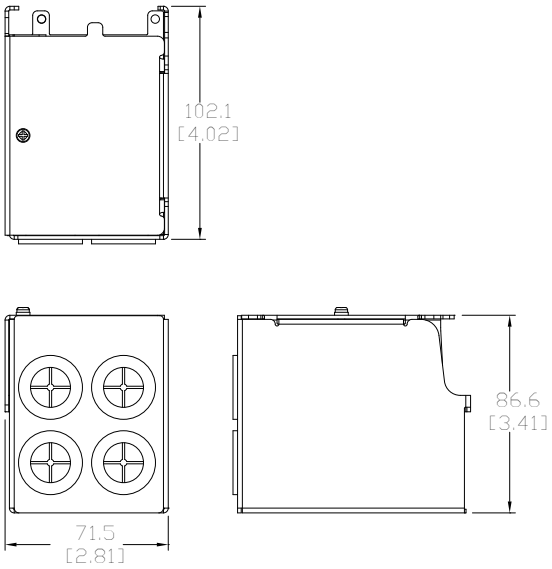
Units = mm [inch]

Frame A1, A2

Applicable models

GS21-10P2, GS21-20P2, GS23-20P2, GS23-20P5

Conduit Box GS20-N1A1

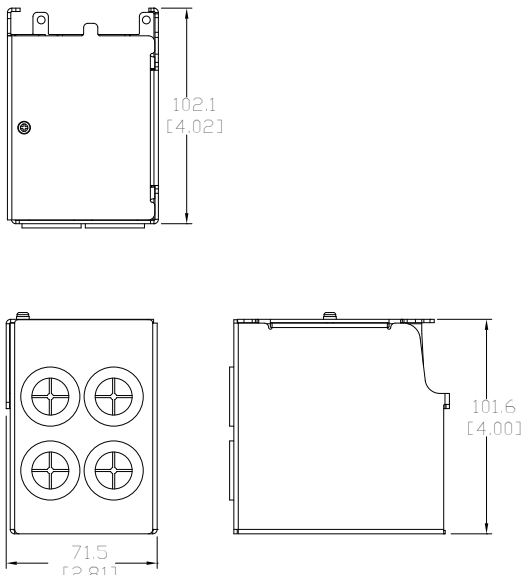


Frame A3–A5

Applicable models

GS21-10P5, GS21-20P5, GS23-40P5, GS23-21P0, GS23-41P0, GS23-51P0

Conduit Box GS20-N1A3

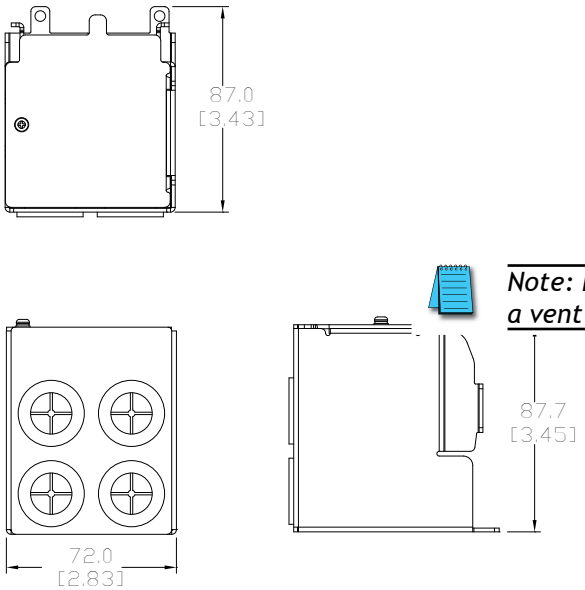


Frame B1, B2

Applicable models

GS23-22P0, GS23-42P0, GS23-52P0, GS21-21P0

Conduit Box GS20-N1B

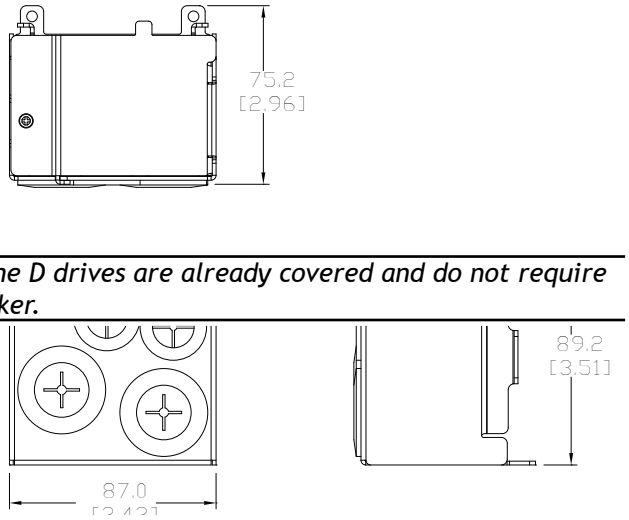


Frame C1

Applicable models

GS21-11P0, GS21-22P0, GS21-23P0, GS23-23P0, GS23-25P0, GS23-43P0, GS23-45P0, GS23-53P0, GS23-55P0

Conduit Box GS20-N1C



Note: Frame D drives are already covered and do not require a vent sticker.

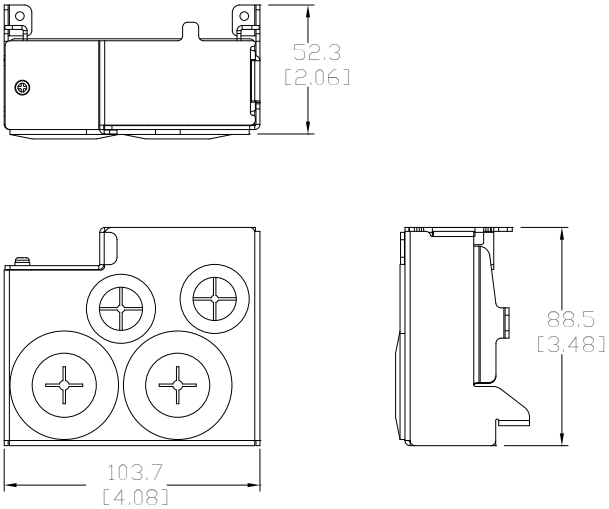
Units = mm [inch]

Frame D1

Applicable models

GS23-27P5, GS23-47P5, GS23-4010, GS23-57P5, GS23-5010

Conduit Box GS20-N1D

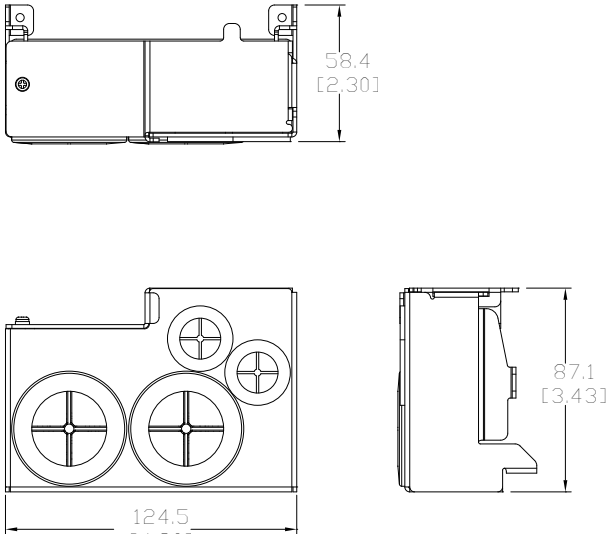


Frame E1

Applicable models

GS23-2010,, GS23-2015, GS23-4015, GS23-4020,

Conduit Box GS20-N1E

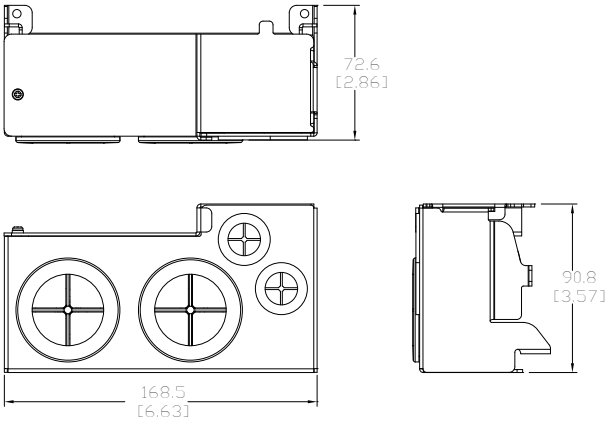


Frame F1

Applicable models

GS23-2020, GS23-4025, GS23-4030

Conduit Box GS20-N1F



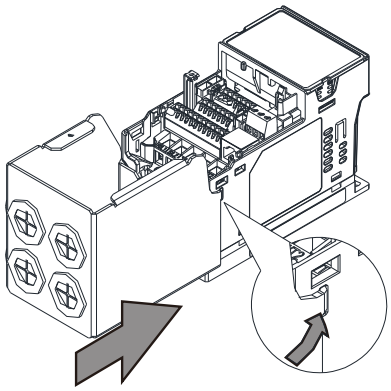
Conduit Box Installation

Follow the steps below to install a conduit box to your GS20 drive. The first set of instructions are for Frame A drives, the second set of instructions is for Frame B–F drives.

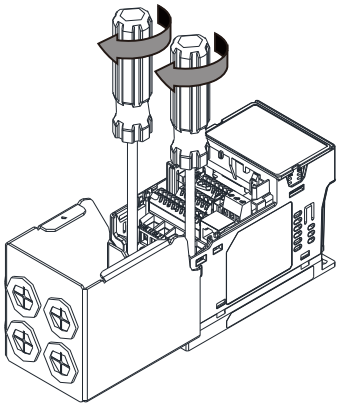
Recommended Screw Size and Torque Value	
Screw	***Torque***
M3	4–6 kg-cm (3.5–5.2 lb-in.) [0.39–0.59 N•m]
M3.5	4–6 kg-cm (3.5–5.2 lb-in.) [0.39–0.59 N•m]
M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]

Frame A Conduit Box Installation:

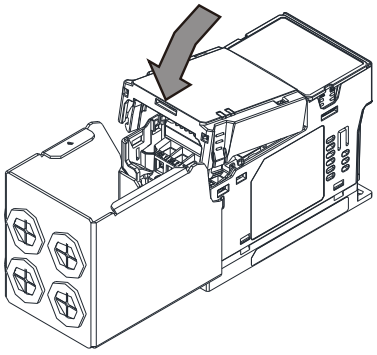
1)



2)



3)



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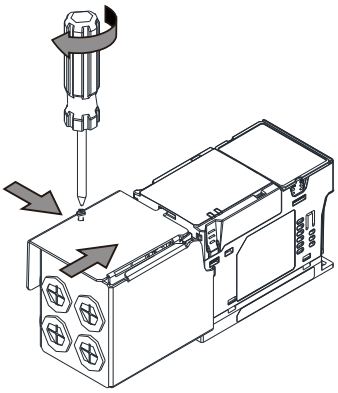
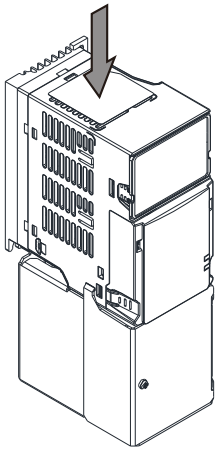
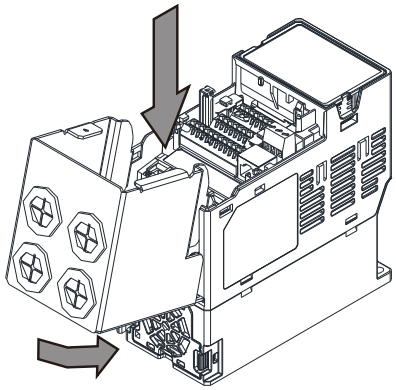


5)

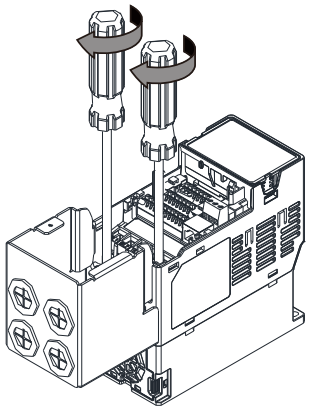


Frame B–F Conduit Box Installation:

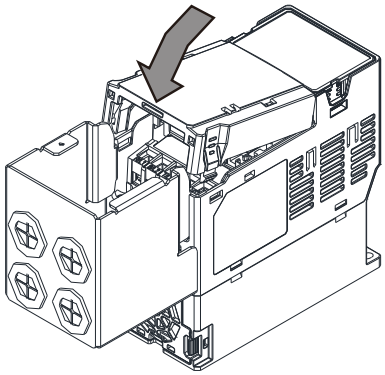
1)



2)



3)



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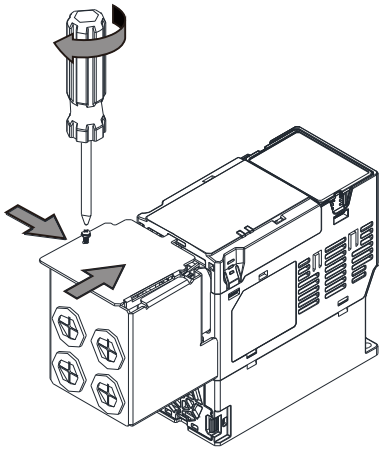

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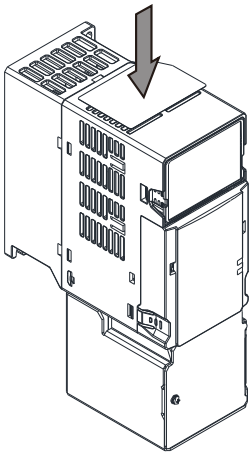


Disconnect Switch

The GS20XA-DSx series accessory provides a local on/off disconnect switch that is easily mounted to the GS20X drive. This accessory provides an easy, quick, single hasp lockout point to isolate power to the drive.

Note: DSC series disconnect switches are for use with GS20X NEMA4X drives only.

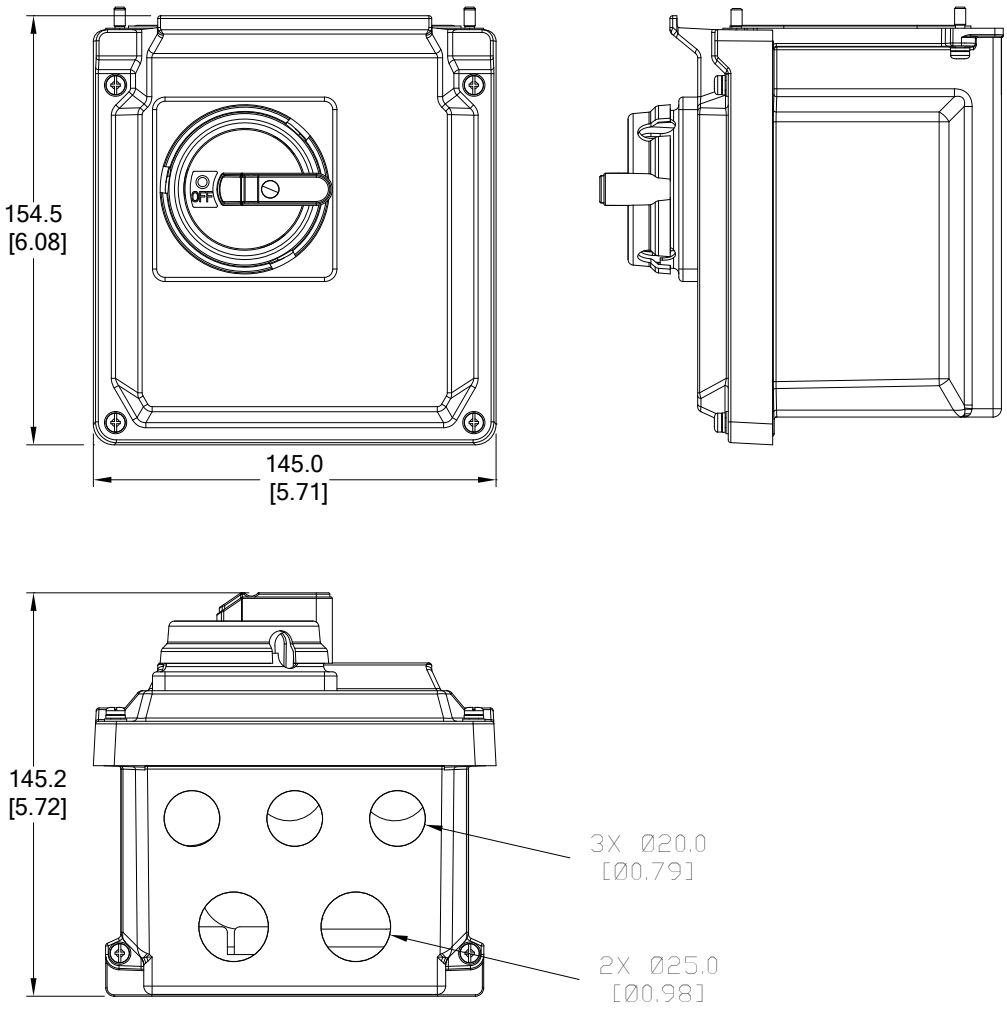
Disconnect Switch Compatibility

GS20X Disconnect Switch Selection	
Frame	***Disconnect Switch***
A	GS20XA-DSA
B	GS20XA-DSB
C	GS20XA-DSC

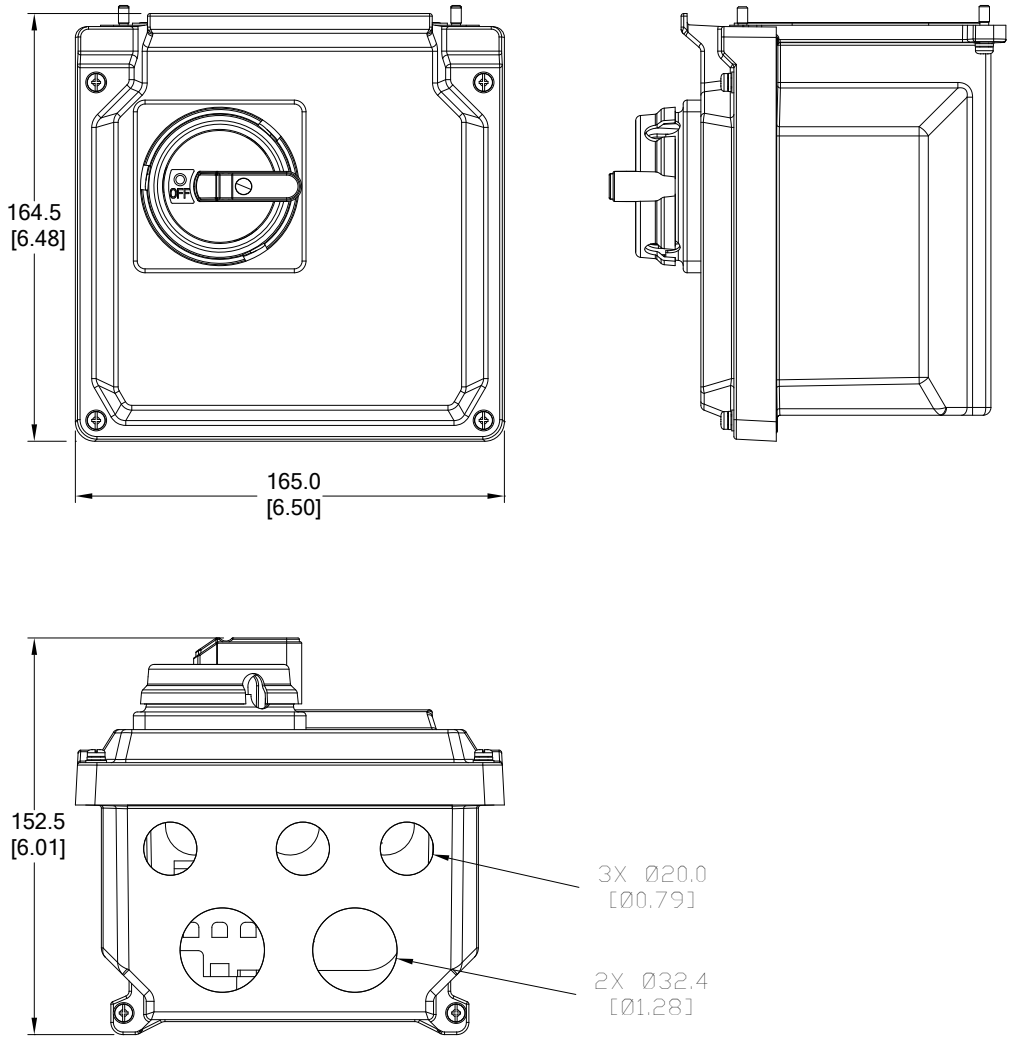
DSC Series Dimensions

Units = mm [inch]

GS20XA-DSA

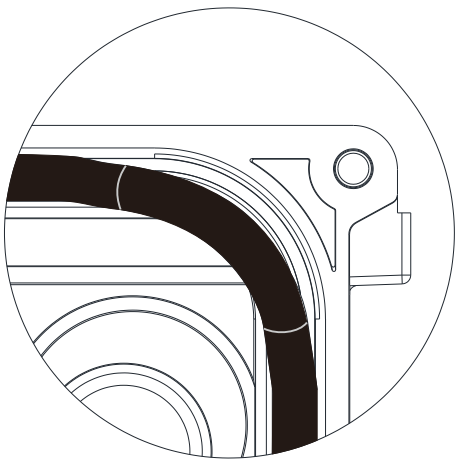


GS20XA-DSB and GS20XA-DSC

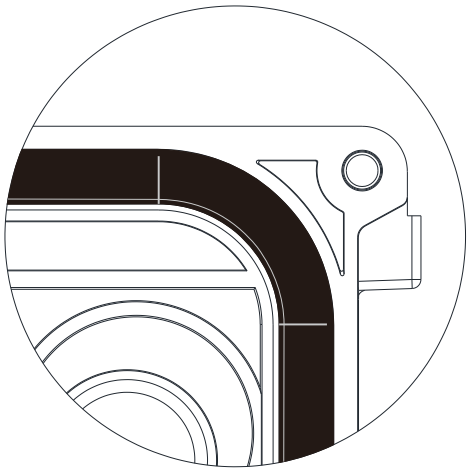


Installing the Disconnect Switch

Before installing the main switch, ensure that the waterproof ring is mounted tightly.



Waterproof ring mounted incorrectly.

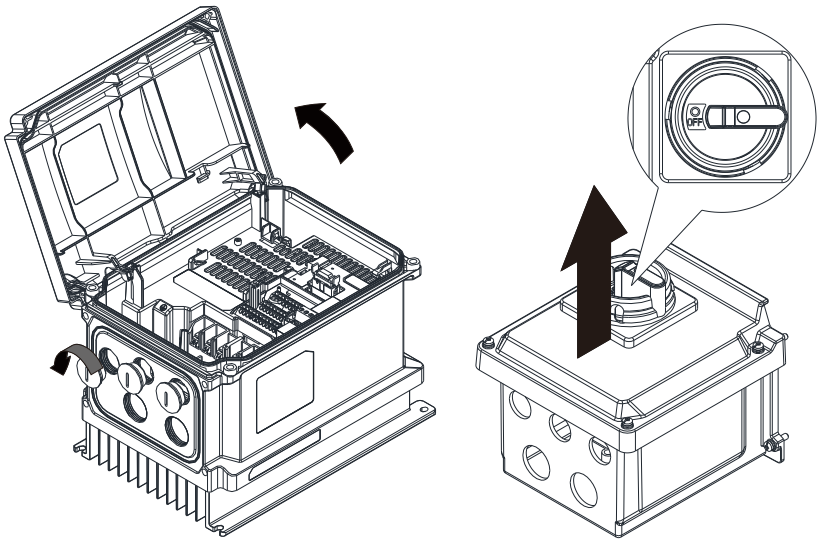


Waterproof ring forming a tight seal.

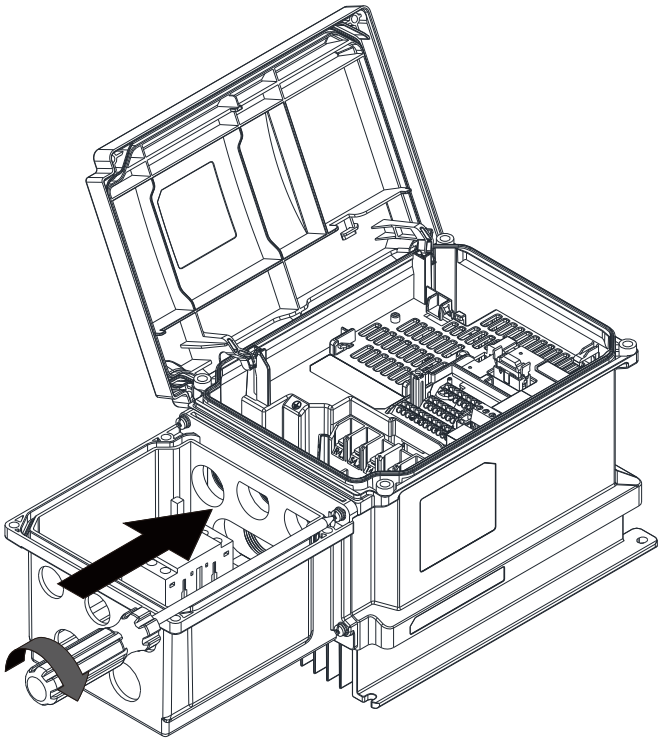
Torque for all screws:

Screw	*Torque*
M4	6–8 kg-cm (5.2–6.9 lb-in.) [0.59–0.78 N•m]

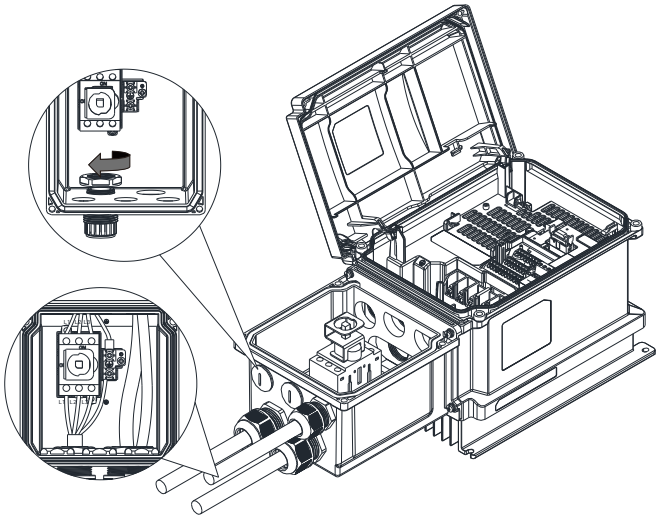
1) Open the front cover of the drive and remove all waterproof plugs. Then open the front cover of the main switch (keep the switch at OFF position).



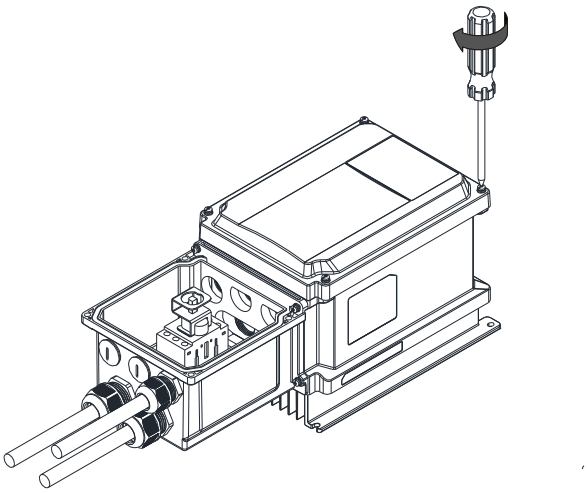
2) Mount the main switch to the drive.



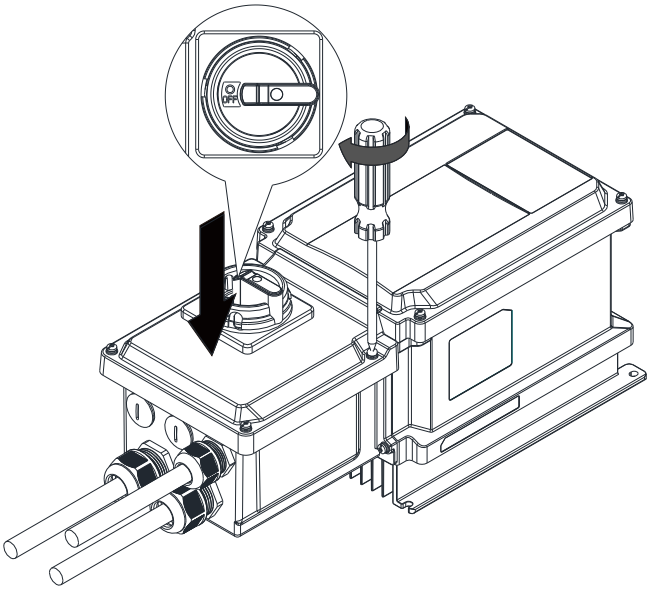
3) Tighten the waterproof connector and waterproof plugs before doing any wiring.



4) Close the front cover of the drive and tighten it.

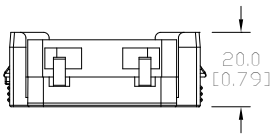
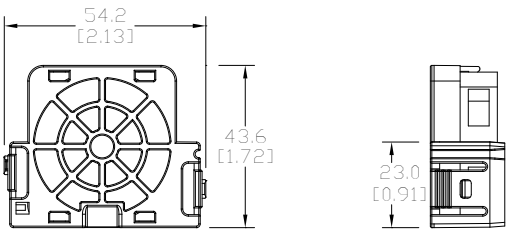
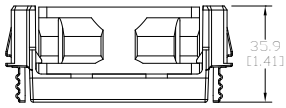
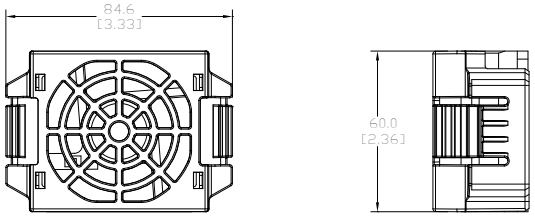
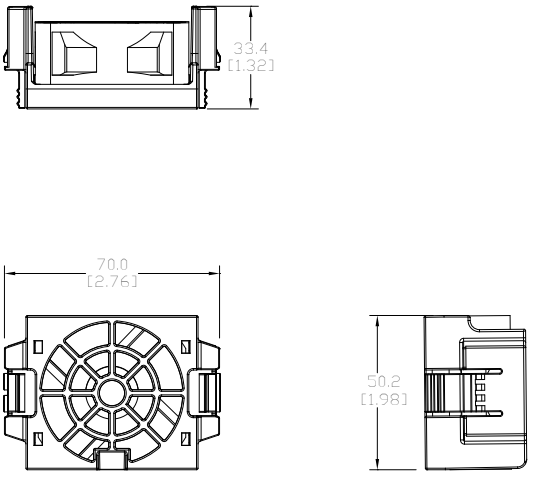


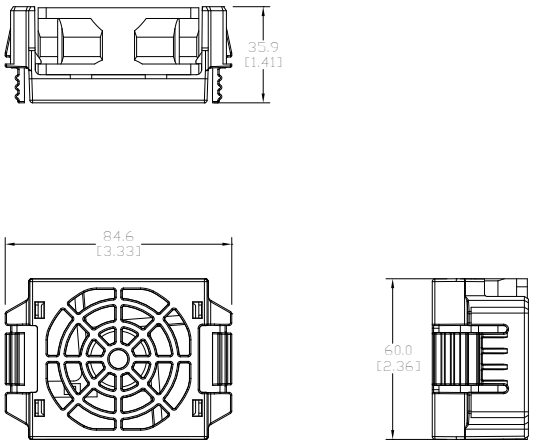
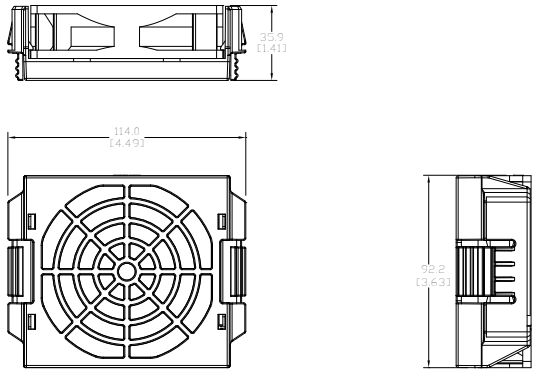
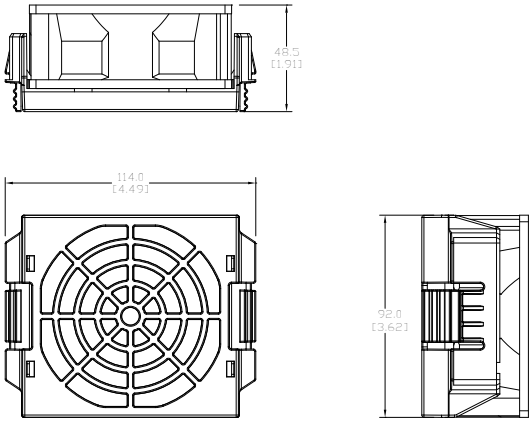
5) Close the front cover of the main switch and tighten it (keep the switch at OFF position).



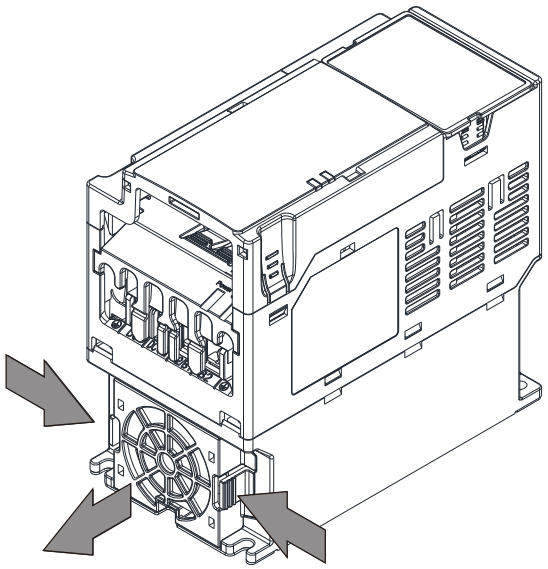
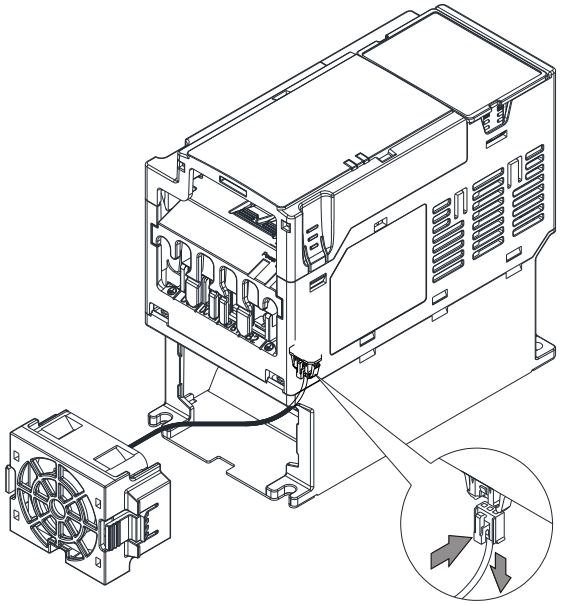
Replacement Fan Kit

Most GS20(X) drives come equipped with a fan that can be replaced if needed. Use the table below to select the right fan for your drive, then remove and replace the existing fan.

GS20(X) Fan Kit Selector			
Frame	***Drive Series***	***Fan Kit Model***	***Reference Drawing (units = mm [inch])***
A	GS20	n/a	
B	GS20	GS20A-FAN-B	
B	GS20X	GS20XA-FAN-B	
C	GS20X	GS20XA-FAN-C	
C	GS20	GS20A-FAN-C	

GS20 Fan Kit Selector (continued)			
Frame		***Fan Kit Model***	***Reference Drawing (units = mm [inch])***
D	GS20	GS20A-FAN-D	
E	GS20	GS20A-FAN-E	
F	GS20	GS20A-FAN-F	

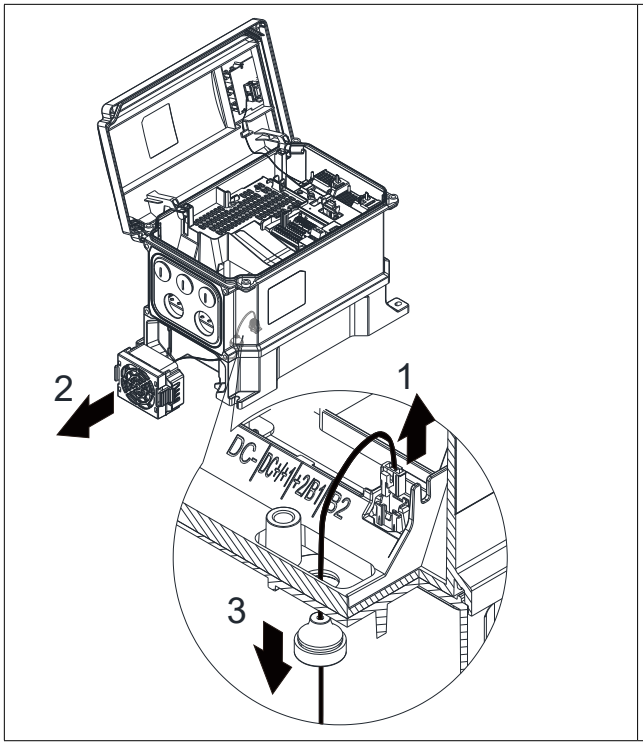
GS20 Series Fan Removal

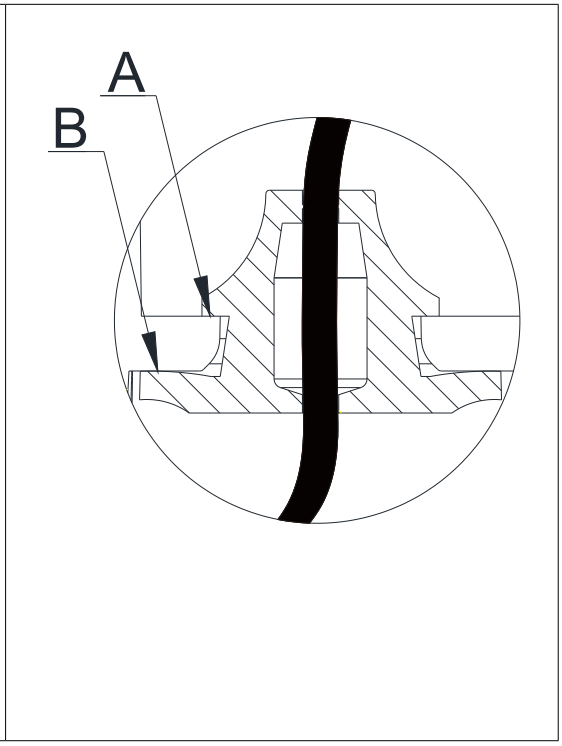
1) As shown in the figure below, press the tabs on both sides of the fan to remove it.	2) Disconnect the power cable while removing the fan.
	

GS20X Series Fan Removal

Follow the steps below to remove the existing fan from your GS20X drive.

1) Unplug the fan connector.
2) Remove the fan cover from the drive.
3) Remove the rubber bushing from the hole of the casing.
4) To install the new fan, perform steps 1 to 3 in reverse order. Verify that end A is correctly mounted and the petticoat of end B is turned outward after inserting the rubber bushing into the hole of the casing as shown in the lower right figure.

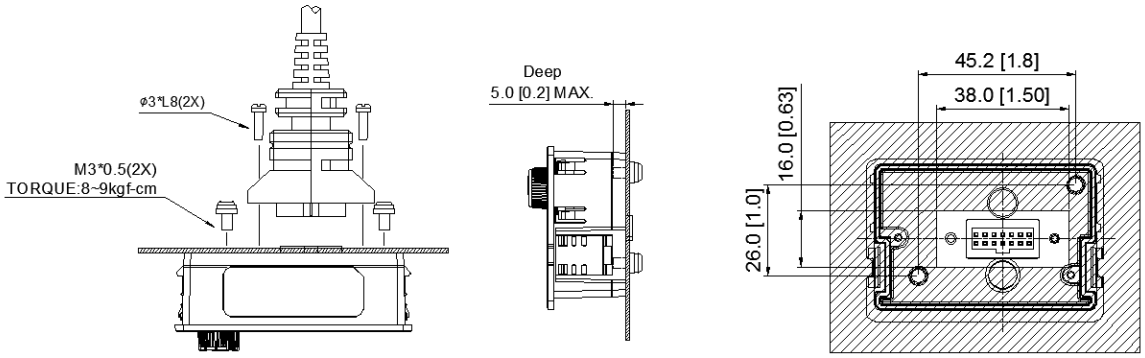




Remote Keypad Mounting

The GS20 keypad can detach from the drive and be mounted remotely. Use an extension cable and screws to create a remote access keypad for the drive.. The keypad can be mounted either directly on a plate, or embedded in a plate. Use the reference material below to mount and connect your GS20 keypad.

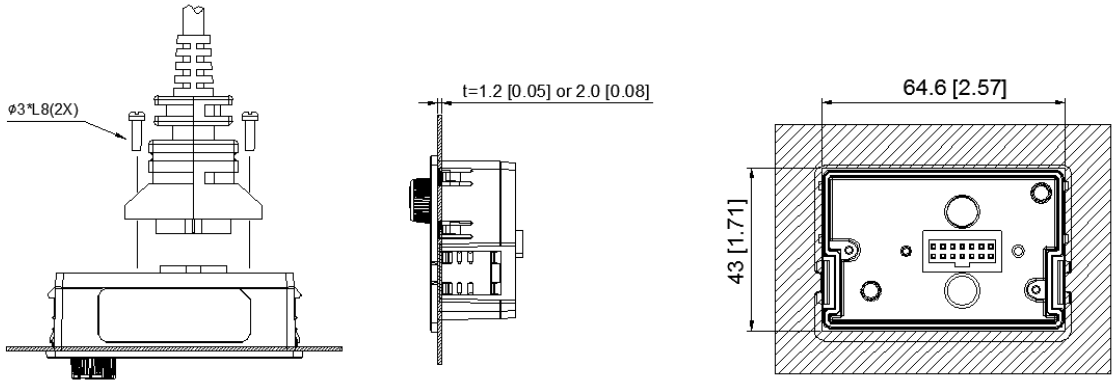
Direct Mounting on a Plate



Screw	*Torque*
M3	8–9 kg-cm (6.94–7.81 lb-in.) [0.78–0.88 N•m]

Embedded Mounting in a Plate

Plate Thickness (mm[inch]) = 1.2 [0.05] or 2.0 [0.08]



Available Extension Cables

GS20 Keypad Compatible Extension Cables	
Cable	*Length (units = m [ft])*
GS-CBL2-1L	1 [3.28]
GS-CBL2-3L	3 [9.84]
GS-CBL2-5L	5 [16.4]

DIN Rail Mounting

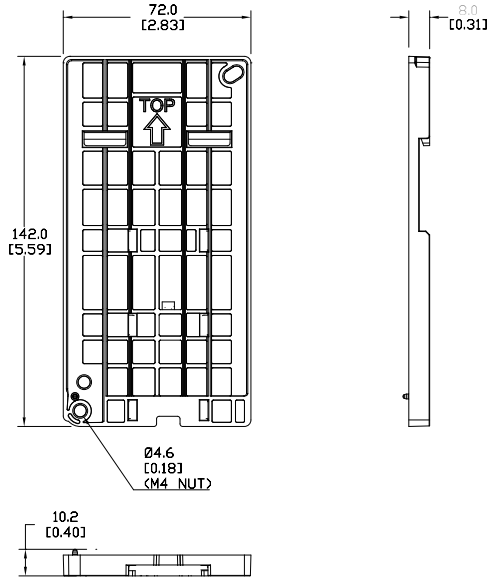
Frame A, B, and C GS20 drives can be DIN rail mounted using a DIN rail mounting kit. One kit is used for A and B frame drives, while a second kit is used for C frame drives.

GS20 DIN Rail Mounting Compatibility		
Drive Model	***Frame***	***Mounting Plate***
GS21-10P2	A1	GS20A-DR-AB
GS21-20P2	A1	
GS23-20P2	A1	
GS23-20P5	A2	
GS21-10P5	A3	
GS21-20P5	A3	
GS23-40P5	A4	
GS23-21P0	A5	
GS23-41P0	A5	
GS23-51P0	A5	
GS23-22P0	B1	
GS23-42P0	B1	
GS23-52P0	B1	
GS21-21P0	B2	
GS21-11P0	C1	GS20A-DR-C
GS21-22P0	C1	
GS21-23P0	C1	
GS23-23P0	C1	
GS23-25P0	C1	
GS23-43P0	C1	
GS23-45P0	C1	
GS23-53P0	C1	
GS23-55P0	C1	

GS20A-DR-AB

Used with Frame A and B GS20 drives.

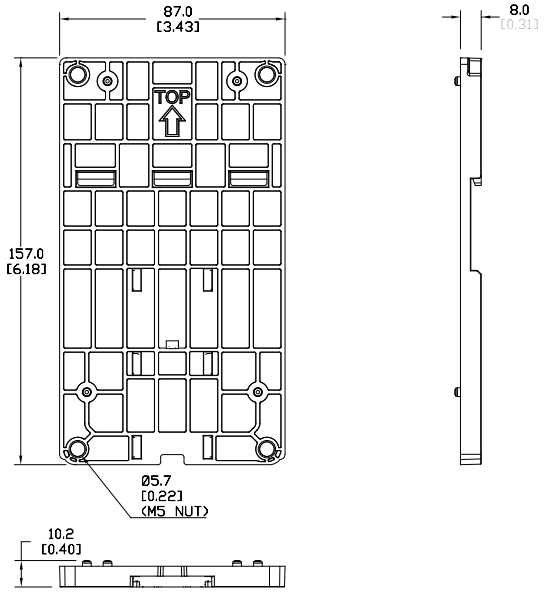
Screw	***Torque***
M4 x 2	8–10 kg-cm (6.9–8.7 lb-in.) [0.78–0.98 N•m]



GS20A-DR-C

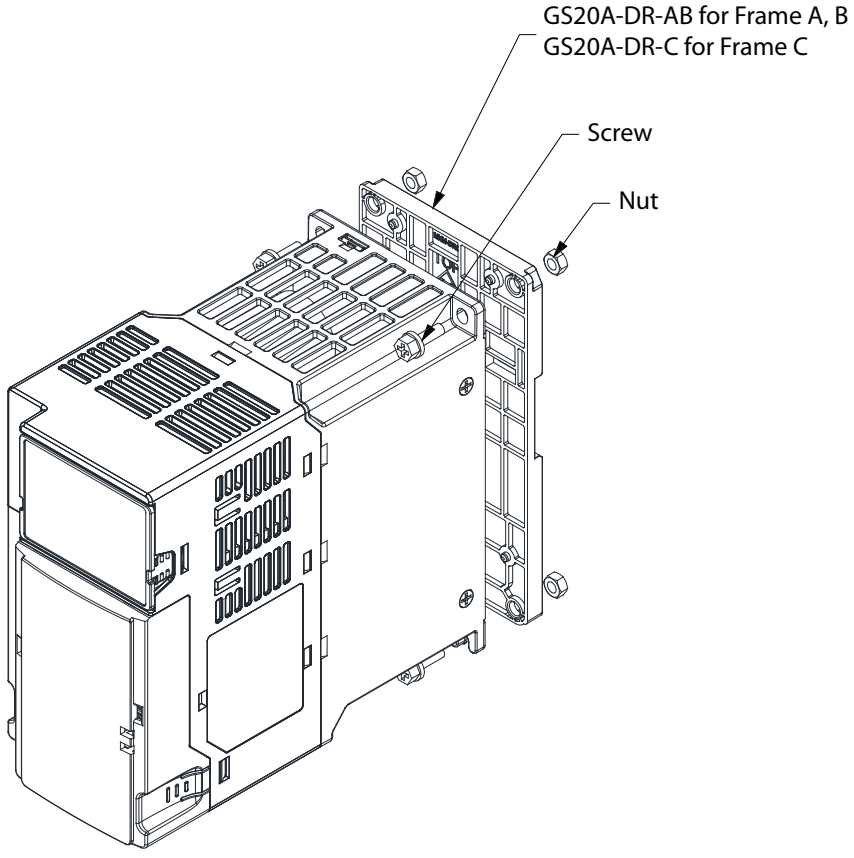
Used with Frame C GS20 drives.

Screw	*Torque*
M5 x 4	10–12 kg-cm (8.7–10.4 lb-in.) [0.98–1.18 N•m]



GS20 DIN Rail Installation

Attach the GS20 drive to the DIN rail kit mounting bracket as shown below. The diagram is for a Frame C drive, for Frame A or B, use one screw at the top and one at the bottom.



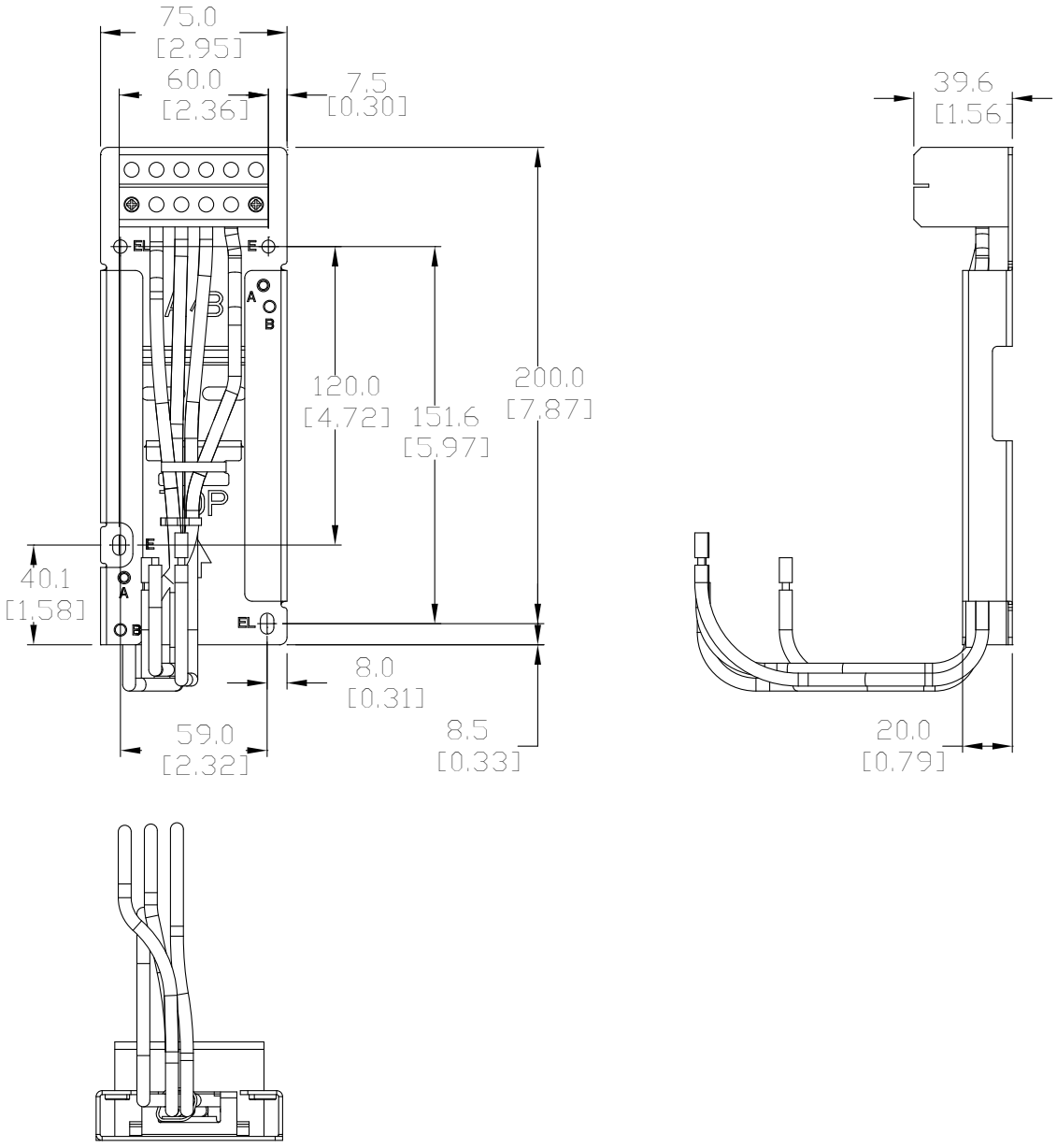
Mounting Adapter Plate

The mounting adapter plate can be used to change the wiring method for the GS20 series and provides flexibility for installation. This accessory changes the wiring method from the “bottom-mains input/ bottom-motor output" to the “top-mains input/bottom-motor output" for GS20. Use the table below to select the correct mounting plate for your drive.

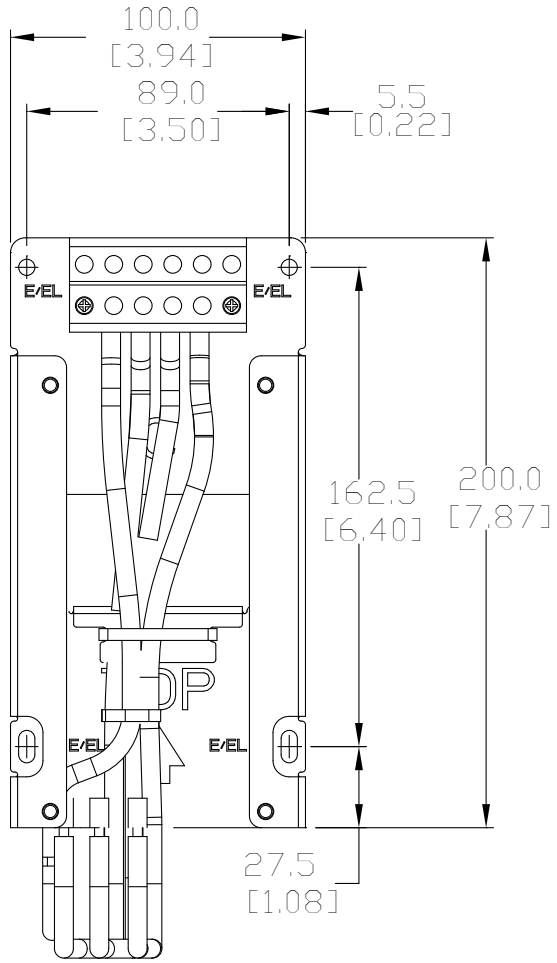
GS20 Mounting Adapter Compatibility		
Drive Model	***Frame***	***Mounting Plate***
GS21-10P2	A1	GS20A-MP-AB
GS21-20P2	A1	
GS23-20P2	A1	
GS23-20P5	A2	
GS21-10P5	A3	
GS21-20P5	A3	
GS23-40P5	A4	
GS23-21P0	A5	
GS23-41P0	A5	
GS23-51P0	A5	
GS23-22P0	B1	
GS23-42P0	B1	
GS23-52P0	B1	
GS21-21P0	B2	
GS21-11P0	C1	GS20A-MP-C
GS21-22P0	C1	
GS21-23P0	C1	
GS23-23P0	C1	
GS23-25P0	C1	
GS23-43P0	C1	
GS23-45P0	C1	
GS23-53P0	C1	
GS23-55P0	C1	

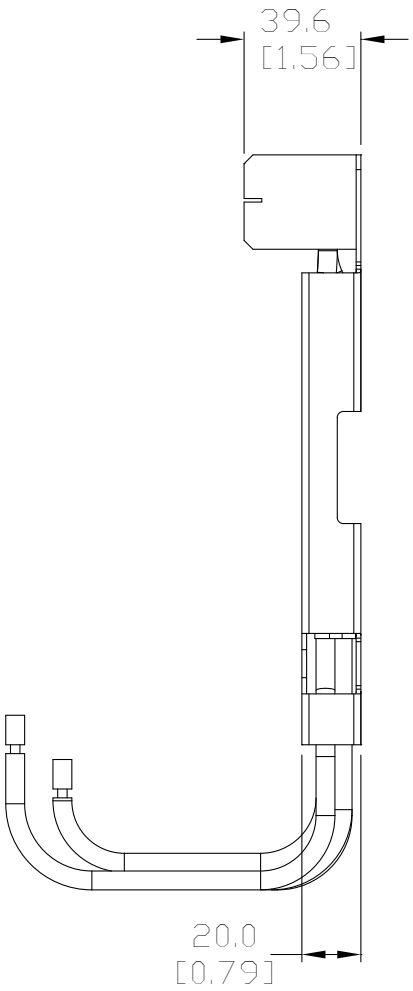
Mounting Adapter Plate Dimensions

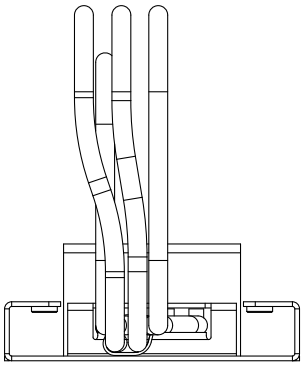
GS20A-MP-AB



GS20A-MP-C


100.0
[3.94]
89.0
[3.50]
5.5
[0.22]
E/EL
E/EL
162.5
[6.40]
200.0
[7.87]
DP
E/EL
E/EL
27.5
[1.08]


39.6
[1.56]
20.0
[0.79]

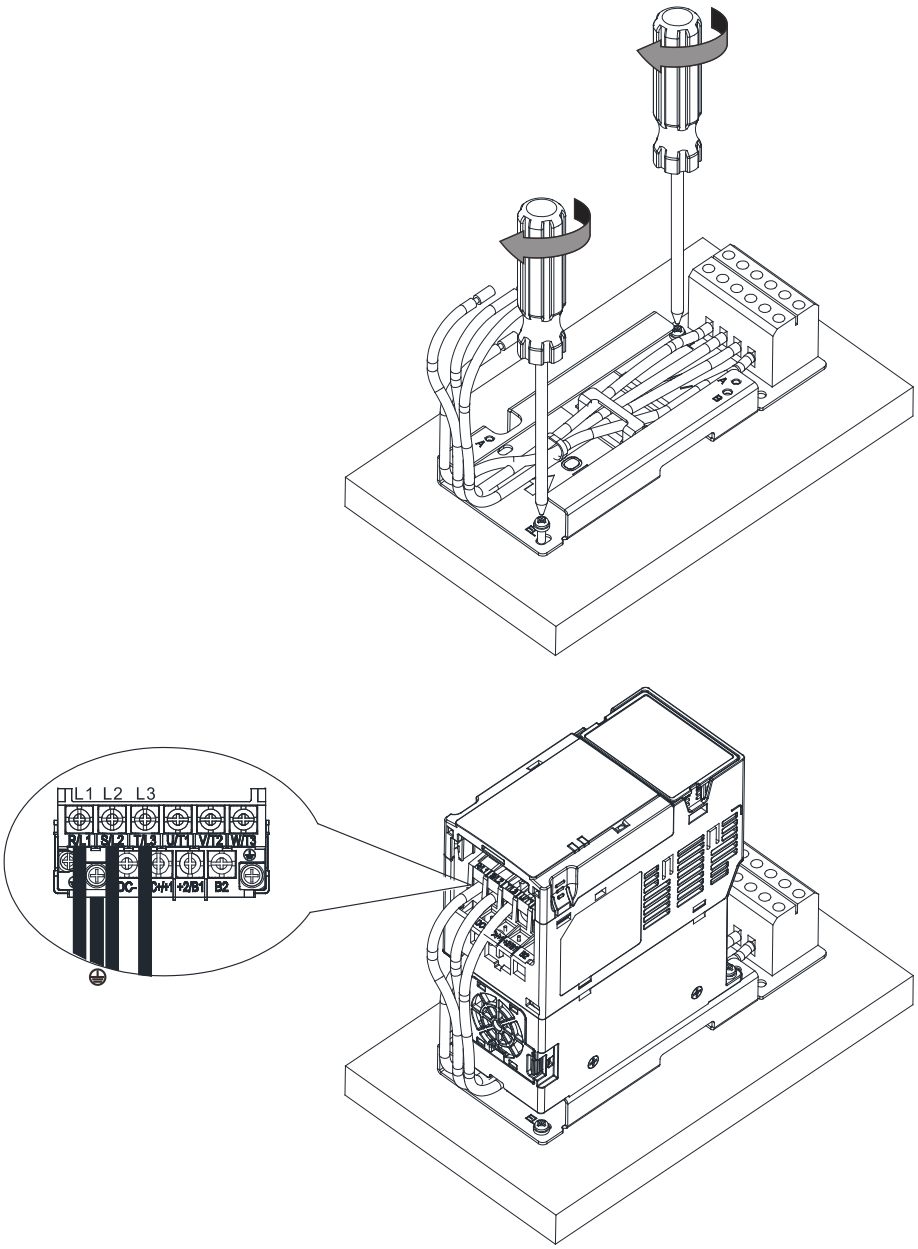


Mounting Adapter Plate Installation

Use the diagrams below and on the following page to install the mounting adapter plate and reroute the wiring.

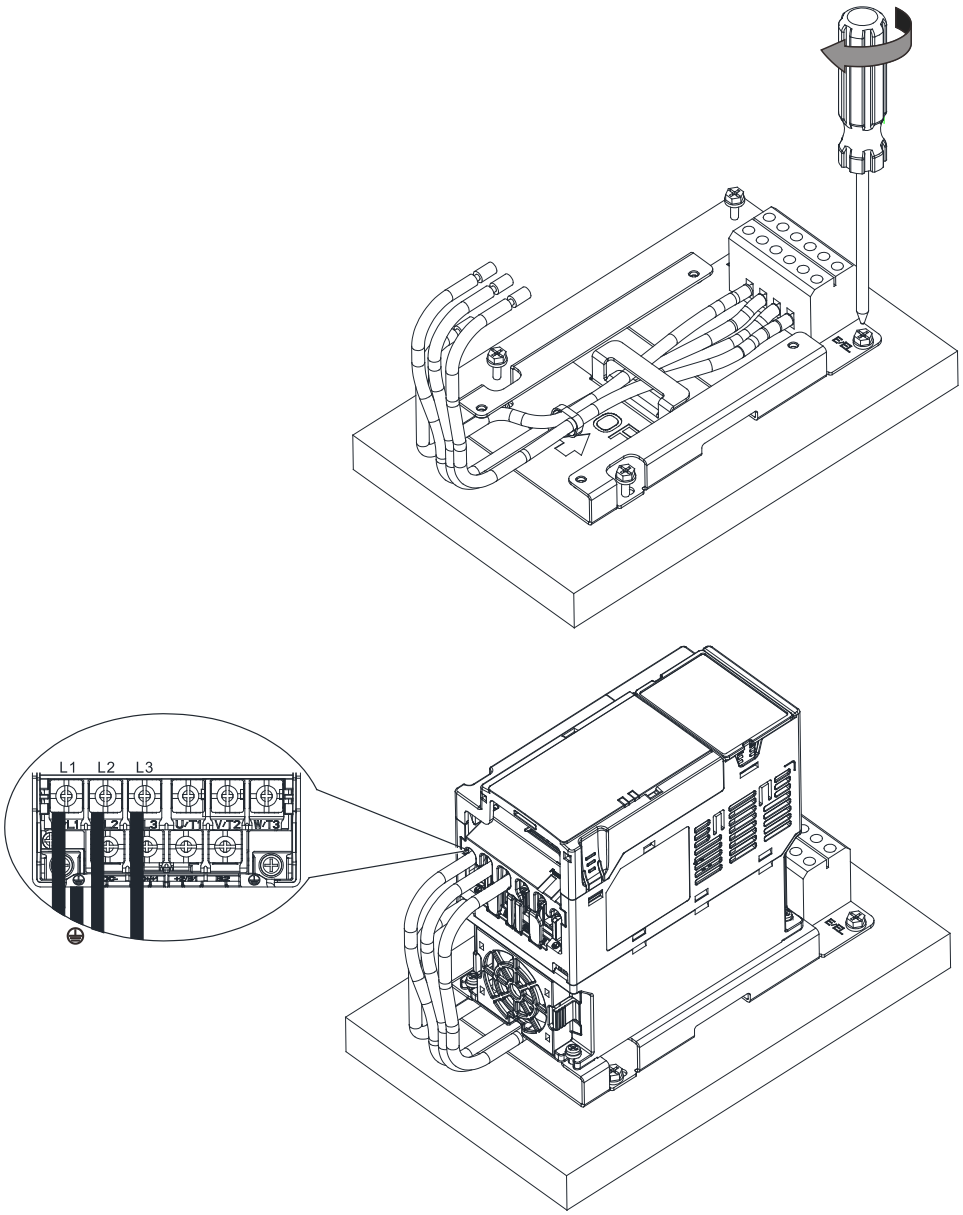
GS20A-MP-AB

GS20A-MP-AB Screw Size and Torque Value	
Screw	***Torque***
M4	14–16 kg-cm (12.4–13.9 lb-in.) [1.37–1.57 N•m]
M5	16–20 kg-cm (13.9–17.4 lb-in.) [1.57–1.96 N•m]



GS20A-MP-C

GS20A-MP-C Screw Size and Torque Value	
Screw	***Torque***
M4	14–16 kg-cm (12.4–13.9 lb-in.) [1.37–1.57 N•m]
M5	16–20 kg-cm (13.9–17.4 lb-in.) [1.57–1.96 N•m]



Optional Advanced Keypad

GS4-KPD

The GS4-KPD can be used with GS20(X) drives and offers a more advanced interface with additional features. The keypad can be installed flat on the surface any control panel (with or without bezel GS4-BZL). The front cover is IP56 rated.

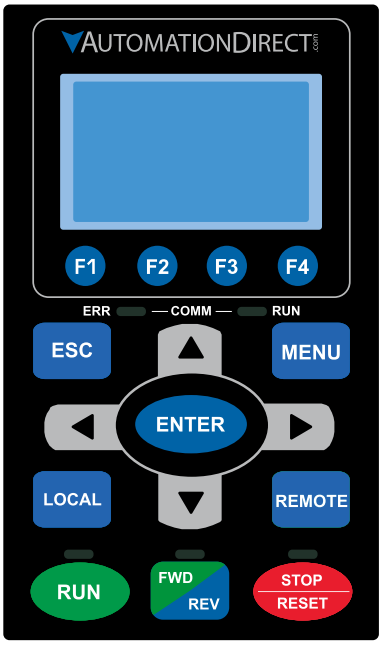
The maximum RJ45 extension lead is 5m (16ft). The keypad communication connection to the drive when mounted remotely can be accomplished by using a standard RJ45 CAT5e straight through patch cable. No other wiring is required. The small RJ45 plastic connector that comes standard with each GS4-KPD kit is not used with GS20.

The communication protocol for GS4-KPD is RTU 19200, 8, N, 2. Therefore, you must set GS20(X) communication parameters so as to connect with the digital keypad GS4-KPD. The setting steps are as follows:

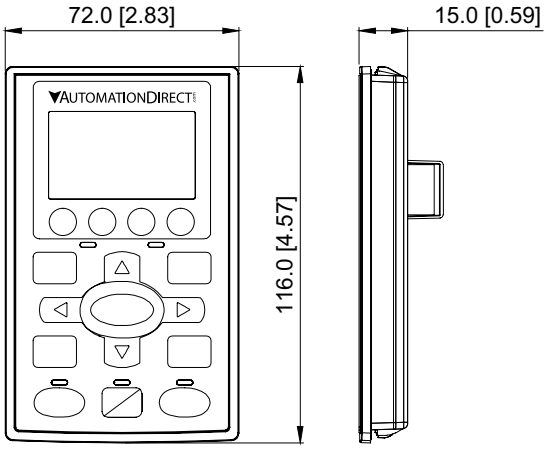
1) Set P09.00 communication address = 1
2) Set P09.01 COM1 transmission speed (Baud rate) = 19.2 Kbps
3) Set P09.04 COM1 communication protocol = 13: 8N2 (RTU)

To control the GS20(X) drive motion and speed with the keypad, the setting steps are as follows:

1) Frequency control - Parameter P00.20 and/or P00.30 to 1:RS-485 input
2) Operation control- Parameter P00.21 and/or P00.31 to 2: RS-485 input.



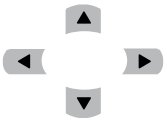
RJ45 Connector (included, not used)



Dimensions mm [in]

Descriptions of Keypad Functions	
RUN	**RUN Key** 1) It is only valid when the source of operation command is from the advanced keypad via RS-485. 2) It can operate the AC motor drive by the function setting and the RUN LED will be ON. 3) RUN can be pressed even when drive is in process of stopping. 4) When enabling "LOCAL" mode, it is only valid when the source of operation command is from the advanced keypad via RS-485.
STOP RESET	**STOP/RESET Key** *This key has the highest processing priority in any situation.* 1) When it receives STOP command, whether or not the AC drive is in operation or stop status, the AC motor drive will execute a "STOP" command. 2) The RESET key can be used to reset the drive after the fault occurs. For those faults that can't be reset by the RESET key, see the fault records after pressing MENU key for details.

Continued on next page.

Descriptions of Keypad Functions (*continued*)	
	Operation Direction Key 1) This key only controls the operation direction and does NOT activate the drive. FWD: forward. REV: reverse. 2) Refer to the LED descriptions for more details.
	ENTER Key Press ENTER and go to the next menu level. If it is the last level, then press ENTER to execute the command.
	ESC Key The ESC key function serves to leave the current menu and return to the last menu. It also functions as a return key while in the sub-menu.
	MENU Key Press MENU to return to the main menu. Menu Content: 1) Param Setup 2) Quick Start 3) Keypad Lock 4) Fault Record 5) PLC 6) Copy Param 7) Copy PLC 8) Displ Setup 9) Time Setup 10) Language 11) Start-up
	**Direction: Left/Right/Up/Down** 1) In the numeric value setting mode, it is used to move the cursor and change the numeric value. 2) In the menu/text selection mode, it is used for item selection.
	Function Keys 1) F1 is JOG function 2) The F2, F3, F4 keys are reserved for future use.
	LOCAL Key 1) This key is executed by the parameter settings of the source of Local frequency and Local operation. The factory settings of both source of Local frequency and Local operation are the digital keypad. 2) Pressing the LOCAL key with the drive stopped will switch the operation and frequency to the LOCAL source. Pressing the LOCAL key with the drive running will stop the drive, with "AHSP" warning displayed and when stopped, will switch the operation and frequency source to the LOCAL source. 3) The selected mode, LOCAL or REMOTE, will be displayed on the GS4-KPD. 4) When P00.29=0 then LOCAL correlates to HAND mode. The Digital Input Definition must not be set to 56 (LOC/REM Switch). *Refer to P00.29 for more detail and other options on how the drive behaves when switching between LOCAL and REMOTE.*
	REMOTE Key 1) This key is executed by the parameter settings of the source of Remote frequency and Remote operation. The digital keypad is the the factory default source for both Remote frequency and Remote operation. 2) Pressing the REMOTE key with the drive stopped will switch the operation and frequency to the REMOTE source. Pressing the REMOTE key with the drive running will stop the drive, with “AHSP” warning displayed and when stopped, will switch the operation and frequency source to the REMOTE source. 3) The selected mode, LOCAL or REMOTE, will be displayed on the GS4-KPD. 4) When P00.29=0 then LOCAL correlates to HAND mode. The Digital Input definition must not be set to 56 (LOC/REM Switch). *Refer to P00.29 for more detail and other options on how the drive behaves when switching between LOCAL and REMOTE.*

Descriptions of LED Functions	
	Steady ON: Operation indicator of the AC motor drive, including DC brake, zero speed, standby, restart after fault and speed search. **Blinking**: Drive is decelerating to stop or in the status of base block. **Steady OFF**: Drive is not currently executing an operational (RUN) command.
	Steady ON: Stop indicator of the AC motor drive. **Blinking**: Drive is in the standby status. **Steady OFF**: Drive is not currently executing an operational (STOP) command.
	Operation Direction LED 1) Green light is on, the drive is running forward or will run forward when given a run command. 2) Red light is on, the drive is running backwards or will run backwards when given a run command. 3) Alternating green/red light: the drive is changing direction.
	ERR_COMM_RUN Descriptions reserved for future use.

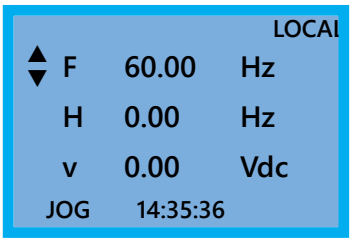
GS20(X) Display Screens for GS4-KPD

Start-Up Display

At power up, the Start-up Page displays the *DURAPULSE*, GS20 logo. This page is replaced by the Status Page in 3 seconds.

Pressing the UP Arrow while the Start-up Page is displayed will show the current keypad firmware.

Status Page



Drive status:
Press the LOCAL key to allow local control of the drive.
Press the REMOTE key to allow remote control of the drive.
Pressing the Up and Down Direction keys allow the user to scroll through the Status Page items.
F X.xx Hz (actual GS20 command frequency)
H X.xx Hz (actual GS20 output frequency)
U XXX.x User defined value (in this example P00.04 = 3 DC bus voltage*
A X.xx Amp (output amperage)
JOG and time:
JOG appears above the F1 key and is the function assigned to that key.
The internal clock is displayed, center bottom.

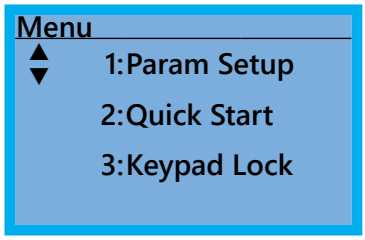
NOTE: When Power is applied, the keypad will display the startup Page followed by the Status Page. The Status Page displays the GS20(X) default settings F/H/U/A. While the order F/H/U/A is always fixed, P00.03 can be used to set which value appears on the top row at power-up. The UP and DOWN Arrows will scroll through the display options.

NOTE: If an "Err" appears on the keypad after pressing <Enter> in any menu or parameter, then the action did not take affect. The keypad will report back "End" if the action was performed correctly. Ex: writing a value out of range to a parameter will cause a "Err" message.

** NOTE: Refer to Parameter P00.04 in Chapter 4, AC Drive Parameters for a complete list of the values that can be displayed on line 3 of the keypad display. The value in P00.04 is the value that will be shown when the drive powers up. By scrolling to the User Defined row, the Left and Right Direction keys can be used to display any of the other selections available.*

NOTE: The GS4-KPD is connected to the GS20(X) by the RJ45 communiations port with a standard ethernet cable. The following communications settings must be used: P09.01=19.2 (kBps) and P09.04=13 (8N2 RTU).

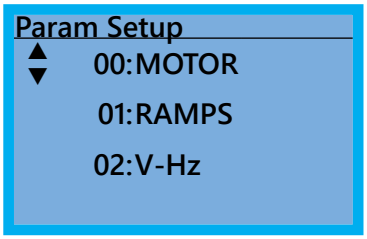
Menu Page



Press the Menu button from any page to access the Menu Page. Use the Up and Down Direction keys to scroll through the Menu content. Press the Enter key to open the selected Menu content item.

1: Param Setup - Parameter Setup
Set up the individual drive parameters.
2: Quick Start - This function not available for GS20(X).
3: Keypad Lock
Lock the Keypad.
4: Fault Record
Display fault information for the drive.
5: PLC
Run the current PLC program.
6: Copy Param - Copy Parameters
Save drive parameters to the keypad or drive.
7: Copy PLC
Copy a previously saved PLC program to the keypad or drive.
8: Displ Setup
Adjust contrast and backlight settings for the display.
9: Time Setup
Set the time.
10: Language
Set the display language.
11: Start-up
Set the Start-up Page display.

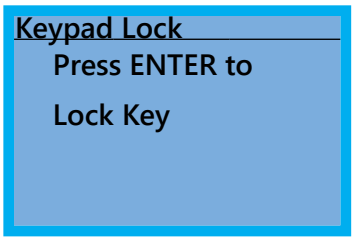
Param Setup - Parameter Setup Page



See the individual parameter summary tables in *Chapter 4 - AC Drive Parameters* for specific parameter explanations and settings.

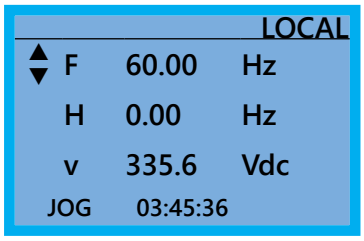
00: DRIVE
01: BASIC
02: DIGITAL
03: ANALOG
04: SPEED
05: MOTOR
06: PROTECT
07: SPECIAL
08: PID
09: COMMUNICATION
10: FEEDBACK
11: ADVANCED
13: USER
14: PROTECT(2)

KEYPAD LOCK - KEYPAD LOCK PAGE

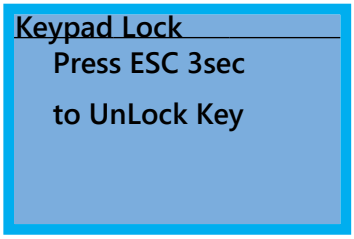


Keypad Lock is used to lock the keypad from unintentional activation during operation.

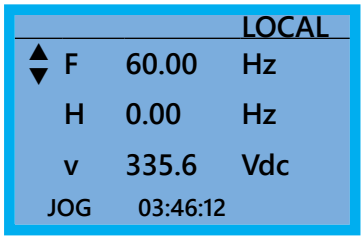
Press the Enter key to lock the keypad.



The Status Page will again display.

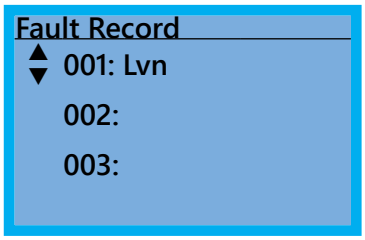


Pressing ANY key will display the message Press ESC to UnLock Key.



Press and hold the ESC key for 3 seconds to unlock the keypad. The display will return to the Status Page.

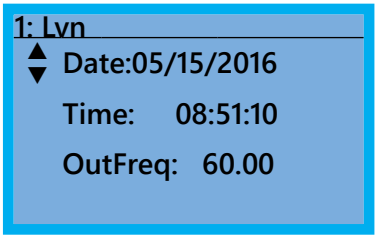
Fault Record - Fault Record Page



GS20 drive faults are stored from 1: to 20:. Refer to *Chapter 6: Maintenance and Troubleshooting* for a complete list of fault messages that may appear. Use the Up and Down Direction keys to scroll through the list.

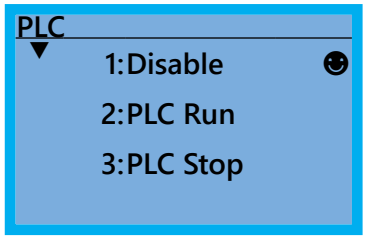
1:
2:
3:
▲
▼
18:
19:
20:

Press the Enter key to display information about the drive status when the fault occurred.



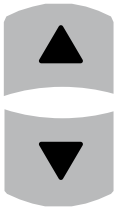
Date: 00/00/0000
Time: 00:00:00
OutFreq: 0.00
OutAmp: 0.00
OutVolt 0.0
DCBus: 0.0

PLC - PLC Function Page



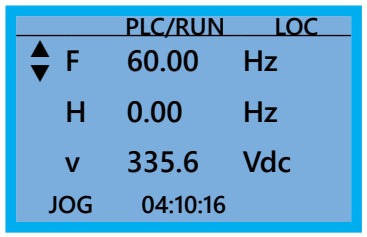
PLC Function is used to Enable/Disable and Run/Stop the internal PLC. The active selection is marked by a smiley face character on the far right of the display.

WARNING: On a power cycle the PLC Run/Stop state will be determined by the last state the keypad was placed in, or by the configured digital inputs. If the state was changed via GSLogic, that Run/Stop state may not be true on a power cycle.



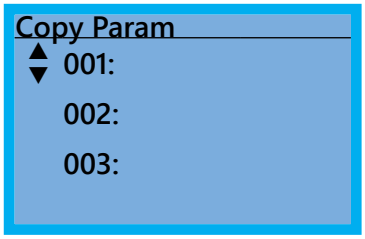
Use the Up and Down Direction keys to select Disable, PLC Run or PLC Stop.

Press the Enter key to confirm the selection.



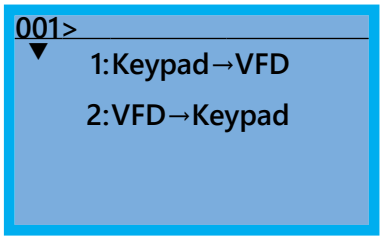
Selecting PLC Run will activate the GS20 internal PLC. The keypad status Page will display PLC/RUN at the top, center of the display. If PLC Stop is selected, the PLC program will stop and the Status Page will display PLC/STOP at the top center of the page. Selecting Disable will disable the GS20 internal PLC and return control to the drive. Selecting PLC Run or PLC Stop also can determine whether the physical I/O are controlled by the Drive or are controlled by the PLC. See Chapter 8 for more information on the integrated PLC and GSLogic software.

Copy Param - Copy Parameters Page (Keypad Copy)



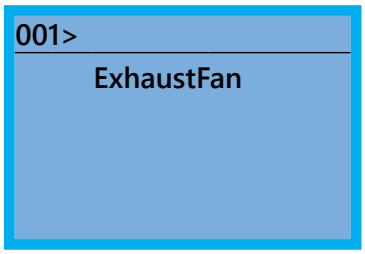
Copy Parameters is used to save up to four drive configurations into the keypad. The keypad can then download any of these configurations into the drive, or it can be moved to a different drive and download the parameter settings of the original drive. Use the Up and Down Direction keys to scroll through the four available copy parameter locations. If a field is blank, then no copy has been made to that location.
001: ExhaustFan
002: IntakeFan1
003: Filename02
004:

Press the Enter key to select the desired location for writing the current parameter settings.



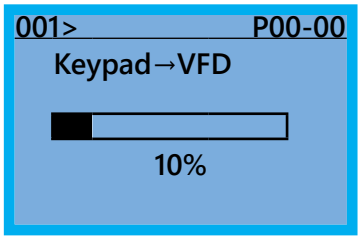
Use the Up and Down Direction keys to select Keypad→VFD to copy the current parameter settings from the keypad to the drive or VFD→Keypad to write the current parameter settings from the drive to the keypad. Press the Enter key.

VFD→ Keypad



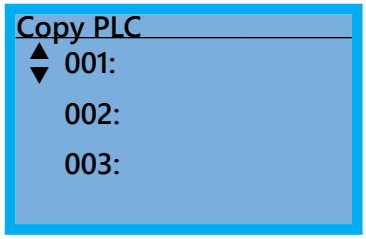
After VFD→Keypad is selected, the keypad will prompt you for a filename to save the existing configuration into. Use the Left/Right Arrows to scroll from character to character and the Up/Down Arrows to change the alphanumeric character. Pressing Enter will begin the transfer of parameters from the drive into the keypad.

Keypad→ VFD



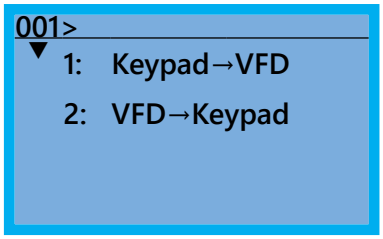
When Keypad→VFD is selected, the keypad will begin the transfer of the preselected file parameters from the keypad into the drive.
As shown in the example to the left, “001” is the file to be transferred.
Pressing F4 while in the Copy Param menu will prompt you to Delete All 4 saved programs (“Press ENTER to clear”).

Copy PLC - Copy PLC Page



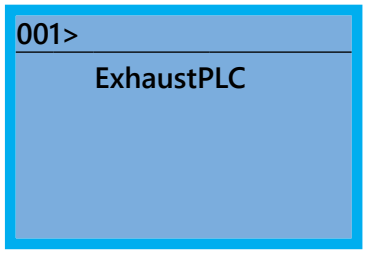
Copy PLC is used to copy previously saved PLC program from the keypad to the drive or from the drive to the keypad. Use the Up and Down Direction keys to scroll through the four available Copy PLC locations. If the field is blank, then no copies have been made. The keypad can store both the parameters and the PLC program at the same time.

Press the Enter key to select the desired location for writing the current program.



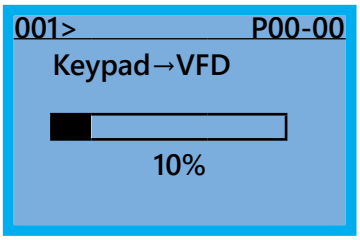
Use the Up and Down Direction keys to select Keypad→VFD to copy the previously saved PLC settings from the keypad to the drive or VFD→Keypad to write the current PLC program from the drive to the keypad.

VFD→ Keypad



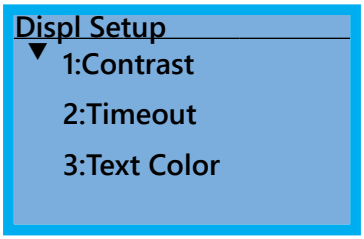
When VFD→Keypad is selected, the keypad will prompt you for a filename to save the existing configuration into. Use the Left/Right arrows to scroll from character to character and the Up/Down arrows to change the alphanumeric character. Pressing Enter will begin the transfer of PLC program from the drive into the keypad.

Keypad→ VFD



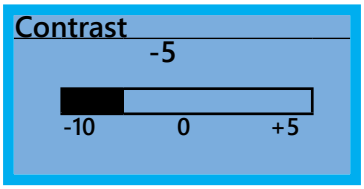
When Keypad→VFD is selected, the keypad will begin the transfer of PLC program from the keypad into the drive.

Displ Setup - Display Setup Page

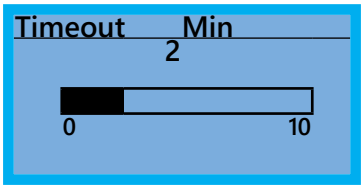


The Display Setup Page allows the user to adjust the Contrast, Backlight time and Text Color of the display.

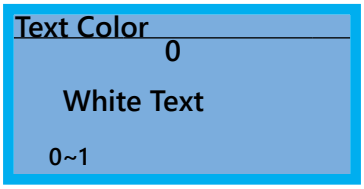
1: Contrast
2: Timeout
3: Text Color



Use the Up and Down direction arrows to adjust the Contrast to the desired setting.
The range of adjustment is from -20 to +20.
The default value is 0.
Entering a value of 0 will keep the backlight ON all the time.

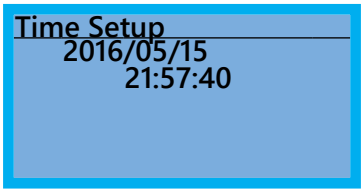


Use the Up and Down direction arrows to adjust the time when the display backlight turns off. The range of adjustment is from 0 to 10 minutes. The default value is 5 minutes.



Use the Up and Down direction arrows to select from white text or blue text for the display.

Time Setup - Time Setup Page

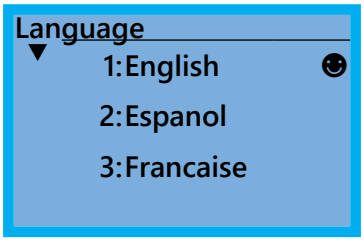


The Time Setup Page allows the user to change the date and time. The date format is Year/Month/Day. Time is displayed in 24-hour clock format and is displayed as Hours:Minutes:Seconds. Use the Right and Left Arrow keys to move the cursor to the desired location and use the Up and Down Arrow keys to adjust the setting.

After adjusting the time, move the cursor to the Seconds entry before pressing the Enter Key.

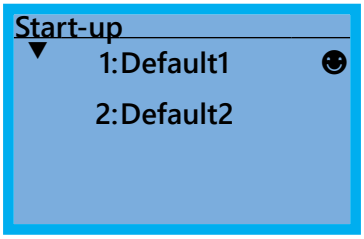
The real time clock (RTC) is maintained in the keypad. A capacitor is used to provide power for the RTC during power loss. The capacitor can maintain power for the RTC for 7 days with no drive power applied.

Language - Language Page



The Language Page sets the language shown on the display. Select from English, Spanish or French. The translation applies to the keypad menu structure only. The Detailed parameter settings will remain in English.

Start-up - Start-up Page



The Start-up Page allows the user to select from two different screens that display during initial start-up. Default1 setting displays the GS20 logo screen, Default2 setting displays "Initializing, Please Wait."

Keypad Fault Codes

Following are the fault codes and descriptions for the GS4-KPD. To reset the fault codes press the Enter and Reset buttons simultaneously. These faults indicate either a communication error between the keypad and the drive or a keypad failure. To correct: 1) Inspect and clean the RJ45 connectors on the back of the keypad and the RJ45 connector leading into the drive. 2) Replace the cable and/or RJ45 M-M adapter with a standard Ethernet patch cable. 3) If the RJ45 connections are OK, replace the keypad.

① Display error signal

② Abbreviated error code
The code is displayed as shown on GS4-KPD

③ Display error description

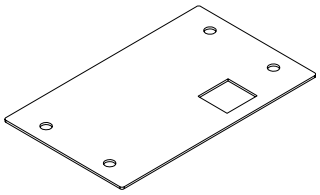
ID No.	*Description*	*Corrective Actions*
LOCAL Fault FrEr kpdFlash Read Er	Keypad flash memory read error.	An error has occurred on keypad's flash memory. 1. Press RESET on the keypad to clear the error. 2. Verify what kind of error has occurred on keypad's flash memory. 3. Shut down the system, wait 10 minutes and power up the system. If the error remains contact technical support.
LOCAL Fault FSEr kpdFlash Save Er	Keypad flash memory save error.	An error has occurred on keypad's flash memory. 1. Press RESET on the keypad to clear the error. 2. Verify what kind of error has occurred on keypad's flash memory. 3. Shut down the system, wait 10 minutes and power up the system. If the error remains contact technical support.
LOCAL Fault FPEr kpdFlash Pr Er	Keypad flash memory parameter error.	Errors occurred on factory setting parameters possibly caused by firmware update. 1. Press RESET on the keypad to clear the error. 2. Verify if there is a problem on the FLASH IC. 3. Shut down the system, wait 10 minutes and power up the system. If the error remains contact technical support.
LOCAL Fault VFDr Read VFD Info Er	Keypad flash memory when read AC data error.	Keypad can't read data from drive. 1. Verify if the keypad is properly connected to the drive with the RJ45 connector. 2. Press RESET on the keypad to clear the error. 3. Shut down the system, wait 10 minutes and power up the system. If the error remains contact technical support.
LOCAL Fault ERR88 Type Mismatch	Keypad/Drive parameter file mismatch.	There has been an attempt to copy an incorrect file between the keypad and the drive. Ensure that there is a valid file in the keypad (if attempting Keypad → VFD transfer).

Keypad Panel Mounting Kit GS4-BZL

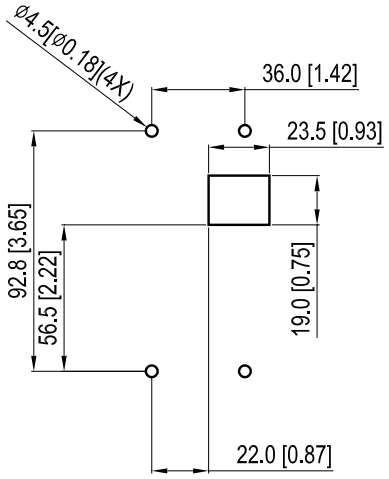
This panel mounting kit can be used for wall mounting or embedded mounting of the GS4-KPD.

Wall Mounting

Accessory 1



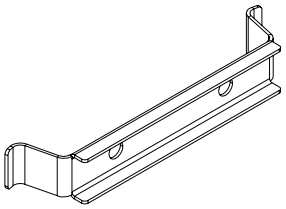
Screws: (4) M4*p 0.7 *L8mm
Torque: 10-12 kg·cm (8.7-10.4lb-in.)



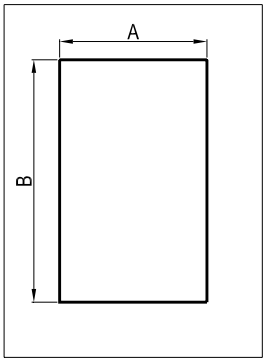
Panel cutout dimensions mm [in]

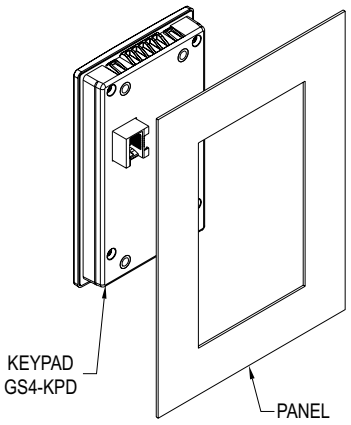
Embedded Mounting

Accessory 2



Screws: (4) M4*p 0.7 *L8mm
Torque: 10-12 kg·cm (8.7-10.4 lb·in)





Normal cutout dimension

Panel Thickness	1.2 mm	1.6 mm	2.0 mm
A	66.4 [2.614]		
B	110.2 [4.339]	111.3 [4.382]	112.5 [4.429]

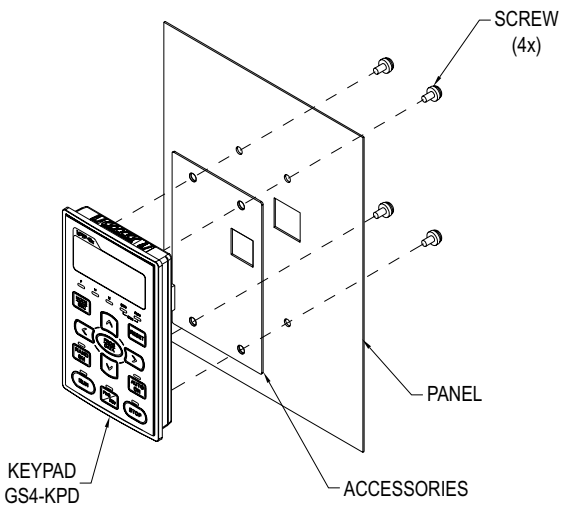
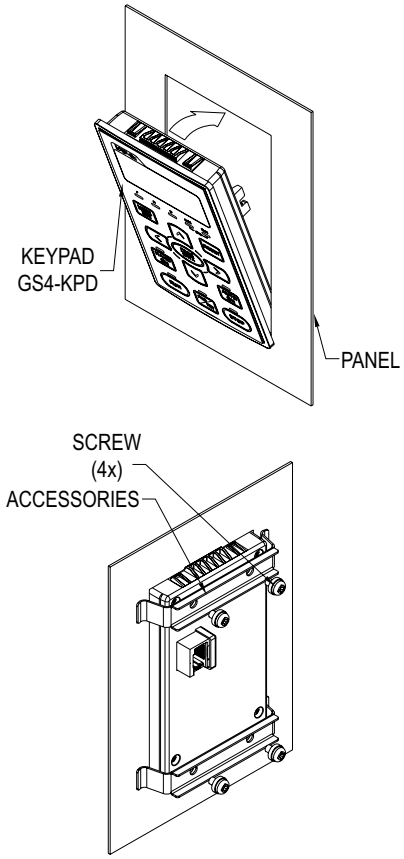
* Deviation: ± 0.15 mm / ± 0.0059 in

Cutout dimension (Waterproof level: IP56)

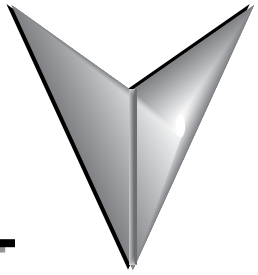
Panel Thickness	1.2 mm	1.6 mm	2.0 mm
A	66.4 [2.614]		
B	110.8 [4.362]		

* Deviation: ± 0.15 mm / ± 0.0059 in

Continued on next page.

Wall Mounting	Embedded Mounting
	

Optional I/O and Communication Cards



Appendix

B

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Introduction

GS20(X) drives have two option cards that can be used to expand the functionality of the drive.

- *GS20A-CM-ENETIP: Provides Modbus TCP or EtherNet/IP communication*
- *GS20A-BPS: Provides ability to keep drive control power on when main power is off.*

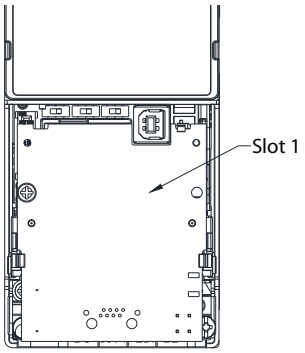
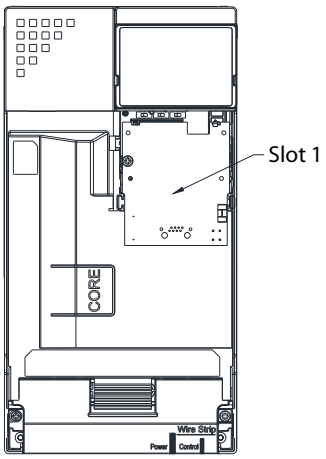
Only one option card can be installed in a GS20(X) drive at one time.

Option Card Installation

The option cards in this chapter are optional accessories. Select the applicable option cards for your GS20(X) drive, or contact AutomationDirect for suggestions. The option cards can significantly improve the functionality of the drive. To prevent damage to the GS20(X) drive during installation, remove the digital keypad and the cover before wiring.

Option Card Locations

Any optional comm card must be installed in Slot #1.

GS20(X) Optional I/O and Communication Cards			
Part Number	***Description***	***Placement***	***Reference Diagram***
GS20A-BPS	DURApulse GS20 series backup power supply module, for use with GS20 and GS20X series AC drives.	Slot 1	 ***Card Installed in Slot 1 of GS20 Frame A-D***
GS20A-CM-ENETIP	DURApulse GS20 series communication module, EtherNet/IP and ModbusTCP, 1 port, (1) Ethernet (RJ45) port. For use with GS20 and GS20X series AC drives.	Slot 1	 ***Card Installed in Slot 1 of GS20 Frame E-F***

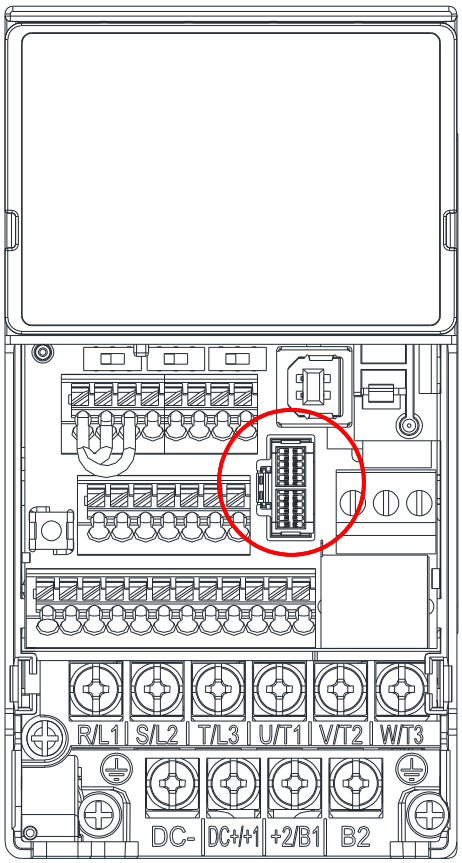
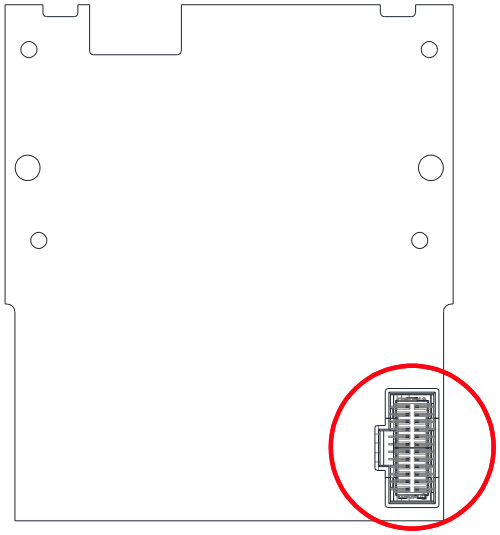
Removing the Card Slot Cover

WARNING: AC input power must be disconnected before performing any maintenance. Do not connect or disconnect wires or connectors while power is applied to the circuit. Maintenance must be performed only by a qualified technician.

WARNING: A CHARGE MAY STILL REMAIN IN THE DC-LINK CAPACITOR WITH HAZARDOUS VOLTAGES, EVEN IF THE POWER HAS BEEN TURNED OFF. TO AVOID PERSONAL INJURY, DO NOT REMOVE THE COVER OF THE AC DRIVE UNTIL ALL "DISPLAY LED" LIGHTS ON THE DIGITAL KEYPAD ARE OFF. PLEASE NOTE THAT THERE ARE LIVE COMPONENTS EXPOSED WITHIN THE AC DRIVE. DO NOT TOUCH THESE LIVE PARTS.

NOTE: To prevent damage during installation, remove the digital keypad and cover before option card installation. See "Chapter 2: Installation and Wiring" for instructions.

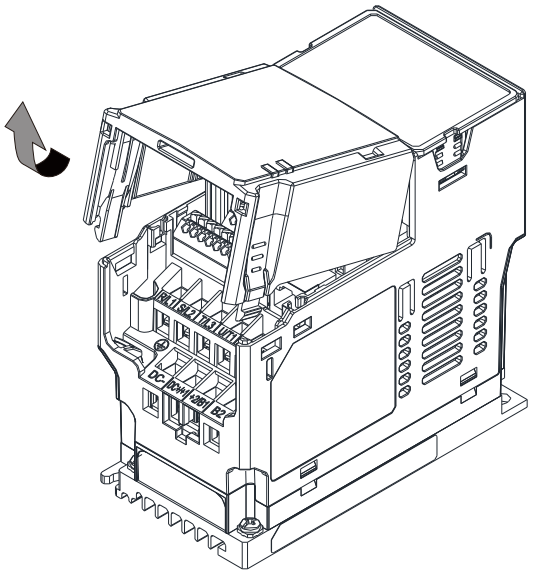
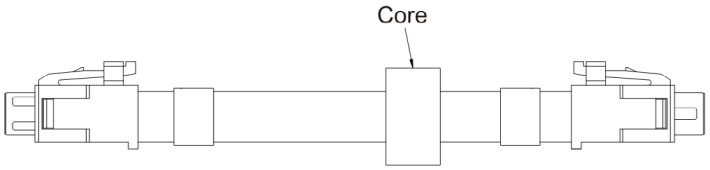
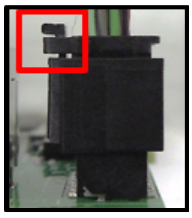
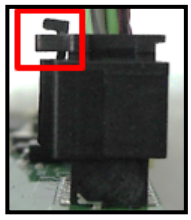
Option Card Wiring

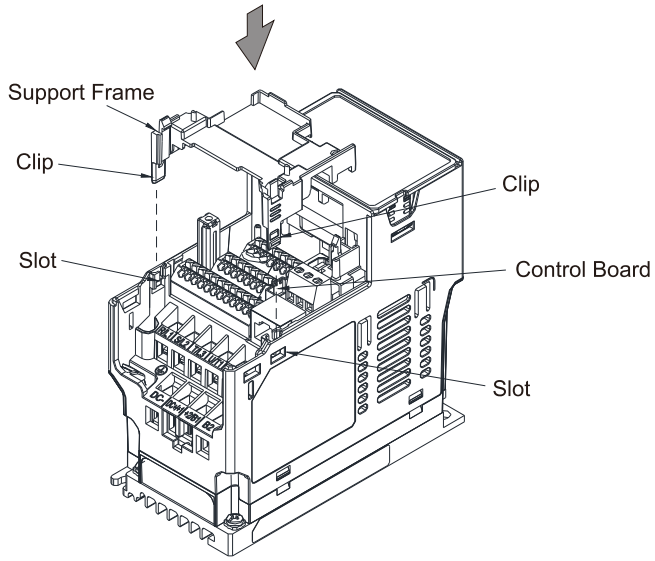
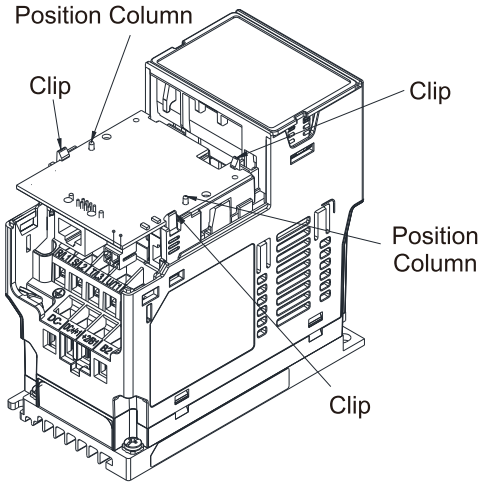
GS20(X) Card Wiring	
GS20(X) Control Board Connector	***Option Card Connector***
	

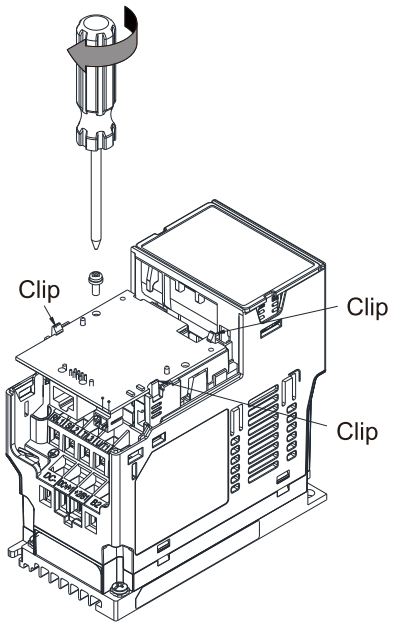
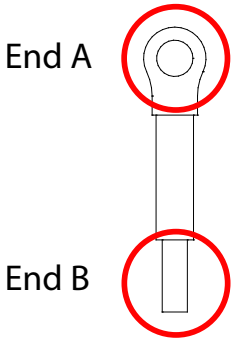
WARNING: PLEASE READ THE DESCRIPTIONS ON THE CONNECTING CABLES AND INSTALL CAREFULLY. USING INCORRECT CABLES CAN DAMAGE THE OPTION CARD OR THE DRIVE.

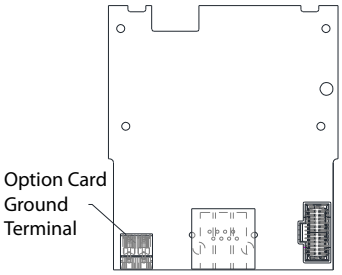
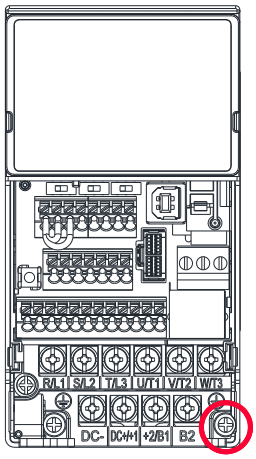
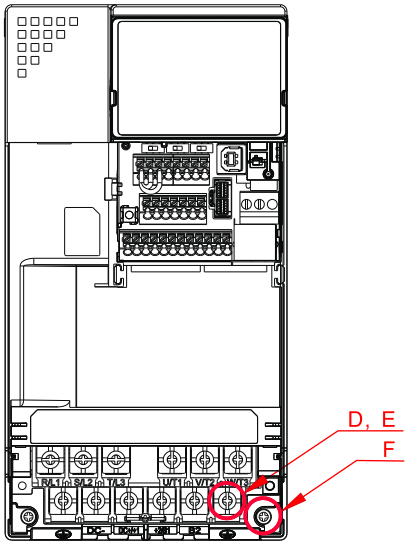
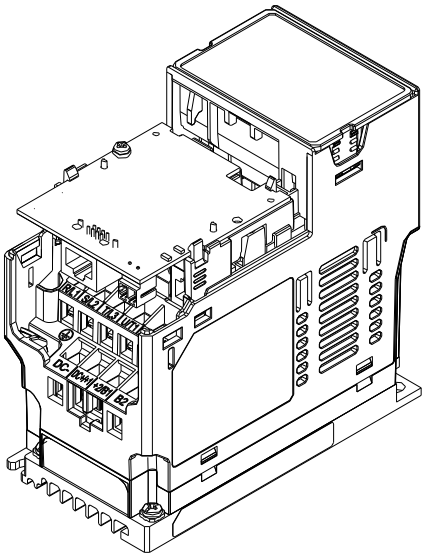
Install the Option Card

Installation method: Back-mount the option card by connecting flat cables to the control board.

GS20(X) Option Card Installation Steps	
Step	***Description***
1	Turn off the power of the motor drive, and then remove the front cover. 
2	Plug each end of the control board connector cable included with the option card into the appropriate slot on the card and the drive. Apply enough pressure to ensure the connector is properly locked into place.   **Locked**  **Unlocked**

GS20(X) Option Card Installation Steps (continued)	
Step	***Description***
3	Aim the two clips at the two slots on the motor drive, and then press downward to have the two clips engage the slots. 
4	Connect the connector at the other end of the connection cable to the connector of the option card.
5	With the terminal block and connector of the option card facing downward, aim the two holes of the option card to the position column and press downward so that the three clips engage the option card. 

GS20(X) Option Card Installation Steps (continued)	
Step	***Description***
6	Make sure the three clips properly engage the option card and then tighten the screws (suggested torque value: 4–6 kg-cm [3.5–5.2 lb-in.] [0.39–0.59 N•m]). 
7	Both the GS20A-BPS and GS20A-CM-ENETIP need to be grounded. The ground terminal is included in the option card package and looks like this: 

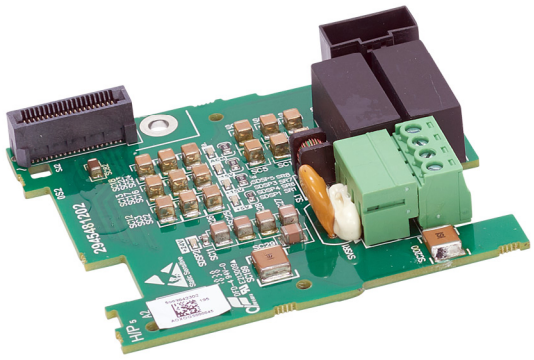
GS20(X) Option Card Installation Steps (continued)	
Step	***Description***
8	Connect the "B" end of the grounding wire to the ground terminal block of the option card, and the "A" end of the grounding wire to the grounding screw of the drive.   Frame A–C  Frame D–F
9	Assembly is completed and should look similar to the example below. 

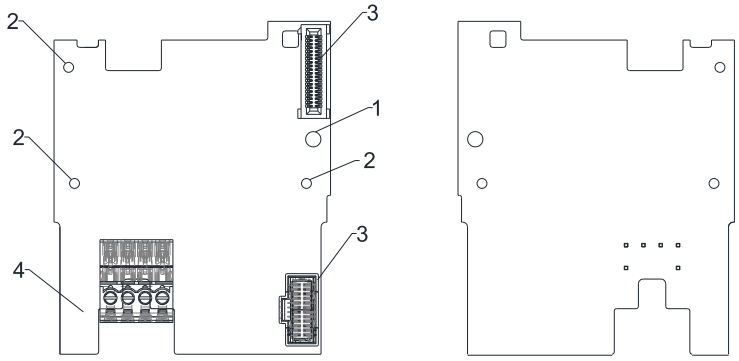
NOTE: See DURApulse GS20A Option Card Quick-Start Guide for more detailed installation.

GS20A-BPS

The GS20A-BPS is a backup power supply for GS20 and GS20X series AC drives that can be installed in Slot 1. If the GS20A-BPS is installed, no other option cards may be installed on the GS20(X) drive.

A backup power supply card allows external 24VDC to be connected to the drive, which keeps communications and some I/O of the drive active during main power downs. This is especially useful if frequent operator lockouts turn line power off to the drive. Network communications will remain active during power downs.





GS20A-BPS Overview			
Drawing Item	***Description***	***Wiring Info***	***Screw Torque***
1	Screw fixing hole	Wire gauge: 0.25–0.5 mm² [24–20 AWG] Stripping length: 7–8 mm	Screw torque: 2 kg-cm / [1.7 lb-in.] / [0.2 N•m]
2	Positioning hole		
3	AC motor drive connection port		
4	+24 V terminal block		

Features

- *Provides external power supply*
- *Supports 24 VDC input.*
- *Supports parameter reading and writing and status monitoring of the drive.*

Specifications

If the GS20(X) drive is running solely on power provided by the GS20A-BPS, GS20(X) communication works normally along with the following functions:

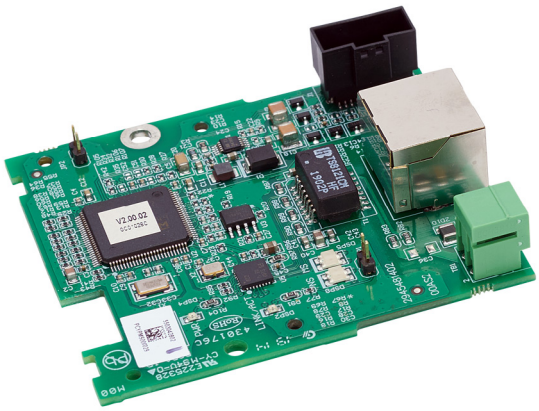
- *Parameter reading and writing*
- *Keypad display*
- *Keys on the keyboard panel (except the RUN key)*
- *Analog input with +10 V terminal supply power*
- *Multi-function inputs (FWD/DI1, REV/DI2, DI3–DI7) with +24V terminal or external power supply*
- *Relay output*
- *Pulse sequence frequency command*

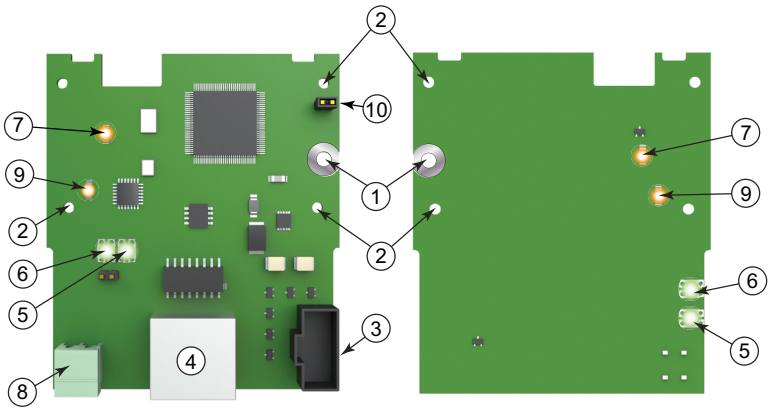
The following functions are not supported when running on backup power only:

- *DO digital frequency signal output*
- *AO1 multi-function analog voltage output*
- *PLC functions*

GS20A-CM-ENETIP

The GS20A-CM-ENETIP is a communication card for GS20 and GS20X series AC drives that enables Modbus TCP and EtherNet/IP communications and can be installed in Slot 1. If the GS20A-CM-ENETIP is installed, no other option cards may be installed on the GS20(X) drive.





GS20A-CM-ENETIP Overview			
Drawing Item	***Description***	***Wiring Info***	***Screw Torque***
1	Screw fixing hole	Wire gauge: 0.25–0.5 mm^2 [24–20 AWG] Stripping length: 7–8 mm	Screw torque: 2 kg-cm / [1.7 lb-in.] / [0.2 N•m]
2	Positioning hole		
3	AC motor drive connection port		
4	Communication port		
5	MS (module status) indicator		
6	NS (network status) indicator		
7	Power indicator		
8	Ground terminal block		
9	Link Inidcator		
10	Jumper J2 (for FW updates only)		

Features

- *Supports Modbus TCP and EtherNet/IP protocol*
- *User-defined corresponding parameters*
- *MDI / MDI-X auto-detect*
- *IP filter simple firewall function*

Specifications

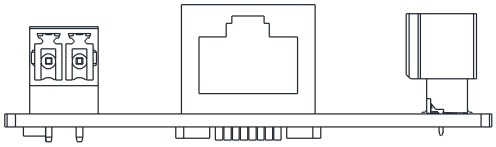
GS20A-CM-ENETIP Specifications	
Network Interface	
Interface	RJ45 with Auto MDI/MDIX
Number of ports	1 Port
Transmission method	IEEE 802.3, IEEE 802.3u

GS20A-CM-ENETIP Specifications (continued)	
Transmission cable	Category 5e shielding 100MHz
Transmission speed	10/100 Mbps Auto-Detect
Network protocol	ICMP, IP, TCP, UDP, DHCP, HTTP, SMTP, Modbus over TCP/IP, EtherNet/IP, BOOTP
Electrical	
Power supply voltage	15VDC (supplied by the AC motor drive)
Insulation voltage	500VDC
Power consumption	0.8W
Weight	25g
Environment	
Noise immunity	ESD (IEC 61800-5-1, IEC 61000-4-2) EFT (IEC 61800-5-1, IEC 61000-4-4) Surge Test (IEC 61800-5-1, IEC 61000-4-5) Conducted Susceptibility Test (IEC 61800-5-1, IEC 61000-4-6)
Operation / storage	Operation: -10°C~50°C [14°F~122°F] (temperature), 90% (humidity) Storage: -25°C~70°C [-13°F~158°F] (temperature), 95% (humidity)
Vibration / shock immunity	International standard: IEC 61800-5-1, IEC 60068-2-6/IEC 61800-5-1, IEC 60068-2-27

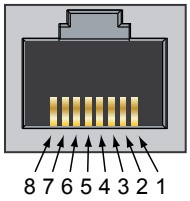
Connecting Comm Card to PC

To connect the GS20A-CM-ENETIP to the network:

1) Turn off the power of the drive.
2) Open the front cover of the drive.
3) Connect the CAT-5e network cable to the RJ45 port of the GS20A-CM-ENETIP (as shown in the right figure).



PIN Description for GS20A-CM-ENETIP					
PIN	***Signal***	***Description***	***PIN***	***Signal***	***Description***
1	TX+	Transmit Data +	***5***	–	N/C
2	TX–	Transmit Data –	***6***	RX –	Receive Data –
3	RX+	Receive Data +	***7***	–	N/C
4	–	N/C	***8***	–	N/C



GS20A-CM-ENETIP LED Indicators and Troubleshooting

There are four LED indicators on the GS20A-CM-ENETIP. The POWER LED displays the status of the power supply, and the LINK LED displays the communication status with the network. If any of these conditions exist and the cause cannot be determined, power down the drive, remove the comm card and reinstall it. Re-seating the card may eliminate certain problems.

GS20A-CM-ENETIP LED Indicators				
LED	***Status***		***Indication***	***How to correct it?***
POWER	Amber	On	Power supply in normal status	None
		Off	No power supply	Re-seat comm card connection and verify drive power
LINK	Amber	On	Network is connected	None
		Off	No network connection	Verify network cable is connected
MS (module status)	Off	Off	The device is powered off, or is powered on but with no IP address configured	Re-seat comm card connection cable and verify drive power
	Green	Flashes	Device in Standby, has not been configured	None
		On	Device Operational	None
	Red	Flashes	Major Recoverable Fault	An incorrect or inconsistent configuration. Update configuration settings.
		On	Major Unrecoverable Fault	Cycle power on the drive, reseat cables. If error doesn't clear, contact ADC Technical support
	Red/ Green	Flashes	Self-Test, Device is performing power up testing.	None
NS (network status)	Off	Off	The device is powered off, or is powered on but with no IP address configured	Re-seat comm card connection cable and verify drive power. Enter IP address in device
	Green	Flashes	Network in operation. An IP address is configured, but no CIP connections are established, and an Exclusive Owner connection has not timed out.	None
		On	IP address is configured, at least one CIP connection is established, and an Exclusive Owner connection has not timed out.	None
	Red	Flashes	Connection timeout- An IP address is configured, and an Exclusive Owner connection for which this device is the target has timed out.	Verify that the Originator is attempting communication with the target. Verify operation of network cabling and switches.
		On	Major Fault- Duplicate IP detected	Ensure no other device on the network has the same IP address
	Red/ Green	Flashes	Self-Test, , Device is performing power up testing.	Device is performing power up testing.

NOTE: If the communication card is not recognized by the drive (P09.60=0), try the following:
1) Ensure cable connector is in locked position on the card.
2) Ensure the J2 Jumper is removed from the card and then cycle power to the drive.

GS20A-CM-ENETIP LED Troubleshooting		
Abnormality	***Cause***	***How to correct it?***
POWER LED off	AC motor drive not powered	Check if AC motor drive is powered, and if the power supply is normal.
	GS20A-CM-ENETIP not connected to the AC drive	Make sure GS20A-CM-ENETIP is connected to the AC motor drive.
MS or NS LED off	GS20A-CM-ENETIP not connected to the network	Make sure the network cable is correctly connected to the network.
	Poor contact to RJ-45 connector	Make sure the RJ-45 connector is connected to the Ethernet port.
Cannot find communication card	The GS20A-CM-ENETIP is not connected to the network.	Ensure that the GS20A-CM-ENETIP is correctly connected to the network. Ensure Jumper J2 is not left in place on the ENETIP card after a FW update.
	The PC and the GS20A-CM-ENETIP are in different networks and blocked by network firewall.	Search by IP or set up relevant settings using the AC motor drive keypad.
Cannot open GS20A-CM-ENETIP setup page	The GS20A-CM-ENETIP is not connected to the network.	Ensure that the GS20A-CM-ENETIP is correctly connected to the network.
	Incorrect communication setting in GSoft2.	Ensure that the communication setting in GSoft2 is set to Ethernet.
	The PC and the GS20A-CM-ENETIP are in different networks and blocked by network firewall.	Use the drive keypad to set the ethernet card address.

GS20A-CM-ENETIP Error Codes		
ID	***Code***	***Definition***
71	ECLv	5V power that drive provides to the Comm card is too low
72	ECtt	Communication card is in test mode
75	ECFF	Incorrect default setting
76	ECiF	Serious internal error
80	ECEF	Ethernet connection error
81	ECto	Communication timeout between GS20A-CM-ENETIP and GS20(X)
82	ECCS	Checksum error in the communication between GS20A-CM-ENETIP and GS20(X)
83	ECrF	Reset GS20A-CM-ENETIP to default setting
84	ECo0	Exceeds max. number of communications in Modbus TCP
85	ECo1	Exceeds max. number of communications ini EtherNet/IP
86	ECiP	IP error: Default Gateway address must match subnet of IP address or be set to 0.0.0.0
87	EC3F	reserved
88	ECbY	GS20(X) is busy.
89	ECCb	ExCom card break

GS20A-CM-ENETIP IP Address and Network Configuration

Ethernet communication cards must have their own unique IP address. While the card addresses can be set for DHCP (IP address is set and can be changed by the network), we recommend using static IP addresses. That way, the IP address of the drive will stay fixed. Either method requires the IP addresses (and subnet masks) of the communication cards to be compatible with any other devices that want to connect to the drive. For an easy subnet mask calculator, please visit www.subnet-calculator.com.

NOTE: If at any point the communication card configuration becomes problematic, the communication card can always be reset to factory defaults by entering a "1" into P09.90 Com Card Factory Reset.

The following **example** will set the IP addresses of the PC and drive. **Your actual addresses may need to be different, depending on your local network.**

Set the IP address of the GS20(X) Drive

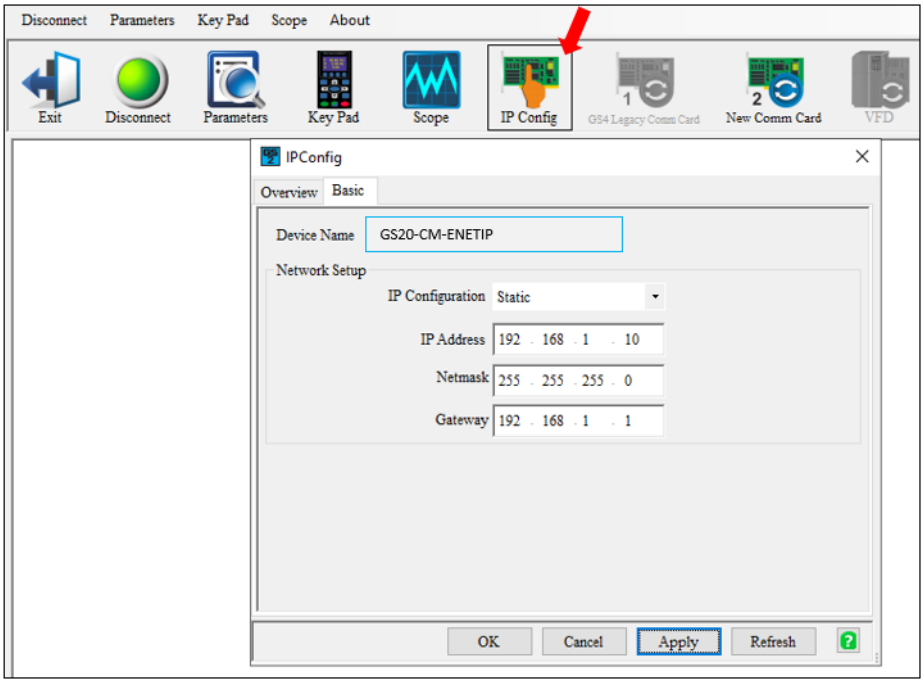
Set the IP address of the drive through GSoft2 software or by the drive keypad.

NOTE: Changing an Ethernet communication parameter in the drive does not immediately affect the communication card; there is a second set of registers in the comm card. Entering a value of 2 in parameter P09.91 causes the drive to push the P09 communication parameters to the card. Bits in P09.91 reset themselves automatically.

GSoft2 method

Connect to the drive thru the Type B serial port. Once connected, the "IP Config button" will become active. Click on it. The Overview tab that pops up shows the current drive configuration. Click on the Basic tab to edit the IP address. Enter the following:

IP Configuration = Static
IP Address = 192.168.1.10
Subnet Mask = 255.255.255.0
Gateway = 0.0.0.0 (or same as IP address 1st three octets; ex: 192.168.1.1)
Press Apply for the changes to take effect. (This effectively sets bit 1 in P09.91)



Keypad method

Enter the following parameter data in the drive keypad:

GS20(X) IP Configuration		
Parameter	***Set Value***	***Explanation***
P09.75	0	Set the IP to "Static"
P09.76	192	IP address 1
P09.77	168	IP address 2
P09.78	1	IP address 3
P09.79	10	IP address 4
P09.80	255	Subnet Mask 1
P09.81	255	Subnet Mask 2
P09.82	255	Subnet Mask 3
P09.83	0	Subnet Mask 4
P09.84	192	Gateway Address 1
P09.85	168	Gateway Address 2
P09.86	1	Gateway Address 3
P09.87	1	Gateway Address 4

Enter a "2" into P09.91 (sets bit 1 = 1) and press "Enter" to transfer the network parameters to the comm card. P09.91 will save the parameters to the card and will then reset P09.91 to zero.

GS20A-CM-ENETIP Common Parameters

When the GS20(X) drive is connected via Ethernet, please use the communication parameters in the table below to configure the drive. The master will be able to read/write the frequency word and control word for the GS20(X) drive after the communication parameters are set up.

GS20(X) Communication Parameters			
Parameter	***Function***	***Set Value (Dec)***	***Explanation***
P00.20	Source of frequency command setting	8	The frequency command is controlled by communication card.
P00.21	Source of operation command setting	5	The operation command is controlled by communication card.
P09.30	Communication decoding method	0	Set decoding method
P09.74	Set Comm Master Protocol	1	Set master
P09.75	IP setting	0	Static IP(0) / Dynamic distribution IP(1)
P09.76	IP address -1	192	IP address 192.168.1.5
P09.77	IP address -2	168	IP address 192.168.1.5
P09.78	IP address -3	1	IP address 192.168.1.5
P09.79	IP address -4	5	IP address 192.168.1.5
P09.80	Netmask -1	255	Netmask 255.255.255.0
P09.81	Netmask -2	255	Netmask 255.255.255.0
P09.82	Netmask -3	255	Netmask 255.255.255.0
P09.83	Netmask -4	0	Netmask 255.255.255.0
P09.84	Default gateway -1	192	Default gateway 192.168.1.1
P09.85	Default gateway -2	168	Default gateway 192.168.1.1
P09.86	Default gateway -3	1	Default gateway 192.168.1.1
P09.87	Default gateway -4	1	Default gateway 192.168.1.1
P09.93	ENETIP Comm Card Fault Select	3	Set communication timeout settings
P09.94	ENETIP Comm Card Time Out Detection	1	Set communication timeout settings
P09.95	ENETIP Comm Card Time Out Duration	3.0	Set communication timeout settings

Communication Card Special Function Parameters	
Parameter	***Explanation***
P09.90	Communication Card Factory Reset, 1 = Reset to factory defaults
P09.91	Communication Card Set, 2 = Write parameters to card

After changing any of the P09.xx communication card parameters, enter a "2" into P09.91 (Bit1 = 1). This will write any parameter changes from the drive into the communication card.

NOTE: The external controller's RPI must be set greater than 10ms.

Modbus TCP or EtherNet/IP Protocol Selection

The GS20A-CM-ENETIP card can communicate via Modbus TCP or EtherNet/IP protocols.

P09.74 defines the master protocol of the communication card and allows the user to define proper actions in the event of communication timeouts.

If P09.74 = 1: EtherNet/IP, in a timeout situation (defined by P09.93 – P09.95), only the EtherNet/IP connection (Implicit OR Explicit) will trigger the timeout, not Modbus TCP. A 'timeout situation' is defined by 5 different possibilities:

1) A TCP RST or FIN message from the Master in EtherNet/IP Explicit (no EtherNet/IP Implicit).
2) A Forward Close message in EtherNet/IP Implicit.
3) No data message received in the time duration specified in Pr09-95 on EtherNet/IP Explicit.
4) No data message received in the time duration specified in RPI timeout EtherNet/IP Implicit.
5) Physical connection loss (no link available on Ethernet interface).

If P09.74 = 2: Modbus TCP, in a timeout situation (defined by P09.93 – P09.95), only the Modbus TCP connection will trigger the timeout, not EtherNet/IP Explicit (Implicit won't be allowed in this case). A 'timeout situation' is defined by 3 different possibilities:

1) 1) A TCP RST or FIN message from the Master in Modbus TCP
2) 2) No data message received in the time duration specified in Pr09-95 on Modbus TCP
3) 3) Physical connection loss (no Link Good on Ethernet interface).

If P09.74 = 0: Ethernet/IP and Modbus TCP both on, a loss in either will cause a timeout.

Modbus TCP Protocol Configuration

GS20A-CM-ENETIP Control Words - Modbus Addressing

Modbus TCP Protocol Parameter Address Definitions			
Modbus Address		**Definition**	
Decimal	**Hex**		
48193	2000	bit 0~1	00: No function
			01: Stop
			10: Run
			11: Enable JOG
		bit 2~3	reserved
		bit 4~5	00B: No function
			01B: Forward command
			10B: Reverse command
			11B: no function
		bit 6~7	00B: 1st accel. / decel.
			01B: 2nd accel. / decel.
			10B: 3rd accel. / decel.
			11B: 4th accel. / decel.
		bit 8~11	000B: Master speed
			0001B: 1st step speed frequency
			0010B: 2nd step speed frequency
			0011B: 3rd step speed frequency
			0100B: 4th step speed frequency
			0101B: 5th step speed frequency
			0110B: 6th step speed frequency
			0111B: 7th step speed frequency
			1000B: 8th step speed frequency
			1001B: 9th step speed frequency
			1010B: 10th step speed frequency
			1011B: 11th step speed frequency
			1100B: 12th step speed frequency
			1101B: 13th step speed frequency
			1110B: 14th step speed frequency
			1111B: 15th step speed frequency
		bit 12	1: Enable bit 06-11 function. Must =1 to use above bits
		bit 13~14	00B: No function
			01B: No function
			10B: No function
			11B: No function
		bit 15	Reserved
48194	2001*	Frequency Command / PID Setpoint	6000 = 60.00Hz
48195	2002	bit 0	1: E.F. = ON (Trigger an External Fault)
		bit 1	1: Reset command
		bit 2	1: External interruption (B.B) = ON
		bit 3~5	reserved
***Note concerning 2001h: If the Frequency Command (via RS485, Ethernet, Keypad, analog, etc.) is set higher than P01.00 Max Frequency Output, the drive will limit the actual output to P01.00.*			

GS20A-CM-ENETIP Status Words - Modbus Addressing

Modbus TCP Protocol Parameter Address Definitions			
Address		**Definition**	
Modbus Decimal	**Modbus Hex**		
Status Monitor 1 – Warning Codes			
48449	2100	bit 0–7	Fault Code*
		bit 8–15	Warning Code*
		* Refer to Chapter 6: Maintenance and Troubleshooting for code definitions.	
Status Monitor 2 – Status of GS20(X) AC Drive			
48450	2101	bit 0~1	00: Stop
			01: Decel during stop
			10: Standby
			11: Run
		bit 2	1: JOG active
		bit 3~4	00: Forward
			01: Transition from Reverse to Forward
			10: Transition from Forward to Reverse
			11: Reverse
		bit 5~7	reserved
		bit 8	1: Main Frequency comes from Communication Interface
		bit 9	1: Main Frequency comes from Analog/External Terminal signal input
		bit 10	1: The Command is operated by Communication Interface (keypad)
		bit 11	1: Parameters have been Locked
		bit 12	Running Status [0 = Drive Stopped; 1 = Drive Running (including Standby)]
		bit 13~15	reserved
48451	2102	Frequency Command (F) / PID Setpoint	
48452	2103	Output Frequency (H)	
48453	2104	Output Current (A)	
48454	2105	DC Bus Voltage (U)	
48455	2106	Output Voltage (E)	
48456	2107	Multi Speed or PID Inputs current Step Number	
48457	2108	Reserved	
48458	2109	Digital Input Counter Value	
48459	210A	Power Factor Angle (cos Θ)	
48460	210B	Output torque (XXX.X%)	
48461	210C	Actual Motor Speed (rpm)	
48462	210D	reserved	
48463	210E	reserved	
48469	2114	Indicates one or decimal points for value in 210F.	
48464	210F	Power Output in kW	
48471	2116	Multi-function display P00.04	
48476	211B	Maximum Operation Frequency P01.00 or Maximum User- defined Value P00.26 When P00.26 is 0, this value is equal to P01.00 setting. When P00.26 is not 0, and the command source is keypad, this value = P00.24 * P00.26 / P01.00. When P00.26 is not 0, and the command source is 485, this value = P09.10 * P00.26 / P01.00.	
48480	211F	High byte: the decimal place of current value display	
48705	2200	Display the drive's output current XX.XX. When the current is higher than 655.35, it automatically shifts one decimal place as XXX.X. Refer to the high byte of 211F for information on the decimal places.	
48706	2201	Counter value	
48707	2202	Actual output frequency XXXXX Hz	
48708	2203	DC bus voltage XXX.X V	
48709	2204	Output voltage XXX.X V	

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Communication Protocol Parameter Address Definitions (continued)			
Address		***Definition***	
Modbus Decimal	***Modbus Hex***		
48710	2205	Power factor angle XXX.X	
48711	2206	Display the output power of U, V, W XXXX.X kW	
48712	2207	Display the motor speed estimated by the drive or encoder feedback XXXXX rpm	
48713	2208	Display the positive / negative output torque estimated by the drive +0.0: positive torque; -0.0: negative torque XXX.X%	
48714	2209	Reserved	
48715	220A	Display the P ID feedback value after enabling ID function XXX.XX%	
48716	220B	Display the AI1 analog input terminal signal, 0-10 V corresponds to 0.00-100.00% see Explanation 1 in P00.04	
48717	220C	Display the AI2 analog input terminal signal, 4-20 m / 0-10 V corresponds to 0.00-100.00% 2. See Explanation 2 in P00.04,	
48718	220D	Reserved	
48719	220E	IGBT temperature of the power module XXX.X °C	
48720	220F	Reserved	
48721	2210	The digital input status ON / OFF , refer to P02.12. See Explanation 2 in P00.04.	
48722	2211	The digital output status ON / OFF , refer to P02.18. See Explanation 3 in P00.04.	
48723	2212	Current step for the multi-step speed operation	
48724	2213	The corresponding PLC digital input pin status. See Explanation 3 in P00.04	
48725	2214	The corresponding PLC digital output pin status. See Explanation 4 in P00.04	
48726	2215	Reserved	
48727	2216	Pulse input frequency XXX.XX Hz	
48728	2217	Reserved	
48729	2218	Reserved	
48730	2219	Counter value of overload XXX.XX %	
48731	221A	GFF XXX.XX %	
48732	221B	DC bus voltage ripples XXX.X V	
48733	221C	PLC register D1043 data	
48734	221D	Magnetic field area of the synchronous motor	
48735	221E	User page displays the value in physical measure	
48736	221F	Output value of P00.05 XXX.XX Hz	
48737	2220	Reserved	
48738	2221	Reserved	
48739	2222	Reserved	
48740	2223	Control mode of the drive, 0: speed mode 1: torque mode	
48741	2224	Carrier frequency of the drive XX kHZ	
48742	2225	Reserved	
48743	2226	bit 1~0	Drive status
			00b: No direction
			01b: Forward
			10b: Reverse
		bit 3~2	01b: Drive ready
			10b: Error
		bit 4	0b: Motor drive does not output
			1b: Motor drive outputs
		bit 5	0b: No warning
			1b: Warning

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Communication Protocol Parameter Address Definitions (continued)		
Address		***Definition***
Modbus Decimal	***Modbus Hex***	
48744	2227	Drive's estimated output torque positive or negative direction XXXX N•m
48745	2228	Reserved
48746	2229	KWH display XXXX.X
48747	222A	Reserved
48748	222B	Reserved
48749	222C	Reserved
48750	222D	Reserved
48751	222E	PID target value XXX.XX %
48752	222F	PID offset XXX.XX %
48753	2230	PID output frequency XXX.XX Hz
48754	2231	Reserved
48755	2232	Display the auxiliary frequency
48756	2233	Display the master frequency
48757	2234	Display the frequency after adding and subtracting of the master and auxiliary frequencies.

Modbus TCP Communication

GS20A-CM-ENETIP Modbus Function Codes	
Code	***Definition***
0x03	Read register from GS20(X)
0x06	Write single register to GS20(X)
0x10	Write multiple data registers to GS20(X)

EtherNet/IP Protocol

GS20A-CM-ENETIP EtherNet/IP I/O Messaging (Implicit Messaging)

- *Trigger type: Cyclic*
- *Transport class: 1*
- *Application connection type: Exclusive owner*

Parameter	O→T		T→O	
Data size		Fixed		Fixed
Connection type	Point-to-Point		Mulitcast, Point to Point	

GS20A-CM-ENETIP EtherNet/IP Communication Parameter

- *Input buffer register: In Assembly Instance = 101, Data Type = 16 bits, Size = 16*
- *Output buffer register: Out Assembly Instance = 100, Data Type = 16 bits, Size = 3*
- *Configuration: Instance = 102, Data Type = 8 bits, Size = 0*

GS20A-CM-ENETIP EtherNet/IP CIP Command Status Code

Status Code	Status	Definition
0x00	**Success**	Requested service is successfully executed.
0x01	**Connection failure**	Connected service fails.
0x04	**Path segment error**	Node in the program cannot identify the definition or syntax of a path segment. When this error takes place, the execution of program will be terminated.
0x05	**Path destination unknown**	The path is related to object type, but the node in the program does not cover or cannot identify the type or structure of the object. When this error takes place, the execution of program will be terminated.
0x08	**Service not supported**	The object does not support required service or has not yet defined the service.
0x0E	**Attribute not settable**	Receives request to modify unchangeable attribute
0x13	**Not enough data**	Receives insufficient data and therefore cannot execute command
0x14	**Attribute not supported**	Does not support requested attribute
0x 5	**Too much data**	The received data exceeds what the command execution requires.
0x20	**Invalid parameter**	The requested parameter is invalid, indicating that the parameter does not fit the definition of the requirement, or the requirement has been defined in “Application Object Specification”.
0x26	**Path size invalid**	The size of the path transmitting requested service cannot afford the request to the object or cover too much route data.

GS20A-CM-ENETIP EtherNet/IP Error Code for Monitor Request

Status Code	Extended Status Code	Definition
0x00	–	The execution of service is successful.
0x01	0x0100	The connection is in progress or the connection is re-opened. The code will be sent back when the source is trying to establish a connection to the target but the target has already been connected.
0x01	0x0103	Does not support the combination of this transmission type and trigger. The target does not support the defined combination of transmission type and trigger. The router will not teminate the connection, only the target end has to send back this extended status code.
0x01	0x0106	Clash of control right A connection takes the control, blocking the establishment of other connections. When this device occupies the connection in this way, only one connection will be allowed to control this device.
0x01	0x0107	Cannot find the corresponding target to connect
0x01	0x0108	Invalid network connection parameter When the application program in the target does not support the defined connection type, connection level, or there are too many users, the extended status code will be sent back. Only the node on target has to send back the extended status code.
0x01	0x0109	Invalid setting of the size of the on-line data exchange zone This device does not support the setting of the current data exchange zone. The setting can be too big or too small.
0x01	0x0111	RPI setting not supported
0x01	0x0112	RPI Value(s) Not Acceptable. Module requires an RPI of 10ms or greater.
0x01	0x0113	The number of connections exceeds the maximum. No further connections are able to connect to this device.
0x01	0x0114	The company ID does not match product code. The product code or company ID marked in the electronic key logic section does not match the record in the target device.
0x01	0x0115	Inconsistent product type The product type marked in the electronic key logic section does not match the record in the target device.
0x01	0x0116	Inconsistent version The primary and secondary revised versions marked in the electronic key logic section do not match the record in the target device.
0x01	0x0315	Invalid section exists in the path. The type or value of a section in the path is invalid. When the device cannot interpret the path, it will respond with this extended status code. Cause of this error: Unidentifiable path type, unexpected section type or other problems existing in the path.

GS20A-CM-ENETIP EtherNet/IP Communication Protocol Parameter Address Definitions

EtherNet/IP Communication Protocol Parameter Address Definitions				
Class Code (Parameter Content)	***Instance***	***Address***	***Definition***	
Class 4 (Commands to GS20(X))	Instance 100 (0x64)	0	bit 0~1	00: no function
				01: Stop
				10: Run
				11: Enable JOG
			bit 2~3	reserved
			bit 4~5	00: no function
				01: Forward command
				10: Reverse command
				11: no function
			bit 6~7	00B: 1st accel. / decel.
				01B: 2nd accel. / decel.
				10B: 3rd accel. / decel.
				11B: 4th accel. / decel.
			bit 8~11	0000B: Master speed
				0001B: 1st step speed frequency
				0010B: 2nd step speed frequency
				0011B: 3rd step speed frequency
				0100B: 4th step speed frequency
				0101B: 5th step speed frequency
				0110B: 6th step speed frequency
				0111B: 7th step speed frequency
				1000B: 8th step speed frequency
				1001B: 9th step speed frequency
				1010B: 10th step speed frequency
				1011B: 11th step speed frequency
				1100B: 12th step speed frequency
				1101B: 13th step speed frequency
				1110B: 14th step speed frequency
				1111B: 15th step speed frequency
			bit 12	1: Enable bit 06-11 function. Must =1 to use above bits
			bit 13~14	00B: No function
				01B: No function
				10B: No function
				11B: No function
			bit 15	Reserved
		1	Frequency command (6000 = 60.00Hz)	
		2	bit 0	1: E.F. = ON (trigger an External Fault)
			bit 1	1: Reset command
			bit 2	1: External interruption (B.B) = ON
			bit 3~15	reserved

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Communication Protocol Parameter Address Definitions (continued)				
Class Code (Parameter Content)	**Instance**	**Address**	**Definition**	
Class 4 (Monitor GS20(X) status)	Instance 101 (0x65)	0	bit 0–7	Fault Code*
			bit 8–15	Warning Code*
			*Refer to Chatper 6: Maintenance and Troubleshooting for code definitions.	
		1	bit 0~1	00: Stop
				01: Decel during Stop
				10: Standby
				11: Run
			bit 2	1: JOG active
			bit 3~4	00: Forward
				01: Transition from Reverse to Forward
				10: Transition from Forward to Reverse
				11: Reverse
			bit 5~7	reserved
			bit 8	1: Main frequency comes from communication interface
			bit 9	1: Main frequency comes from analog/external terminal signal input
			bit 10	1: The command is operated by communication interface (keypad)
			bit 11	1: Parameters have been locked
			bit 12	Running status 0: Drive stopped 1: Drive running (including standby)
			bit 13~15	reserved
		2	Frequency command (F) / PID Setpoint (6000 = 60.00Hz)	
		3	Output frequency (H) (6000 = 60.00Hz)	
		4	Output current (A)	
		5	DC bus voltage (U)	
		6	Output voltage (E)	
		7	Multi-speed or PID Inputs current Step Number	
		8	Reserved	
		9	Digital Input counter value	
		10	Power Factor angle (cosθ)	
		11	Output torque (XXX.X%)	
		12	Actual Motor Speed (rpm)	
		13	reserved	
		14	reserved	
		15	Power Output (kW)	

EtherNet/IP Communication Protocol Parameter Address Definitions – Class 300			
Class Code (Parameter Content)	***Instance***	***Attribute***	***Definition***
Explicit Class 0x300 (Montior GS20x Status)	Instance 33 (0x21)	0x16	Multi-function display P00.04
		0x1B	Maximum Operation Frequency P01.00 or Maximum User-defined Value P00.26 When P00.26 is 0, this value is equal to P01.00 setting. When P00.26 is not 0, and the command source is keypad, this value = P00.24 * P00.26 / P01.00. When P00.26 is not 0, and the command source is 485, this value = P09.10 * P00.26 / P01.00.
		0x1F	High byte: the decimal place of current value display
	Instance 34 (0x22)	0x00	Display the drive's output current XX.XX. When the current is higher than 655.35, it automatically shifts one decimal place as XXX.X. Refer to the high byte of 211F for information on the decimal places.
		0x01	Counter value
		0x02	Actual output frequency XXXXX Hz
		0x03	DC bus voltage XXX.X V
		0x04	Output voltage XXX.X V
		0x05	Power factor angle XXX.X
		0x06	Display the output power of U, V, W XXXX.X kW
		0x07	Display the motor speed estimated by the drive or encoder feedback XXXXX rpm
		0x08	Display the positive / negative output torque estimated by the drive +0.0: positive torque; -0.0: negative torque XXX.X%
		0x09	Reserved
		0x0A	Display the P ID feedback value after enabling ID function XXX.XX%
		0x0B	Display the AI1 analog input terminal signal, 0-10 V corresponds to 0.00-100.00% see Explanation 1 in P00.04
		0x0C	Display the AI2 analog input terminal signal, 4-20 m / 0-10 V corresponds to 0.00-100.00%. See Explanation 2 in P00.04.
		0x0D	Reserved
		0x0E	IGBT temperature of the power module XXX.X °C
		0x0F	Reserved
		0x10	The digital input status ON / OFF , refer to P02.12. See Explanation 2 in P00.04
		0x11	The digital output status ON / OFF , refer to P02.18. See Explanation 3 in P00.04.
		0x12	Current step for the multi-step speed operation
		0x13	The corresponding PLC digital input pin status. See Explanation 3 in P00.04.
		0x14	The corresponding PLC digital output pin status. See Explanation 4 in P00.04.
		0x15	Reserved
		0x16	Pulse input frequency XXX.XX Hz
		0x17	Reserved
		0x18	Reserved
		0x19	Counter value of overload XXX.XX %
		0x1A	GFF XXX.XX %
		0x1B	DC bus voltage ripples XXX.X V
		0x1C	PLC register D1043 data
		0x1D	Magnetic field area of the synchronous motor
		0x1E	User page displays the value in physical measure
		0x1F	Output value of P00.05 XXX.XX Hz
		0x20	Reserved
		0x21	Reserved
		0x22	Reserved
		0x23	Control mode of the drive, 0: speed mode 1: torque mode
		0x24	Carrier frequency of the drive XX kHZ
		0x25	Reserved

Continued on next page

EtherNet/IP Communication Protocol Parameter Address Definitions – Class 300 (continued)				
Class Code (Parameter Content)	***Instance***	***Attribute***	***Definition***	
Explicit Class 0x300 (Montior GS20x Status)	Instance 34 (0x22)	0x26		Drive status
			bit 1~0	00b: No direction
				01b: Forward
				10b: Reverse
			bit 3~2	01b: Drive ready
				10b: Error
			bit 4	0b: Motor drive does not output
				1b: Motor drive outputs
			bit 5	0b: No warning
				1b: Warning
		0x27	Drive's estimated output torque positive or negative direction XXXX N•m	
		0x28	Reserved	
		0x29	KWH display XXXX.X	
		0x2A	Reserved	
		0x2B	Reserved	
		0x2C	Reserved	
		0x2D	Reserved	
		0x2E	PID target value XXX.XX %	
		0x2F	PID offset XXX.XX %	
		0x30	PID output frequency XXX.XX Hz	
		0x31	Reserved	
		0x32	Display the auxiliary frequency	
		0x33	Display the master frequency	
		0x34	Display the frequency after adding and subtracting of the master and auxiliary frequencies.	

GS20(X)-CM-ENETIP Explicit Messaging

EtherNet/IP Services and Objects

EtherNet/IP Objects Supported		
Object	***Class Code***	***Definition***
Identity Object	0x01	For device identity
Message Router Object	0x02	For message route
Assembly Object	0x04	For assembly
Connection Manager Object	0x06	For connection management
TCP/IP Interface Object	0xF5	For TCP/IP interface
Ethernet Link Object	0xF6	For Ethernet connection
BR Object	0x64	For basic control registers
AL Object	0x65	For alarm registers
AC Drive (VFD) Data Object	0x300	For any VFD parameter

EtherNet/IP Data Formats Supported	
Data Format	***Explanation***
BYTE	8-bit string
WORD	16-bit string
DWORD	32-bit string
STRING[n]	String composed of n bytes
SHORT_STRING	String combined from bytes (1 byte length indicator, 1 byte characters)
USINT	8-bit unsigned integer
UINT	16-bit unsigned integer
UDINT	32-bit unsigned integer

Identity Object (Class Code: 0x01)

Instance Code: 0x01

Instance Attributes

Attribute ID	***Access Rule***	***Name***	***Data Type***	***Description of Attribute***
0x01	Get	Vendor ID	UINT	660
0x02	Get	Device Type	UINT	Communications Adapter 12
0x03	Get	Product Code	UINT	Model code: 0x0104
0x04	Get	Revision	STRUCT of: USINT, USINT	Firmware version Major revision Minor revision
0x05	Get	Status	WORD	Summary status of devices.
0x06	Get	Serial Number	UDINT	32-bit serial number of device
0x07	Get	Product Name	SHORT_STRING	GS20A-CM-ENETIP

Common Services

Service Code	***Implemented for***		***Service Name***	***Description of Service***
	Class	***Instance***		
0x05		✓	Reset	Resets device settings
0x0E		✓	Get Single Attribute	Sends back attribute of designated object

Message Router Object (Class Code: 0x02)

Instance Code: 0x01

Instance Attributes: None

Common Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object

Assembly Object (Class Code: 0x04)

Instance Code

Instance	Description
0x64	Corresponds to output buffer register
0x65	Corresponds to input buffer register
0x66	Corresponds to setup object

Instance Attributes

Attribute ID	Access Rule	Name	Data type	Description of attribute
0x03	Get / Set	Data	ARRAY of BYTE	Instance Code = 0x64 (Get/Set) Others Get only

Common Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object
0x10		✓	Set Single Attribute	Modifies attribute

Connection Manager Object (Class Code: 0x06)

Instance Code: 0x01

Instance Attributes: None

Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x4E		✓	Forward Close	Shuts down the connection
0x54		✓	Forward Open	Establishes the connection, max. 511 bytes per transmission.

TCP/IP Interface Object (Class Code: 0xF5)

Instance Code: 0x01

Instance Attributes

Attribute ID	Access Rule	Name	Data type	Description of attribute
0x01	Get	Status	DWORD	Interface status
0x02	Get	Configuration Capability	DWORD	Interface capability flags
0x03	Get / Set	Configuration Control	DWORD	Interface control flags
0x04	Get	Path Size, Path	STRUCT of: UINT, Padded EPATH	 Path size Path
0x05	Get / Set	Interface Configuration	STRUCT of: UDINT, UDINT, UDINT, UDINT, UDINT, STRING	 IP Address Network Mask Gateway Address Name Server Name Server 2 Domain Name
0x06	Get / Set	Host Name	STRING	Host name

Status Instance Attribute

Bits	Name	Description
0~3	Interface Configuration Status	0 = The Interface Configuration attribute has not been configured. 1 = The Interface Configuration attribute contains valid configuration obtained from BOOTP, DHCP or non-volatile storage. 2 = The IP address member of the Interface Configuration attribute contains valid configuration, obtained from hardware settings (e.g.: pushwheel, thumbwheel, etc.) 3-15 = reserved for future use.

Configuration Capability Attribute

Bits	Name	Description
2	DHCP Client	1 (TRUE) shall indicate the device is capable of obtaining its network configuration via DHCP.
4	Configuration Settable	1 (TRUE) shall indicate the Interface Configuration attribute is settable.

Configuration Control Attribute

Bits	Name	Description
0~3	Startup Configuration	0 = The device shall use the interface configuration values previously stored in non-volatile memory. 1 = The device shall obtain its interface configuration values via BOOTP. 2 = The device shall obtain its interface configuration values via DHCP upon start-up. 3-15 = reserved for future use.

Common Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object
0x10		✓	Set Single Attribute	Modifies attribute

Ethernet Link Object (Class Code: 0xF6)

Instance Code: 0x01

Instance Attributes

Attribute ID	Access Rule	Name	Data type	Description of attribute
0x01	Get	Interface Speed	UDINT	Interface speed currently in use Speed in Mbps (e.g., 0, 10, 100, 1000, etc.)
0x02	Get	Interface Flags	DWORD	Interface status flags
0x03	Get	Physical Address	USINT[6]	MAC address

Interface Flags

Bits	Name	Description
0	Link Status	0 indicates an inactive link; 1 indicates an active link.
1	Half/Full Duplex	0 indicates the interface is running half duplex; 1 indicates full duplex.
2-4	Negotiation Status	Indicates the status of link auto-negotiation 0 = Auto-negotiation in progress. 1 = Auto-negotiation and speed detection failed. Using default values for speed and duplex. defaults are 10Mbps and half duplex. 2 = Auto negotiation failed but detected speed. default is half duplex. 3 = Successfully negotiated speed and duplex. 4 = Auto-negotiation not attempted. Forced speed and duplex.

Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object

GS20A-CM-ENETIP EtherNet/IP Basic Registers

GS20A-CM-ENETIP Basic Registers			
BR#	**Read / Write**	**Content**	**Explanation**
#0	R	Model name	Set up by the system; read only. The model code of GS20A-CM-ENETIP=0204H
#1	R	Firmware version	Displaying the current firmware version in hex, e.g. 0100H indicates the firmware version V1.00.
#2	R	Release date of the version	Displaying the data in decimal form. 10,000s digit and 1,000s digit are for "month"; 100s digit and 10s digit are for "day". For 1 digit: 0 = morning; 1 = afternoon.
#6	R	GS20(X) Drive station number	1 – 254
#11	R/W	Modbus Timeout	Pre-defined setting: 50 (ms)
#13	R/W	Keep Alive Time	Pre-defined setting: 30 (s)

BR#0 - Model Name: Model code for GS20A-CM-ENETIP is 0x0104. Read the model code to confirm connection with GS20A-CM-ENETIP.

BR#1 - Firmware Version: The firmware version of GS20A-CM-ENETIP displayed in hexadecimal. Example: 0100h indicates version V1.00.

BR#2 - Release Date of the Version: The date is displayed in decimal form. 10,000s digit and 1,000s digit are for "month;" 100s digit and 10 digit are for "day." For 1s digit: 0 = morning; 1 = afternoon.10 Example: 12191 indicates that the version was released the afternoon of December 19.

BR#6 - GS20(X) Drive Station Number: Station number of the GS20(X) series drive. Range 1~254.

BR#11 - Modbus Communication Timeout: Sets the communication timeout (ms) for Modbus TCP.

BR#13 - Modbus TCP Keep Alive Time: Range 5~65,535 seconds. If the connection idle time exceeds the keep alive time, GS20A-CM-ENETIP will cut the idling connection.

BR Object (Class Code: 0x64)

Instance Code

Instance	Description
0x01	Corresponds to BR0: Model name
0x02	Corresponds to BR1: Firmware version
0x03	Corresponds to BR2: Release date of the version
0x07	Corresponds to BR6: GS20(X) station No.
0x0C	Corresponds to BR11: MODBUS communication timeout
0x0E	Corresponds to BR13: Network keep alive time (TCP/IP)

Instance Attributes

Attribute ID	Access Rule	Name	Data type	Description of attribute
0x03	Get / Set	Data	UINT	Refer to 4.2 for corresponding value Instance Code = 0x0E Get/Set Others Get Only

Common Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object
0x10		✓	Set Single Attribute	Modifies attribute

GS20A-CM-ENETIP EtherNet/IP Alarm Register

GS20A-CM-ENETIP EtherNet/IP Alarm Register (Alarm Modbus Address Base – 0x0200, 40513)				
AL#	**Bit in each AL**	**Read / Write**	**Function**	**Explanation**
#0~#15	bit 15	R	Function enabling flag	bit 15 = 1 → Function enabled bit 15 = 0 → Function disabled
	bit 4~bit 14	R	reserved	
	bit 2~bit 3	R	Type of triggered event	bit 3 / bit 2: reserved 0 0; reserved 0 1; reserved 1 0; reserved 1 1
	bit 1	R	Status of trigger	bit 1 = 1 → Not yet triggered bit 1 = 0 → Already triggered
	bit 0	R	Type of trigger	bit 0 = 1 → Triggered by software bit 0 = 0 → Triggered by hardware

AL Object (Class Code: 0x65)

Instance Code

Instance	Description
0x01~0x10	Corresponds to AL0~AL15: Alarm register

Instance Attributes

Attribute ID	Access Rule	Name	Data type	Description of attribute
0x03	Get	Data	UINT	Refer to 4.3 for corresponding value

Common Services

Service Code	Implemented for		Service Name	Description of service
	Class	Instance		
0x0E		✓	Get Single Attribute	Sends back attribute of designated object

AC Drive (VFD) Data Object (Class Code: 0x300)

Class Attributes & Instance Attributes

- *Object Class = 0x300*
- *Instance = Parameter Group*
- *Attribute = Parameter Member*

Instance & Attributes					
Instance	**Attributes**	**Access Rule**	**Name**	**Data Type**	**Description of Attribute**
0x20	0x00~0x02	Get / Set	VFD Command	UINT	VFD Command Data
0x21	0x00~0x1F	Get	VFD Status	UINT	VFD Status Data
0x22	0x00~0x34	Get	VFD Status	UINT	VFD Status Data

Services

Instance & Attributes				
Service Code	**Implemented for**		**Service Name**	**Description of Service**
	Class	**Instance**		
0x0E	✓	✓	Get_Attribute_Single	Returns the attributes of a designated element
0x10	✓	✓	Set_Attribute_Single	Gets the attributes of a designated element

EtherNet/IP Communication Card Register Settings

The EtherNet/IP interface of the GS20(X) AC Drive supports the drive's various modes of control. The communication protocol provides support for two packet types for data exchange:

- *Explicit Message*
- *Implicit Message*

Explicit Message-based Data Exchange:

The host controller directly assigns values to the GS20(X) Drive. Therefore it is necessary for the EIP communication card to allocate a corresponding address for the Object Class.

Currently, the address of the Object Class occupied by the GS20(X) Drive is 0x300.

The regular correspondence between parameter addresses and explicit messages is as follows:

EIP Communication Data Format

Object Class	+	*Instance*	+	*Attribute*
0x300	+	Parameter Group #	+	Parameter Member #

For example:

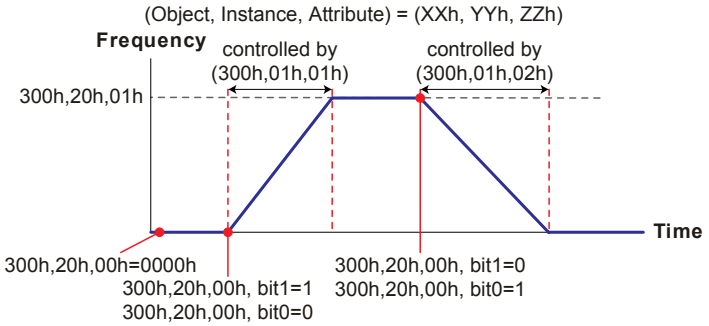
If we wish to write a command for parameter P01.01 (to set Acceleration Time 1), proceed as follows:

Explicit Message Format to Write to P1.01

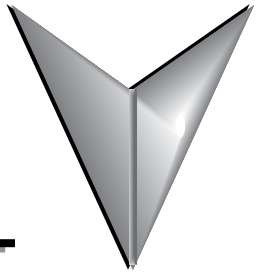
	Object Class	+	*Instance*	+	*Attribute*
=	0x300	+	Parameter Group #	+	Parameter Member #
=	0x300	+	1 [0x01]	+	1 [0x01]
=	0x300	+	0x01	+	0x01

Using Speed Mode as a Control Method

1) Setting the Target Frequency:
   Set (Object, Instance, Attribute) = (300h, 20h, 01h);
   Unit = Hz, with a decimal precision at the hundredths position;
   Example: 1000 represents 10.00.
2) Operation:
   Setting (Object, Instance, Attribute) = (300h, 20h, 00h) = 0002h indicates Run;
   Setting (Object, Instance, Attribute) = (300h, 20h, 00h) = 0001h indicates Stop.
3) Acceleration/Deceleration time Operations:
   If the first accel/decel section is used as the basis,
   the accel time is set to (Object, Instance, Attribute) = (300h, 01h, 01h),
   and the decel time is set to (Object, Instance, Attribute) = (300h, 01h, 02h),
   with unit = seconds and a decimal precision at the tenths position.
   Example: 100 represent 10.0 seconds.



Digital and Analog I/O Parameter Maps



Appendix C

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Appendix C: Digital and Analog I/O Parameter Maps

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Introduction

This section contains worksheets to help with designing and programming the physical inputs and outputs of the GS20(X) (digital, analog, and frequency interfaces). These worksheets provide the GS20(X) parameters and addresses associated with each input and output. For detailed parameter descriptions, please see Chapter 4 “AC Drive Parameters”. For more detailed wiring information, please see Chapter 2 “Installation and Wiring.

Digital and analog I/O parameter maps begin on the following page.

GS20(X) Digital Inputs								
GS20(X) Terminals	FWD/DI1	REV/DI2	DI3	DI4	DI5	DI6	DI7	Comments
PLC Address	X0	X1	X2	X3	X4	X5	X6	
Parameter	**P02.00** if ≠ 0, else: **P02.01**	**P02.02**	**(P02.00** if=**3 or 6)** else **P02.03**	**P02.04**	**P02.05**	**P02.06**	**P02.07**	See Digital Input Con-figurations Below
Default Setting	**P2.00**=1, **P02.01**=0	**P02.00**=1, **P02.02**=0	1	2	3	4	0	
Default Configuration	2 wire mode: FWD/STOP	2 wire mode: REV/STOP	Multi Spd 1	Multi Spd 2	Multi Spd 3	Multi Spd 4	No Function	
User Defined Selection / Value								
DI - N.C. / N.O. Select **P02.12 - Bit #**	0	1	2	3	4	5	6	0 = N.O. 1 = N.C.
Default Configuration	0 = Normally Open							
User Defined Selection / Value								
DI - Response Time	**P02.11**							0 to 30.000 seconds
Default Configuration	0.005 seconds							
User Defined Selection / Value								
DI - Active Status Monitor **P02.50 - Bit #**	0	1	2	3	4	5	6	Read Only!
DI - PLC Status Monitor **P02.52 - Bit #**	0	1	2	3	4	5	6	

** Note for PLC Address: When an external input is used in the PLC and the PLC is in Run or Stop mode, the PLC then controls that input and any Multi-Function Input setting assigned via P02.00~P02.07 is void. To read the status of an input into the PLC while maintaining the multifunction input setting use the RPR command on the DI Status Register (P02.50). The control of the IO can be given back to the drive by disabling the PLC either through the Keypad or Digital Inputs when they are assigned values 51 and 52.*

Digital Input Configurations – Parameters P02.01~P02.07			
0: No function 1: Multi-step speed command 1 2: Multi-step speed command 2 3: Multi-step speed command 3 4: Multi-step speed command 4 5: Reset 6: JOG [by external control or GS4-KPD (optional)] 7: Acceleration / deceleration speed inhibit 8: 1st and 2nd acceleration / deceleration time selection 9: 3rd and 4th acceleration / deceleration time selection 10: External Fault (EF) Input (P07.20)	11: Base Block (B.B.) input from external source 12: Output stop 13: Cancel the setting of autoacceleration / auto-deceleration time 15: Frequency command from AI1 16: Frequency command from AI2 18: Force to stop (P07.20) 19: Digital up command 20: Digital down command 21: PID function disabled 22: Clear the counter 23: Input the counter value (DI6) 24: FWD JOG command 25: REV JOG command 26: TQC / FOC mode selection 27: ASR1 / ASR2 selection	28: Emergency stop (EF1) 29: Signal confirmation for Y-connection 30: Signal confirmation for δ-connection 31: High torque bias (P11.30) 32: Middle torque bias (P11.31) 33: Low torque bias (P11.32) 38: Disable writing EEPROM function 39: Torque command direction 40: Force coasting to stop 41: HAND switch 42: AUTO switch 48: Mechanical gear ratio switch 49: Enable drive 50: Slave dEb action to execute 51: Selection for PLC mode bit 0 52: Selection for PLC mode bit 1	56: Local / Remote selection 58: Enable fire mode (with RUN command) 59: Enable fire mode (without RUN command) 70: Force auxiliary frequency return to 0 71: Disable PID function, force PID output return to 0 72: Disable PID function, retain the output value before disabled 73: Force PID integral gain return to 0, disable integral 74: Reverse PID feedback 81: Simple positioning zero point position signal input 82: OOB loading balance detection 83: Multi-motor (IM) selection bit 0 84: Multi-motor (IM) selection bit 1

GS20(X) Digital Outputs

GS20(X) Digital Outputs				
GS20(X) Terminals	R1-R1C-R1O	DO1-DOC	DO2-DOC	Comments
PLC Address	Y0	Y3	Y4	
Parameter	**P02.13**	**P02.16**	**P02.17**	See Digital Output Configurations Below
Default Setting	11	0	0	
Default Configuration	Malfunction Indication	No Function		
User Defined Selection / Value				
DO - N.C. / N.O. Select **P02.18 - Bit #**	0	3	4	0 = N.O. 1 = N.C.
Default Configuration	0	0	0	
User Defined Selection / Value				
DO - Active Status Monitor **P02.51 - Bit #**	0	3	4	Read Only!
DO - PLC Status Monitor **P03.53 - Bit #**	0	3	4	

** Note for PLC Address: When an external output is used in the PLC and the PLC is in Run or Stop mode, the PLC then controls that output and any Multi-Function Output setting assigned via P02.13, P02.16, and P02.17 is void. To read the status of an output from the PLC while maintaining the multifunction output setting, use the RPR command on the DO Status Register (P02.51). The ownership of the IO can be given back to the drive by disabling the PLC either through the Keypad or Digital Inputs when they are assigned values 51 and 52.*

Digital Output Configurations – Parameters P02.13, P02.16, and P02.17		
0: No function 1: Indication during RUN 2: Operation speed reached 3: Desired frequency reached 1 (P02.22) 4: Desired frequency reached 2 (P02.24) 5: Zero speed (Frequency command) 6: Zero speed including STOP (Frequency command) 7: Over-torque 1 (P06.06–06.08) 8: Over-torque 2 (P06.09–06.11) 9: Drive is ready 10: Low voltage warning (Lv) (P06.00) 11: Malfunction indication 13: Overheat warning (P06.15) 14: Software brake signal indicator (P07.00) 15: PID feedback error (P08.13, P08.14) 16: Slip error (oSL) 17: Count value reached, does not return to 0 (P02.20)	18: Count value reached, return to 0 (P02.19) 19: External interrupt B.B. input (Base Block) 20: Warning output 21: Over-voltage 22: Over-current stall prevention 23: Over-voltage stall prevention 24: Operation mode 25: Forward command 26: Reverse command 29: Output when frequency ≥ P02.34 30: Output when frequency < P02.34 31: Y-connection for the motor coil 32: δ-connection for the motor coil 33: Zero speed (actual output frequency) 34: Zero speed including STOP (actual output frequency) 35: Error output selection 1 (P06.23) 36: Error output selection 2 (P06.24)	37: Error output selection 3 (P06.25) 38: Error output selection 4 (P06.26) 40: Speed reached (including STOP) 42: Crane function 43: Motor speed detection 44: Low current output (use with P06.71–06.73) 45: UVW output electromagnetic valve switch 46: Master dEb output 51: Analog output control for RS-485 interface 52: Output control for communication cards 53: Fire mode indication 66: SO output logic A 67: Analog input level reached 68: SO output logic B 73: Over-torque 3 74: Over-torque 4 75: Forward RUN status 76: Reverse RUN status

GS20(X) Analog Common Parameters

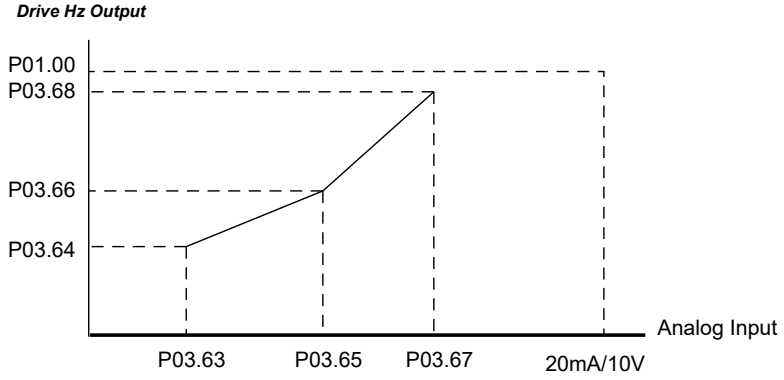
GS20(X) – AI1 and AI2 – Common Parameters				
Parameter		***Selection / Value***	***Default***	***User Selection***
P00.20	Master frequency command source (AUTO, REMOTE)	0: Digital keypad 1: RS-485 communication input 2: External analog input (Refer to P03.00) 3: External UP / DOWN terminal (digital input terminals) 4: Pulse input (DI7) without direction command 6: Not used 7: Digital keypad VR/potentiometer dial (GS20 only) 8: Communication card 9: PID controller	0	
P00.30	Master frequency command source (HAND, LOCAL)		0	

GS20(X) Analog Input 1 Parameters

GS20(X) – AI1 Specific Parameters				
Parameter		***Selection / Value***	***Default***	***User Selection***
Terminals		***AI1 – ACM***	***N/A***	***N/A***
PLC Address		***D1028***	***N/A***	***N/A***
P03.00	Analog input selection (AI1)	1: Frequency command 2: Torque command (torque limit under speed mode) 3: Torque compensation command 4: PID target value 5: PID feedback signal 6: Thermistor (PTC) input value 7: Positive torque limit 8: Negative torque limit 9: Regenerative torque limit 10: Positive / negative torque limit 11: PT100 RTD input value 12: Auxiliary frequency input 13: PID compensation value	1	
P03.28	AI1 terminal input selection	0: 0–10 V (P03.63–P03.68 is valid) 3: -10–10 V (P03.63–P03.74 are valid)	0	
P03.03	Analog input bias (AI1)	-100.0% to +100.0%	0	
P03.07	Positive / negative bias mode (AI1)	0: No bias 1: Lower than or equal to bias 2: Greater than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center	0	
P03.11	Analog input gain (AI1)	-500.0% to +500.0%	100.0	
P03.15	Analog input filter (LPF) time (AI1)	0.00~20.00 sec	0.01	
P03.47	AI1%	-100 to 100%	0	
P03.50	Analog input curve calculation selection	0: Normal curve 1: Three-point curve of AI1 2: Three-point curve of AI2 3: Three-point curve of AI1 & AI2	0	
Parameters below are used to characterize the GS20(X) drive output frequency with three point curve parameters if using AI1 for speed reference (bias and gain parameters above are not used when P03.50 ≠ 0).				
P03.63	AI1 votage lowest point	0.00~10.00V	0	
P03.64	AI1 proportional lowest point	0.00~100.00%	0	
P03.65	AI1 voltage mid-point	0.00~10.00V	5	
P03.66	AI1 proportional mid-point	0.00~100.00%	50.00	

GS20(X) – AI1 Specific Parameters (continued)				
Parameter		**Selection / Value**	**Default**	**User Selection**
P03.67	AI1 voltage highest point	0.00~10.00V	10	
P03.68	AI1 proportional highest point	0.00~100.00%	100.00	
P03.69	Negative AI1 voltage highest point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	0.00	
P03.70	Negative AI1 proportional highest point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	0.00	
P03.71	Negative AI1 voltage mid-point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	-5.00	
P03.72	Negative AI1 proportional mid-point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	-50.00	
P03.73	Negative AI1 voltage lowest point	-10.00–0.00 V (valid when P03.28 sets as -10–10 V)	-10.00	
P03.74	Negative AI1 proportional lowest point	-100.00–100.00% (valid when P03.28 sets as -10–10 V)	-100.00	

Analog Input 1 (AI1) Three Point Curve



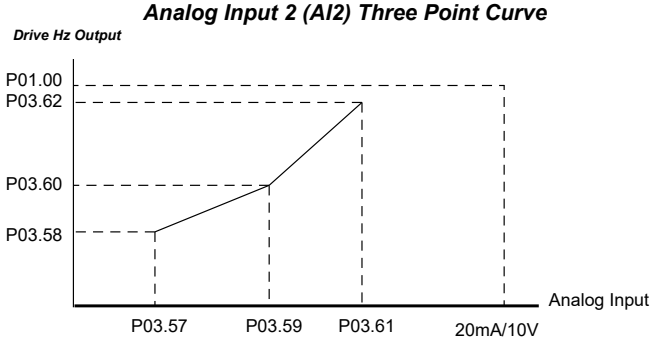
GS20(X) Analog Input 2 Parameters

GS20(X) – AI2 Specific Parameters				
Parameter		**Selection / Value**	**Default**	**User Selection**
Terminals		***AI2 – ACM***	***N/A***	***N/A***
PLC Address		***D1029***	***N/A***	***N/A***
P03.01	Analog input selection (AI2)	1: Frequency command 2: Torque command (torque limit under speed mode) 3: Torque compensation command 4: PID target value 5: PID feedback signal 6: Thermistor (PTC) input value 7: Positive torque limit 8: Negative torque limit 9: Regenerative torque limit 10: Positive / negative torque limit 11: PT100 RTD input value 12: Auxiliary frequency input 13: PID compensation value	0	

GS20(X) – AI2 Specific Parameters (continued)				
Parameter		***Selection / Value***	***Default***	***User Selection***
P03.29	AI2 terminal input selection	0: 4–20 mA 1: 0–10 V 2: 0–20 mA	0	
P03.04	Analog input bias (AI2)	-100.0% to +100.0%	0	
P03.08	Positive/negative bias mode (AI2)	0: No bias 1: Lower than or equal to bias 2: Greater than or equal to bias 3: The absolute value of the bias voltage while serving as the center 4: Bias serves as the center	0	
P03.12	Analog input gain (AI2)	-500.0% to +500.0%	100.0	
P03.16	Analog input filter (LPF) time (AI2)	0.00~20.00 sec	0.01	
P03.48	AI2%	-100 to 100%	0	
P03.50	Analog input curve calculation selection	0: Normal curve 1: Three-point curve of AI1 2: Three-point curve of AI2 3: Three-point curve of AI1 & AI2	0	
Parameters below are used to characterize the GS20(X) drive output frequency with three point curve parameters if using AI2 for speed reference (bias and gain parameters above are not used when P03.50 ≠ 0).				
P03.57	AI2 lowest point	P03.29=0: 0.00~10.00V P03.29=1: 4.00~20.00mA P03.29=2: 0.00~20.00mA	P03.29=0: 0.00V P03.29=1: 4.00mA P03.29=2: 0.00mA	
P03.58	AI2 proportional lowest point	0.00~100.00%	0	
P03.59	AI2 voltage mid-point	P03.29=0: 0.00~10.00V P03.29=1: 4.00~20.00mA P03.29=2: 0.00~20.00mA	P03.29=0: 5.00V P03.29=1: 12.00mA P03.29=2: 10.00mA	
P03.60	AI2 proportional mid-point	0.00~100.00%	50.00	
P03.61	AI2 voltage highest point	P03.29=0: 0.00~10.00V P03.29=1: 4.00~20.00mA P03.29=2: 0.00~20.00mA	P03.29=0: 10.00V P03.29=1: 20.00mA P03.29=2: 20.00mA	
P03.62	AI2 proportional highest point	0.00~100.00%	100.00	

P03.19 (Loss of AI2) determines the drive behavior if the 4~20mA signal is lost.

Analog Input 2 (AI2) Three Point Curve



GS20(X) Analog Output 1 Parameters

GS20(X) – AO1 Specific Parameters				
Parameter		***Selection / Value***	***Default***	***User Selection***
Terminals		***AO1 – ACM***	***N/A***	***N/A***
PLC Address		***D1040***	***N/A***	***N/A***
P03.20	Multi-function output (A01)	0: Output frequency (Hz) 1: Frequency command (Hz) 2: Motor speed (Hz) 3: Output current (rms) 4: Output voltage 5: DC bus voltage 6: Power factor 7: Power 8: Output torque 9: AI1 10: AI2 12: Iq current command 13: Iq feedback value 14: Id current command 15: Id feedback value 16: Vq-axis voltage command 17: Vd-axis voltage command 18: Torque command 19: PG2 (DI7) frequency command 21: RS-485 analog output 22: Communication card analog output 23: Constant voltage output	0	
P03.21	Analog output gain (A01)	0.0~500.0%	100.0	
P03.22	Analog output in REV direction (A01)	0: Absolute Value 1: 0V When Negative 2: Offset 5V = 0 Value	0	
P03.27	A01 output bias	-100.00–100.00%	0.00	
P03.31	A01 output selection	0: 0–10 V output 1: 0–20 mA output 2: 4–20 mA output	0	
P03.32	A01 DC output setting level	0.00~100.00%	0.00	
P03.35	A01 output filter time	0.00–20.00 sec.	0.01	

GS20(X) Frequency Output Parameters

GS20(X) – Frequency Output Specific Parameters				
Parameter		***Selection / Value***	***Default***	***User Selection***
Terminals		***DO – DCM***	***N/A***	***N/A***
PLC Address		***N/A***	***N/A***	***N/A***
P02.21	Digital output gain (DO) (Pulse per second output = actual output frequency x P3.38)	1~55 (1 = no scaling)	1	

USING GS20(X) AC DRIVES WITH AUTOMATIONDIRECT PLCS

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Appendix D Overview

The material presented here will help you connect your GS20(X) drive to an ADC PLC. The concepts and techniques used can also be applied to any 3rd party PLC.

There are two ways a PLC can control the drive; via communications or via physical inputs. The GS20(X) supports serial Modbus via the built-in RS-485 connections. Ethernet communication is available by installing an EtherNet/IP option card (that can be configured as Ethernet/IP or Modbus TCP).

GS20(X) supports a variety of I/O on the main control board.

- *7 Sinking/sourcing DC inputs (includes 1 Hi-speed pulse input, 30V/30mA/33kHz max)*
- *2 Sinking/sourcing DC outputs*
- *1 Form C relay output (inductive load [cosØ 0.4] 1.2A [NO or NC] @ 250VAC)*
- *2 Analog inputs (0~10V, -10~10V, 0~20 mA, 4~20 mA)*
- *1 Analog output (0~10V, -10~10V, 4~20 mA)*
- *1 Hi-speed pulse output (30V/30mA/33kHz max)*

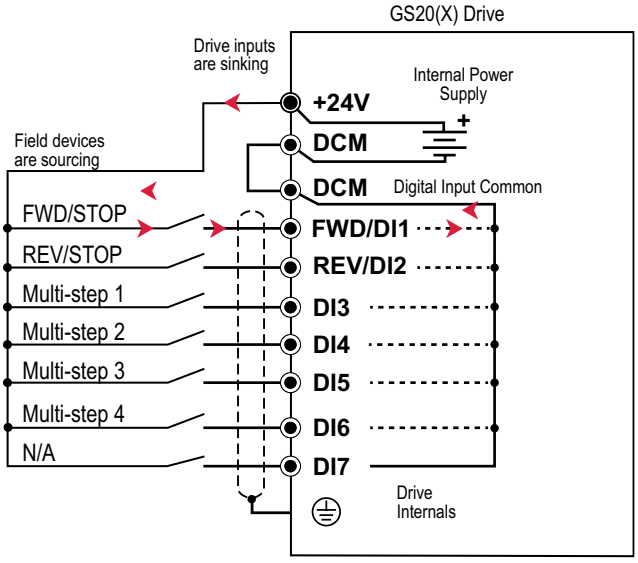
Sinking/Sourcing Basics

GS20(X) DC inputs and outputs can be sinking or sourcing, depending on how they are wired. If you understand the basics of how sinking and sourcing work, the two options can be easily applied.

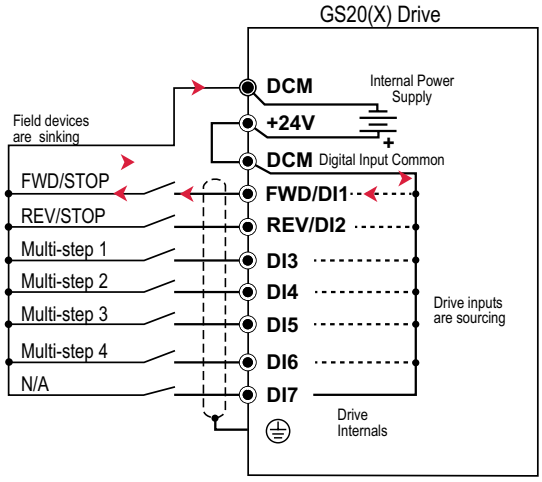
- *For a detailed technical explanation of sink and source, please follow this link: www.automationdirect.com/static/specs/sinksource.pdf*

The term "sinking" means that the device "sinks" current into itself. It does not supply current. Sinking inputs are ON when you apply voltage (and thus, current) to them. A "sinking" device needs to have a "sourcing" device attached to it to supply current.

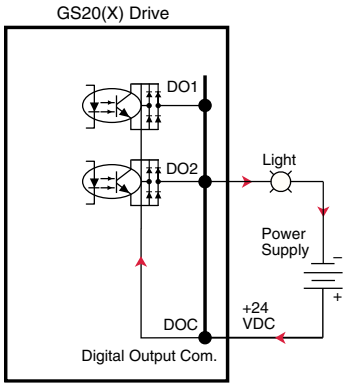
So, if the GS20(X) inputs are wired for sinking, they require the external device (FWD/STOP switch in this example) to supply current (when closed, the external device will "source" current). Notice the current flow represented by the red arrows. The GS20(X) input "sinks" the current flow.



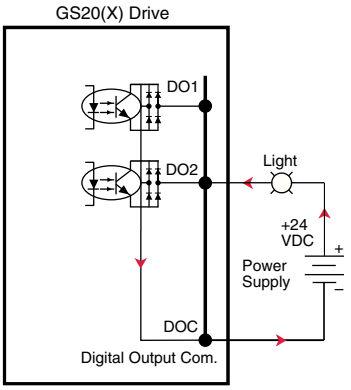
GS20(X) DC inputs can also be wired for sourcing. In this configuration, notice that the 24VDC supply is feeding into the DIC (Digital Input Common) terminal and the current is coming out of the drive input (GS20(X) is sourcing) and the field device is sinking the current.



GS20(X) DC outputs can also be wired as sinking or sourcing. A sourcing output supplies current. This requires a device (pilot light, buzzer, PLC input card) that will sink the current. Notice how the electronics of the output allow current to flow out the DO1 or DO2 terminal. The DOC (Digital Output Common) terminal is connected to +24VDC.



The same drive output circuit can be used to sink current. Notice below that the DOC terminal is now connected to the power supply common. The pilot light sources the current into the drive. The drive output sinks the current. (Even though the light has 24V on it at all times, it will not light up unless current is flowing through it and into the drive output).



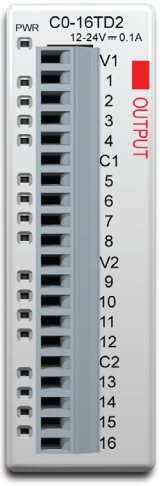
NOTE: GS20(X) output can be wired as sinking or sourcing, but not both at the same time.

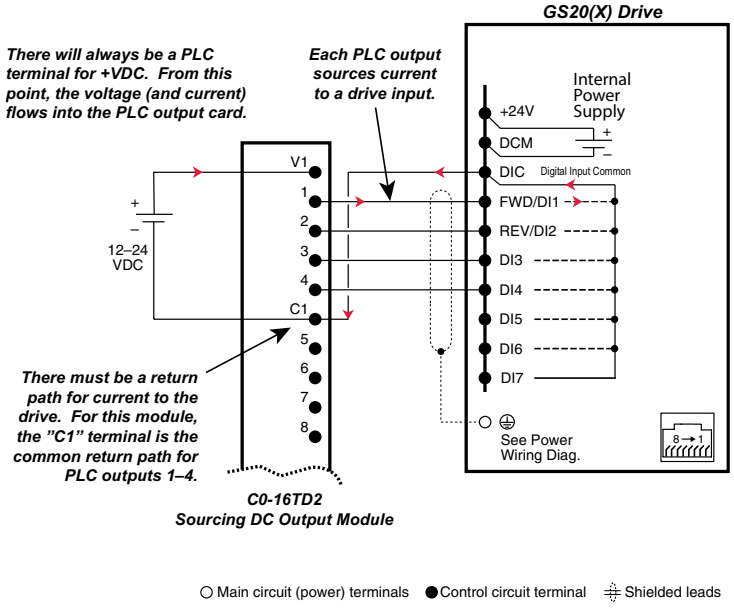
GS20(X)-to-PLC I/O Wiring Examples

This section shows typical wiring examples of PLC inputs and outputs connected to a GS20(X) drive. While we are using CLICK PLCs in the examples, the samples should be relevant to most PLCs. The terminal designation of other PLCs may be different, but the general connections should be the same (i.e. in the 1st example below, all PLC sourcing output modules will have a +VDC connection, a DC common terminal, and individual outputs). In the examples below, we make note of the typical connections involved. We also indicate current flow (with red arrows) to emphasize which modules are sourcing and which modules are sinking.

Drive Wired with DC Sinking Inputs (PLC output card is sourcing)

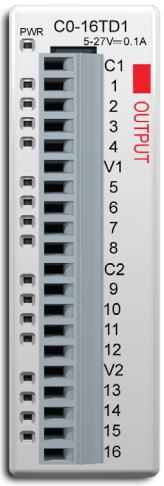
CLICK Expansion Module
C0-16TD2

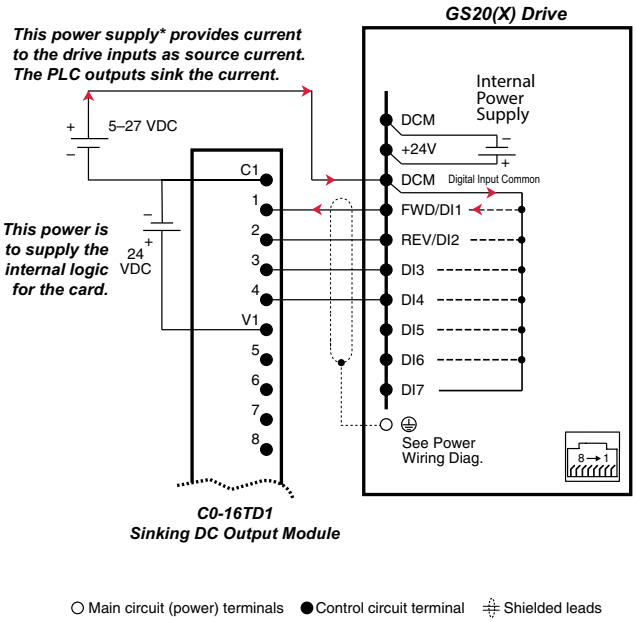




Drive Wired with DC Sourcing Inputs (PLC output card is sinking)

CLICK Expansion Module
C0-16TD1

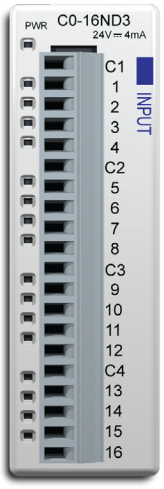


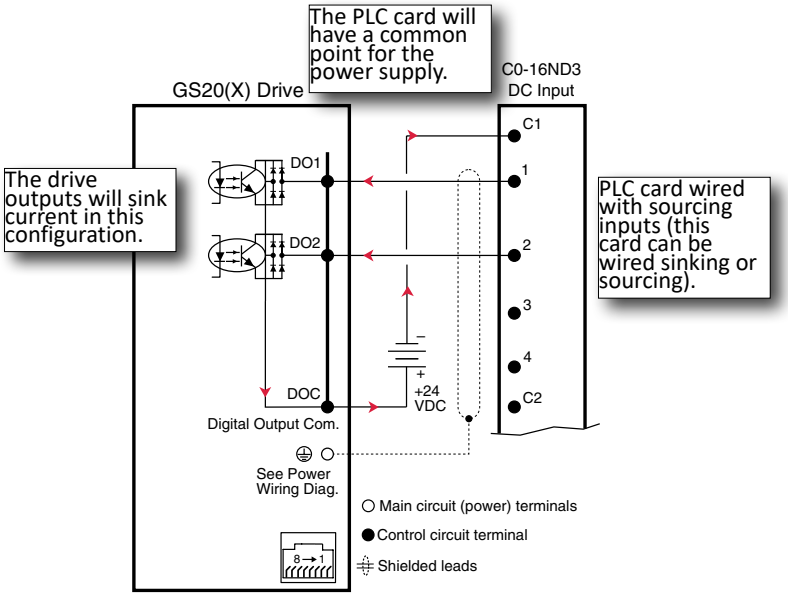


**Alternately, the drive internal power supply (+24V) could be used. However, the DCM common would have to be connected to the PLC power supply common.*

Drive Wired with DC Sinking Outputs (PLC input card is sourcing)

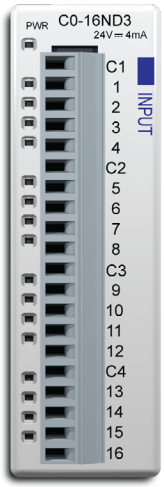
CLICK Expansion Module
C0-16ND3

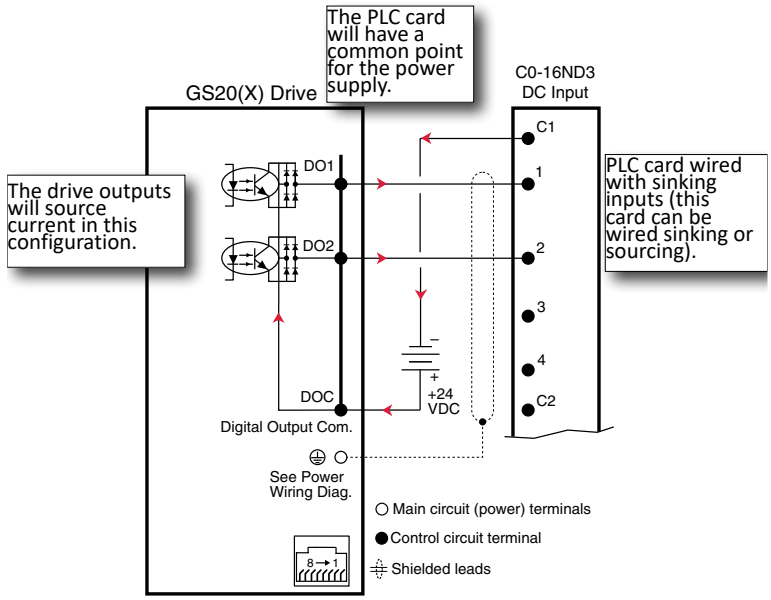




Drive Wired with DC Sourcing Outputs (PLC input card is sinking)

CLICK Expansion Module
C0-16ND3

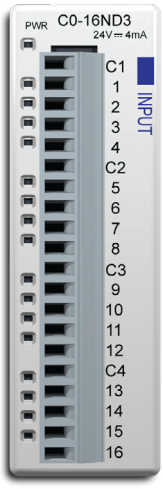


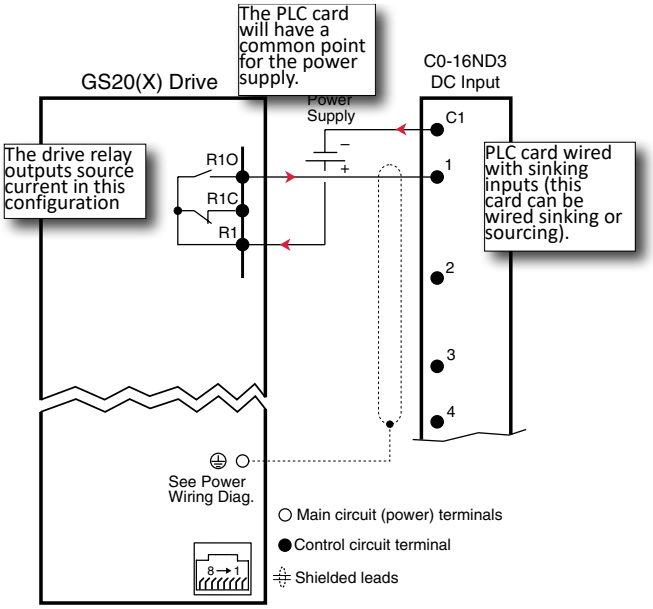


Drive Relay Outputs Wired with Sinking PLC Modules

In this example, the inputs are wired to the Normally-Open contacts (R1O). You could also wire to the Normally-Closed contacts (R1C), but you would not be able to tell if the drive lost power or if the drive outputs are simply OFF.

CLICK Expansion Module
C0-16ND3

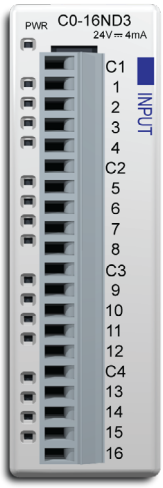


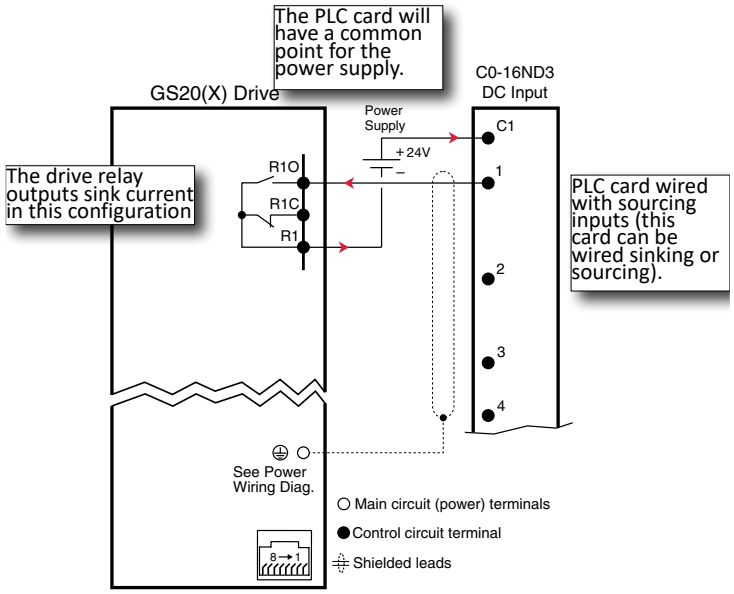


Drive Relay Outputs Wired with Sourcing PLC Modules

In this example, the inputs are wired to the Normally-Open contacts (R1O). You could also wire to the Normally-Closed contacts (R1C), but you would not be able to tell if the drive lost power or if the drive outputs are simply OFF.

CLICK Expansion Module
C0-16ND3





Drive Analog Inputs

The GS20(X) has 2 analog inputs (AI1 and AI2) that can be configured for a variety of input functions. AI1 and AI2 must be configured via drive parameters group 3. AI2 has a DIP switch located above the I/O terminal strip that allows configuration as voltage or current input. AI1 is voltage input only. Both inputs have a variety of settings in Parameter Group 3 (P03.xx) that allows you to customize their scaling, offset, etc.

- *AI1: 0~10V, -10V to +10V*
- *AI2: 0~10V, 4~20 mA, 0~20 mA (See P03.29 and the DIP switch AI2 above the I/O terminals)*

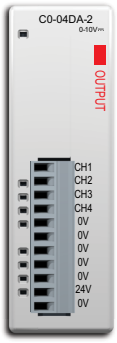
Connecting the analog inputs to PLC outputs is very straightforward. Both analog inputs share the same common.

NOTE: The GS20(X) AI2 analog input does not supply the current when configured for 0~20 mA or 4~20 mA. The analog output device needs to supply the loop power.

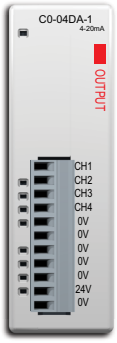
Analog Input Wired for Voltage and Current

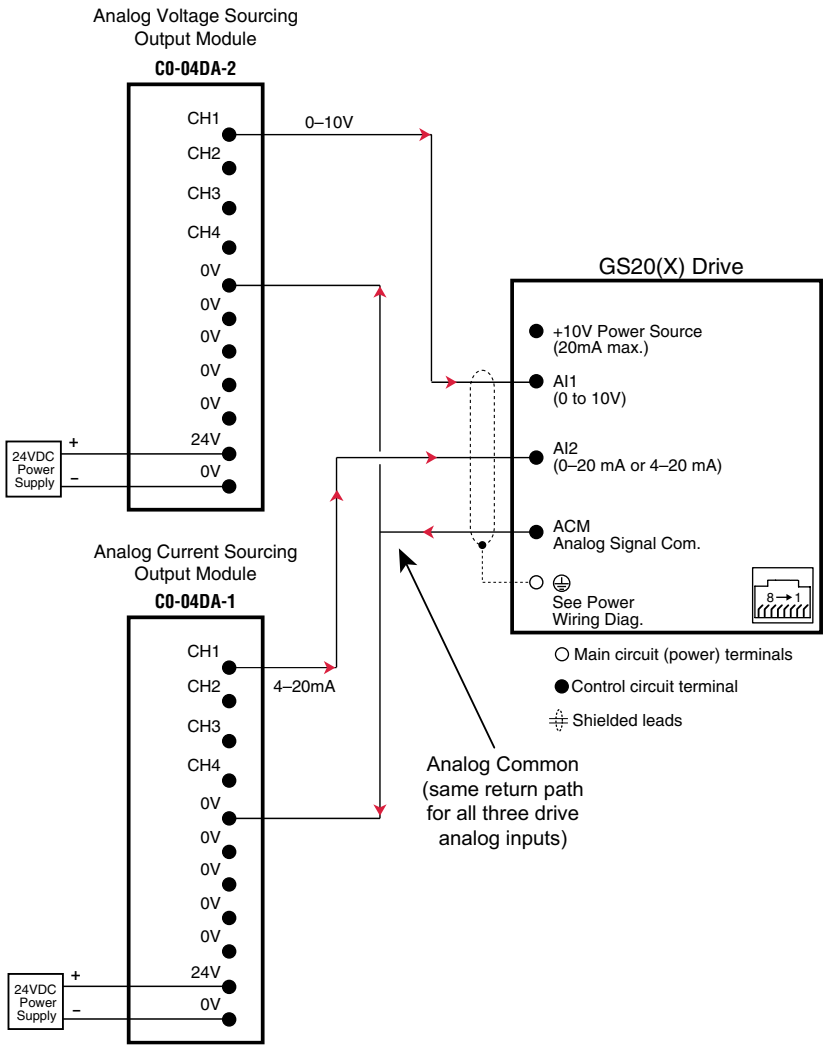
In this example, AI1 is configured for 0~10V (P03.28). AI2 is configured for 4~20 mA (DIP switch and P03.29).

CLICK Expansion Module C0-04DA-2



CLICK Expansion Module C0-04DA-1





Drive Analog Outputs

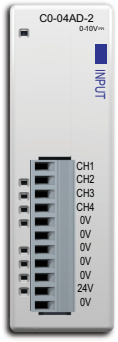
The GS20(X) has one analog output (AO1) which can be configured for a variety of uses. The output is configured via parameters and DIP switch settings (located above the I/O terminal strip). There are several parameters associated with the analog output that defines the signal and adjusts gain, offset, etc.

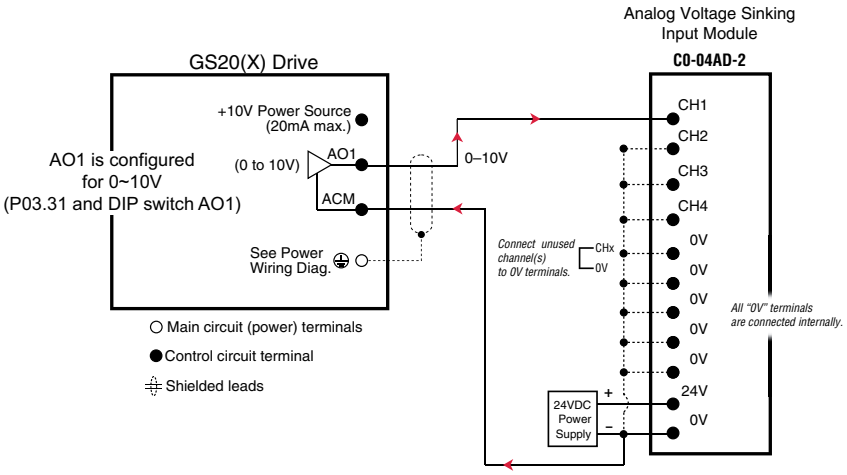
- *AO1: 0~10V or 0~2mA or 4~20mA (see P03.31 and the DIP switch AO1 above the I/O terminals)*

Analog Output Wired for Voltage and Current

In this example AO1 is configured for voltage signal, 0-10V (P03.31 and DIP switch AO1).

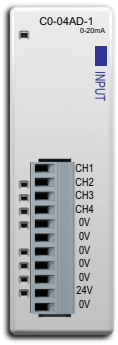
CLICK Expansion module
C0-04AD-2

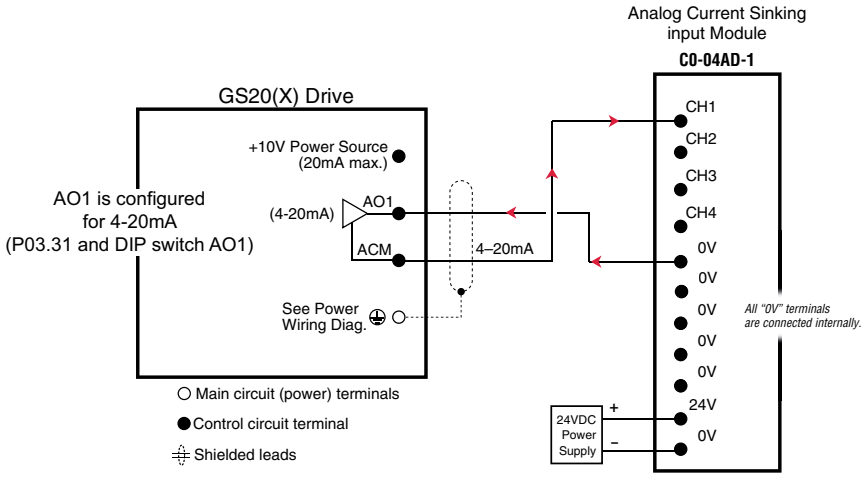




In this example AO1 is configured for current signal, 4-20mA (P03.31 and DIP switch AO1).

CLICK Expansion module
C0-04AD-1





Drive Frequency Output (High-speed pulse output)

The GS20(X) has one high-speed pulse train output: DO. This pulse train output is based on the actual main frequency output of the drive. A scaling factor is available to adjust the frequency.

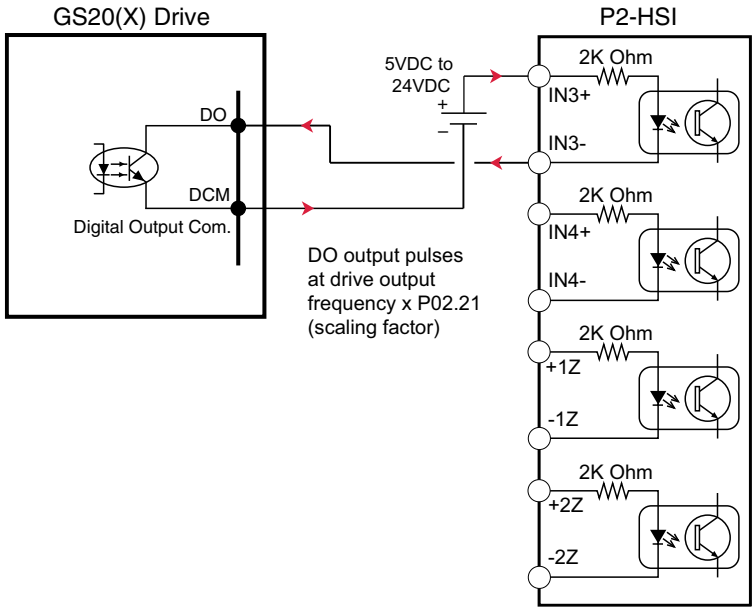
P02.21 Frequency Output Scaling Factor:

- *Actual DO pulses per second output = GS20(X) output frequency (Hz) x P02.21*

Drive DO output is limited to 30V@ 30mA max. Max frequency is 33kHz (50% duty cycle).

The PLC high-speed input will have a certain amount of resistance built-in (P2-HSI module has 2kΩ resistance). The drive terminal DO needs to see a minimum of 1kΩ resistance.

P2 Expansion Module
P2-HSI



Communication with GS20(X) Drives

The GS20(X) drive supports two types of communication:

- *Serial Modbus (built-in RS-485 port)*
- *EtherNet/IP (optional GS20A-CM-ENETIP card)*

Note: Only one serial protocol can be used at a time. Only one Ethernet option card can be installed at a time (You can have serial Modbus and one Ethernet card running at the same time).

Getting Started

This section will point out the "need to know" details of how to connect to your PLC to a GS20(X) drive.

The first thing to do with the GS20(X) drive after the basic wiring, is to set up the motor information and protection features. Detailed information on drive setup can be found in Chapter 4: Parameters. After powering up the drive and ensuring that your E-stop and/or STO input work, press MENU on the keypad.

Configure the following minimal set of parameters:

DURApulse GS20 Parameter Settings – Quick Configuration				
Parameter	***Description***	***Range***	***Default***	***User***
P00.00	GS20 Model ID	Read Only	n/a	
P00.01	Displays AC drive rated current	Displays value based on model	n/a	
P00.02	Restore to default	0=No function 1=Parameter write protect 2=Reset to GS2 mode (1 of 2) 5=Reset kWH display to 0 6=Reset PLC 7=Reserved 8=Keypad doesn't respond 9=Reset 50Hz defaults 10=Reset 60Hz defaults 11=Reset 50Hz defaults (keep user config) 12=Reset 60Hz defaults (keep user config) 20=Reset to GS2 mode (2 of 2)	0	
P00.06	Firmware Version	Read Only	n/a	
P00.10	Control Mode	0=Speed mode 2=Torque mode	0	
P00.11	Speed Control Mode	0=VF (IM V/F control) 1=VFPG (IM V/F control + Encoder) 2=SVC (Parameter 05.33 set as IM or PM) 5=FOC Sensorless	0	
P00.16	Load Selection	0=VT 1=CT	1	
P00.20	Frequency Command Source (Auto)	0=Digital keypad 1=Communication RS-485 input 2=External analog input (refer to parm 03.00) 3=External UP/DOWN terminal 4=Pulse input without direction command (refer to parm 10.16 without direction) 7=Digital keypad dial	0	
P00.21	Operation Command Source (Auto)	0=Digital keypad 1=External terminals 2=Communication RS-485 input 5=Communication card	0	
P00.22	Stop Method	0=Ramp to stop 1=Coast to stop	0	
P00.23	Motor Direction	0=Enable forward/reverse 1=Disable reverse 2=Disable forward	0	

DURApulse GS20 Parameter Settings – Quick Configuration (continued)				
Parameter	***Description***	***Range***	***Default***	***User***
P00.29	Local/Remote Selection	0=Standard HOA function 1=Switching Local/Remote, the drive stops 2=Switching Local/Remote, the drive runs as the REMOTE setting for frequency and operation status 3=Switching Local/Remote, the drive runs as the LOCAL setting for frequency and operation status 4=Switching Local/Remote, the drive runs as LOCAL setting when switched to Local and runs as REMOTE setting when switched to Remote for frequency and operation status	0	
P00.30	Master Frequency Command Source (Hand)	0=Digital keypad 1=Communication RS-485 input 2=External analog input (refer to parm 03.00) 3=External UP/Down terminal 4=Pulse input without direction command (refer to parm 10.16 without direction) 7=Digital keypad dial 8=Communication card	0	
P00.31	Operation Command Source (Hand)	0=Digital keypad 1=External terminals 2=Communication RS-485 input 5=Communication card	0	
P01.00	Motor 1 Max Frequency	0.00-599.00 Hz	60	
P01.01	Motor 1 Base Frequency	0.00-599.00 Hz	60	
P01.02	Motor 1 Rated Voltage	110V/230V: 0.0~255.0 460V: 0.0~510.0V	220.0 440.0	
P01.09	Startup Frequency	0.00-599.0 Hz	0.5	
P01.12	Acceleration Time 1	P01.45=0: 0.00-600.00 sec P01.45=1: 0.00-6000.00 sec	10.00 10.00	
P01.13	Deceleration Time 1	P01.45=0: 0.00-600.00 sec P01.45=1: 0.00-6000.00 sec	10.00 10.00	
P01.20	Jog Acceleration Time	P01.45=0: 0.00-600.00 sec P01.45=1: 0.00-6000.00 sec	10.00 10.00	
P01.21	Jog Deceleration Time	P01.45=0: 0.00-600.00 sec P01.45=1: 0.00-6000.00 sec	10.00 10.00	
P01.22	Jog Frequency	0.00-599.0 Hz	0.5	
P02.00	2-wire / 3-wire Control	0=No function 1=2-wire mode 1, power on for operation control (M1: FWD/STOP, M2: REV/STOP) 2=2-wire mode 2, power on for operation control (M1: RUN/STOP, M2 REV/FWD) 3=3-wire, power on for operation control (M1: RUN, M2: REV/FWD, M3: STOP) 4=2-wire mode 1, fast start up (M1: FWD/STOP, M2: REV/STOP) 5=2-wire mode 2, fast start up (M1: RUN/STOP, M2: REV/FWD) 6=3-wire, fast start up (M1: RUN, M2: REV/FWD, M3: STOP) Note: In fast start up mode, the drive skips detecting IGBT signal and will run immediately. When using fast start up mode: Terminal output stays in ready status and drive responds to commands immediately. The output terminal will have higher voltage If the drive is short circuited an OC error will display when running up	1	
P05.01	Motor 1 Full Load Amps (FLA)	10-120% of drive rated current	#.##	
P05.03	Motor 1 Rated RPM	0-65535	1710	

DURAPULSE GS20 Parameter Settings – Quick Configuration (continued)				
Parameter	***Description***	***Range***	***Default***	***User***
P05.04	Motor 1 Number of poles	2-20	4	
P06.13	Motor 1 Electronic Thermal Overload Relay	0=Inverter motor (with external forced cooling) 1=Standard motor (motor with fan on the shaft) 2=Disabled	2	
P06.14	Motor 1 Electronic Thermal Relay Time	30.0-600.0	60	
P06.55	Drive Derating Method	0=Constant rated current and limit carrier wave by load current and temperature 1=Constant carrier frequency and limit load current by setting carrier wave 2=Constant rated current (same as setting 0) but close current limit	0	
P13.00	Application Selection	00=Disabled 01=User parameter 02=Compressor 03=Fan 04=Pump 05=Conveyor 06=Machine tool 07=Packing 08=Textiles	0	
P09.08	Restore to GS20 default	When in GS2 mode: 20: Reset to GS20 mode from GS2 mode	0	

NOTE: If you have changed many parameters and cannot get your drive to function the way you want, go to Parameter P00.02 Parameter Reset and enter a value of 9 or 10. This will reset your drive to its factory default settings. Then review the quick start parameters to ensure they are configured as needed.

Your drive should now be ready to function from the keypad and be able to properly protect the motor from an overload. The drive should start and stop by pressing the RUN and STOP keys. The output speed can be changed by pressing the UP/DOWN arrows on the "F" setting (frequency). Set P00.20 to 7 to use the VR/Potentiometer dial on the drive. If the drive doesn't run, check all power and control wiring, especially wiring associated with STO (E-Stop).

Serial Modbus Monitoring and Control

Serial Modbus connections over RS485 can be made to the GS20(X) drive using two methods.

The GS20(X) drive is equipped with one RJ45 port. Using this port, the GS20(X) drive can be connected to an RS485 network using standard Ethernet cables. For longer cable runs, use the SG+, SG- and SGND terminals, also located on the control terminal board, with shielded cable. See Chapter 2 for detailed wiring specifications and Chapter 5 for detailed Modbus information.

The most common serial port parameters are shown below:

Serial Port Parameters		
GS20(X)	***Description***	***Default***
P09.00	VFD Comm Address	1
P09.01	MODBUS Baud Rate	9.6 kbps
P09.04	MODBUS Protocol (Range Setting)	12: 8N1 (RTU)

Before starting to control the drive or to write to critical parameters, you should ensure that you are addressing the correct values. To check that your PLC is pointing to the correct location, read and write from a non-critical parameter. A good example is P01.17, Deceleration Time 3. As you can see in the Parameter Summary Table (partial from Ch 4 shown below), the Modbus address for P01.17 is 0111H or 40274 decimal (The hex address = the parameter number).

Parameter Summary Table (Excerpt from Table in Ch4)						
Parameter	***Description***	***Range***	***Run Read/ Write***	***MODBUS Address***		***Settings***
				HEX	***Decimal****	***Default***
P01.17	Deceleration Time 3	P01.45=0: 0.00~600.00 sec P01.45=1: 0.0~6000.00 sec	R/W	0111H	40274	10.00
P01.18	Acceleration Time 4	P01.45=0: 0.00~600.00 sec P01.45=1: 0.0~6000.00 sec	R/W	0112H	40275	10.00
P01.19	Deceleration Time 4	P01.45=0: 0.00~600.00 sec P01.45=1: 0.0~6000.00 sec	R/W	0113H	40276	10.00
**Decimal value is the Modbus address + hexidecimal value; 40001 + 273(0111H) = 40274).*						

From the GS20(X) keypad, change the default value of P01.18 from 10 to 9.97. Now read this value with your PLC to verify your PLC addressing is correct. If your PLC reads back a value of 10, use the keypad to change P01.17 to 9.96 and P1.19 to 9.98. Then try to read again. Remember, some controllers use Base 0 and some use Base 1 addressing. So, you may need to offset your addressing by 1. If you still have issues, please refer to the detailed Modbus information in Chapter 5.

Once you have verified that your PLC addressing is correct, serial control for the drive is very simple. Enter the following values to set up PLC Control RS485 for the drive:

Parameter Settings Table					
Parameter	***MODBUS Address***		***Description***	***Setting Value***	***Note***
	HEX	***Decimal***			
P00.20	0014	40021	Remote source of frequency	1: RS485 Communication	This allows the RS-485 commands to set the drive speed when the REMOTE button is pressed (drive is in REMOTE mode).
P00.21	0015	40022	Remote source of operation	2: RS-485 Communication	This allows the RS-485 commands to start and stop the drive when the REMOTE button is pressed (drive is in REMOTE mode).

Now when the REMOTE button is pressed, the drive will start via serial commands. The drive will stop by either serial command or by pressing the STOP button on the keypad. (To return to full keypad control, press the LOCAL button. The drive will Start and Stop with the keypad. Pressing ENTER when the cursor is beside the “F” on the display, will allow the arrow keys to adjust the drive output frequency).

There are three command words to control the drive over serial Modbus. Toggling these bits and setting the Frequency Command will control the drive.

Parameter Settings Table			
MODBUS Address		***Description***	***Range***
HEX	***Decimal***		
2000	48193	Bit 0~1	00: no function
			01: Stop
			10: Run
			11: Jog+Run (at P5.00 Jog speed)
		Bit 2~3	reserved
		Bit 4~5	00: no function
			01: FWD
			10: REV
			11: no function
		Bit 6~15	reserved
2001*	48194*	Frequency Command / PID Setpoint *	In 1/100 of Hz (1500 = 15.00 Hz output)
2002	48195	External Fault Input	Bit 0: Trigger External Fault (EF) Bit 1: Reset EF Bit 2: External Interruption (B.B) = ON Bit 5: Enable Fire Mode Bits 6~15: reserved
** For 2001h: When the GS20(X) drive is configured with Frequency Reference as RS-485, Modbus TCP, or EtherNet/IP (P00.20=1 or 8 and drive in Remote/Auto) – OR – (P00.30=1 or 8 and drive in Local/hand) – AND – Reference > P01.00 Max Output Freq, then the drive will go up to Max Freq where it will remain until Max Freq is modified lower or a lower Freq Ref or a Stop signal is sent to the drive.*			

NOTE: The bits are edge triggered, meaning that you set them once and they will remain in effect until another command changes operation. Example: if you send the Run command, the drive will run. Clearing the Run bit will have no effect. You must send the Stop bit to make the drive Stop.

The status of the drive is reported back in registers 2100h~2110h (48449~48465 decimal). The six most recent faults are found in P06.17–P06.22 (0611h-0616h , 41555 - 41559 decimal). See Chapter 5 for more detailed explanations of these registers.

GS20(X) Status Addresses (Read Only)						
Description		***Range***		***Modbus Address***		
				Hex	***Dec***	***Octal***
Status Monitor 1	Error Codes	0: No Error 1: Overcurrent during Accel (ocA) 2: Overcurrent during Decel (ocd) 3: Overcurrent during normal speed (ocn) 4: Ground Fault (GFF) 5: IGBT short circuit (occ) 6: Overcurrent during Stop (ocS) 7: Overvoltage during Accel (ovA) 8: Overvoltage during Decel (ovd) 9: Overvoltage during normal speed (ovn) 10: Overvoltage during Stop (ovS) 11: Low voltage during Accel (LvA) 12: Low voltage during Decel (Lvd) 13: Low voltage during normal speed (Lvn) 14: Low voltage during Stop (LvS) 15: Input phase loss (OrP) 16: IGBT Overheat 1 (oH1) 17: Cap Overheat 2 (oH2) 18: Thermistor 1 open (tH1o) 19: Thermistor 2 open (tH2o) 20: Power Reset Off (PWR) 21: Overload (oL) (150% 1Min, Inverter) 22: Motor1 Thermal Overload (EoL1) 23: Motor2 Thermal Overload (EoL2) 24: Motor Overheat-PTC (oH3) 25: reserved 26: Over Torque 1 (ot1) 27: Over Torque 2 (ot2) 28: Under current (uc) 29: reserved 30: EEPROM write error (cF1) 31: EEPROM read error (cF2) 32: reserved 33: U phase current sensor detection error (cd1) 34: V phase current sensor detection error (cd2) 35: W phase current sensor detection error (cd3) 36: CC Hardware Logic error 0 (Hd0) 37: OC Hardware Logic error 1 (Hd1) 38: OV Hardware Logic error 2 (Hd2) 39: OCC Hardware Logic error 3 (Hd3)	40: Motor auto tune error (AuE) 41: PID Feedback loss (AFE) 42~47: reserved 48: Analog input signal loss (ACE) 49: External Fault (EF) 50: Emergency Stop (EF1) 51: Base Block (bb) 52: Password Error (Pcod) 53: Software Code lock (ccod) 54: PC Command error (CE1) 55: PC Address error (CE2) 56: PC Data error (CE3) 57: PC Slave error (CE4) 58: PC Communication Time Out (CE10) 59: PC Keypad Time out (CP10) 60: Braking Transistor Fault (bf) 61: Y-Delta connection Error (ydc) 62: Decel Energy Backup Error (dEb) 63: Over Slip Error (oSL) 64: Electromagnet switch error (ryF) 65~71: reserved 72: STO Loss1 (SrL1) STO1~SCM1 internal hardware detect error 73: ES1 Emergency Stop (S1) 74: In Fire Mode (Fire) 75: reserved 76: Safety Torque Off function active (STO) 77: STO Loss2 (SrL2) STO2~SCM2 internal hardware detect error 78: STO Loss3 (SrL3) – STO1~SCM1 and STO2~SCM2 internal hardware detect errors 79: U Phase Short (Uoc) 80: V Phase Short (Voc) 81: W Phase Short (Woc) 82: U Phase Loss (UPHL) 83: V Phase Loss (VPHL) 84: W Phase Loss (WPHL) 85~89: reserved 90: PLC Force Stop (FStp) 91~96: reserved 97: Ethernet Card Timeout (CD10) 98: reserved 99: CPU Command error (TRAP) 100: reserved	0611	41554	3021

(table continued next page)

GS20(X) Status Addresses (Read Only) (continued)					
Description	**Range**		**Modbus Address**		
			Hex	**Dec**	**Octal**
Status monitor read only	High byte: Warning code / Low Byte: Error code		2100	48449	20400
	bit 1–0	AC motor drive operation status 00B: The drive stops 01B: The drive is decelerating 10B: The drive is in standby status 11B: The drive is operating	2101	48450	20401
	bit 2	1: JOG command			
	bit 4–3	Operation direction 00B: FWD running 01B: From REV running to FWD running 10B: From FWD running to REV running 11B: REV running			
	bit 8	1: Master frequency controlled by the communication interface			
	bit 9	1: Master frequency controlled by the analog / external terminal signal			
	bit 10	1: Operation command controlled by the communication interface			
	bit 11	1: Parameter locked			
	bit 12	1: Enable to copy parameters from keypad			
	bit 15–13	Reserved			
	Frequency command (XXX.XX Hz)		2102	48451	20402
	Output frequency (XXX.XX Hz)		2103	48452	20403
	Display the drive's output current (XX.XX A). When the current is higher than 655.35, it automatically shifts one decimal place as (XXX.X A). Refer to the high byte of 211F for information on the decimal places.		2104	48453	20404
	DC bus voltage (XXX.X V)		2105	48454	20405
	Output voltage (XXX.X V)		2106	48455	20406
	Current step for the multi-step speed operation		2107	48456	20407
	Reserved		2108	48457	20410
	Counter value		2109	48458	20411
	Output power factor angle (XXX.X)		210A	48459	20412
	Output torque (XXX.X %)		210B	48460	20413
	Actual motor speed (XXXXX rpm)		210C	48461	20414

Ethernet/IP and Modbus TCP Monitor and Control

EtherNet/IP and ModTCP are very similar to serial Modbus control. After installing the GS20A-CM-ENETIP option card (see Appendix B for more information on card installation), set the following parameters:

GS20(X) Parameter Settings for Ethernet/IP, Modbus TCP Monitor and Control						
Parameter		***Setting***	***Run[1] Read/ Write***	***Modbus Address***		***Note***
				Hex	***Dec***	
P00.21	1st Source of Operation Command [Remote]	5: Comm Card	R/W	0015	40022	This allows Ethernet commands to start and stop the drive while the drive is in Local or Remote mode
P00.31	2nd Source of Operation Command [Local]		R/W	001F	40032	
P00.20	1st Source of Frequency Command [Remote]	8: Comm Card	♦R/W	0014	40021	This allows Ethernet commands to set the drive speed while the drive is in Local or Remote mode
P00.30	2nd Source of Frequency Command [Local]		♦R/W	001E	40031	
P09.74	Set Comm Master Protocol setting	0: Both Ethernet and Modbus 1: Ethernet/IP 2: Modbus TCP	♦R/W	094A	42379	Select Ethernet or Modbus depending on desired control

Other key parameters that must be modified (or at least must be known) to set up Ethernet communications					
P09.75	Comm Card IP Configuration	0: Static IP 1: Dynamic IP (DHCP)	R/W	0930	42353
P09.76	Comm Card IP Address Octet 1	0~255	R/W	0931	42354
P09.77	Comm Card IP Address Octet 2	0~255	R/W	0932	42355
P09.78	Comm Card IP Address Octet 3	0~255	R/W	0933	42356
P09.79	Comm Card IP Address Octet 4	0~255	R/W	0934	42357
P09.80	Comm Card Mask Octet 1	0~255	R/W	0935	42358
P09.81	Comm Card Mask Octet 2	0~255	R/W	0936	42359
P09.82	Comm Card Mask Octet 3	0~255	R/W	0937	42360
P09.83	Comm Card Mask Octet 4	0~255	R/W	0938	42361
P09.84	Comm Card Gateway Octet 1	0~255	R/W	0939	42362
P09.85	Comm Card Gateway Octet 2	0~255	R/W	093A	42363
P09.86	Comm Card Gateway Octet 3	0~255	R/W	093B	42364
P09.87	Comm Card Gateway Octet 4	0~255	R/W	093C	42365

Refer to Appendix B for detailed information and an example on how to set up these parameters. We recommend using Static IP (P09.75=0) and testing the communications between drive and PC/PLC with either an Ethernet crossover cable or a simple Ethernet hub/switch *Do not try to commission Ethernet communications for the first time on a larger, managed network*.

Set P09.74 = 2: Modbus TCP for Modbus master control.

Once communications have been established, please refer to the serial Modbus section above for all the relevant Command and Status Words.

Appendix B details all the Implicit and Explicit data that can be transferred to and from the GS20(X). Below is a list of the Implicit (I/O messaging) data that will be automatically transferred back and forth between the PLC and drive once the connection is configured.

GS20A-CM-ENETIP EtherNet/IP I/O Messaging (Implicit Messaging)

- *Trigger type: Cyclic*
- *Transport class: 1*
- *Application behavior: Exclusive owner*

Parameter	O→T	T→O
Data size	Fixed	Fixed
Connection type	Multicast, Point to Point	Mulitcast, Point to Point

GS20A-CM-ENETIP EtherNet/IP Communication Parameter

- *Input buffer register: In Assembly Instance = 101, Width = 16 bits, Size = 16*
- *Output buffer register: Out Assembly Instance = 100, Width = 16 bits, Size = 3*
- *Configuration: Instance = 102, Width = 8 bits, Size = 0*

See “GS20A-CM-ENETIP EtherNet/IP Communication Protocol Parameter Address Definitions” on page B–22 for more information.

Program Examples Using AutomationDirect PLCs

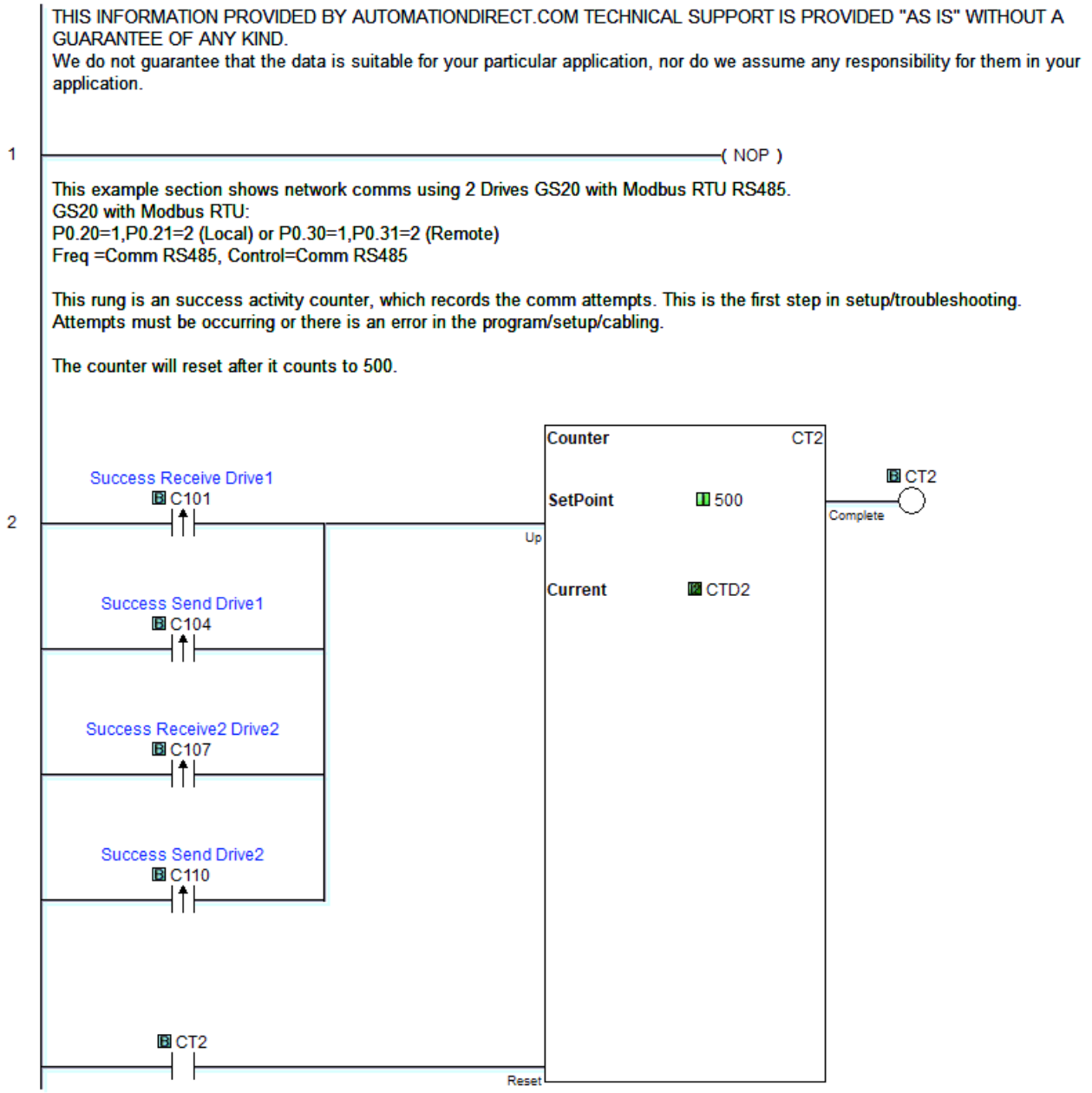
Modbus RTU CLICK Program Example

This example section shows CLICK ladder logic designed to show a method of establishing and monitoring network communications when using two GS20(X) drives with Modbus RTU.

NOTE: The PLC program can be downloaded from the support resources section of the GS20 drive item page on the AutomationDirect website.

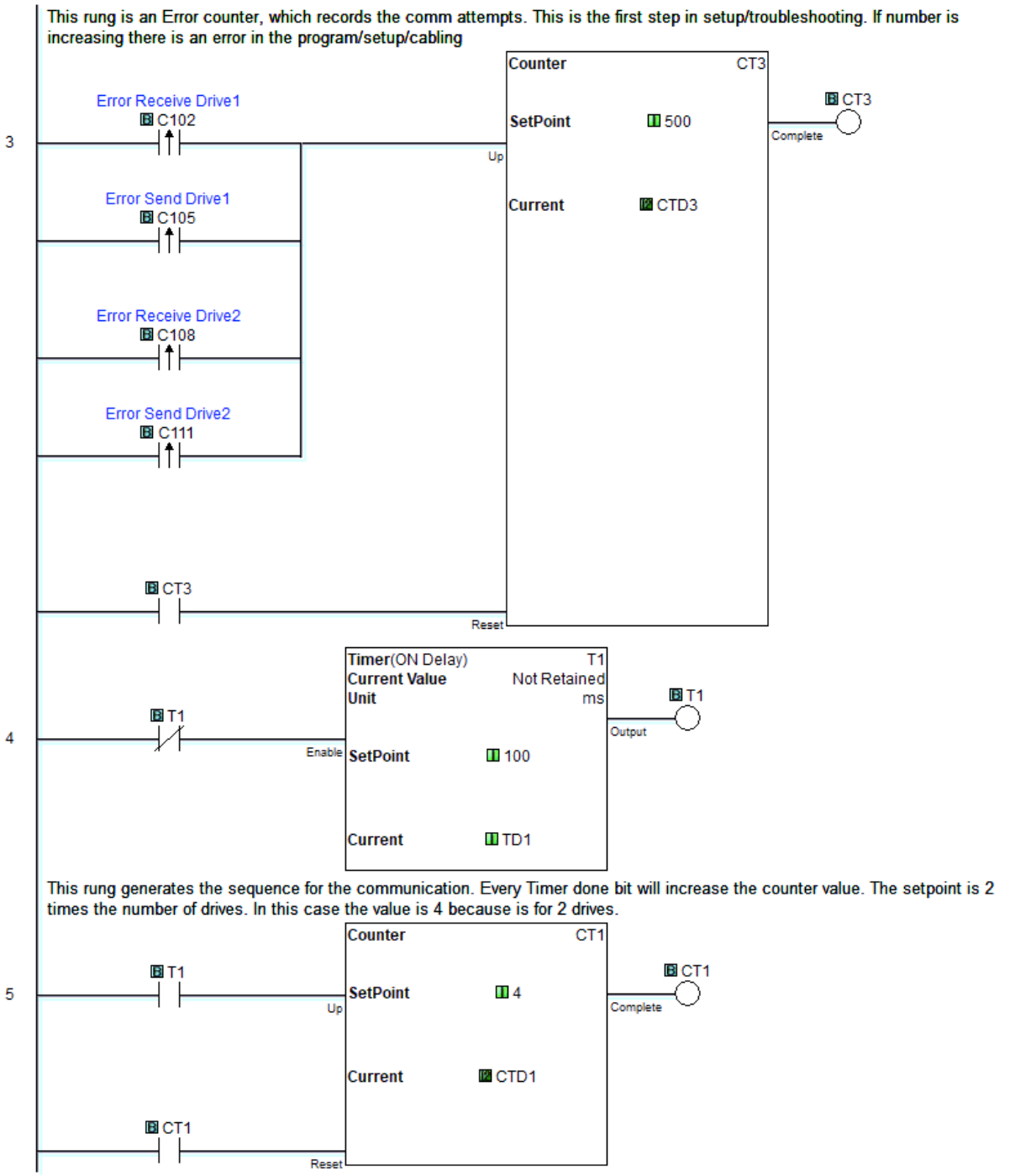
CLICK GS20 MODBUSRTU

Main Program(Page 1 of 7)



CLICK GS20 MODBUSRTU

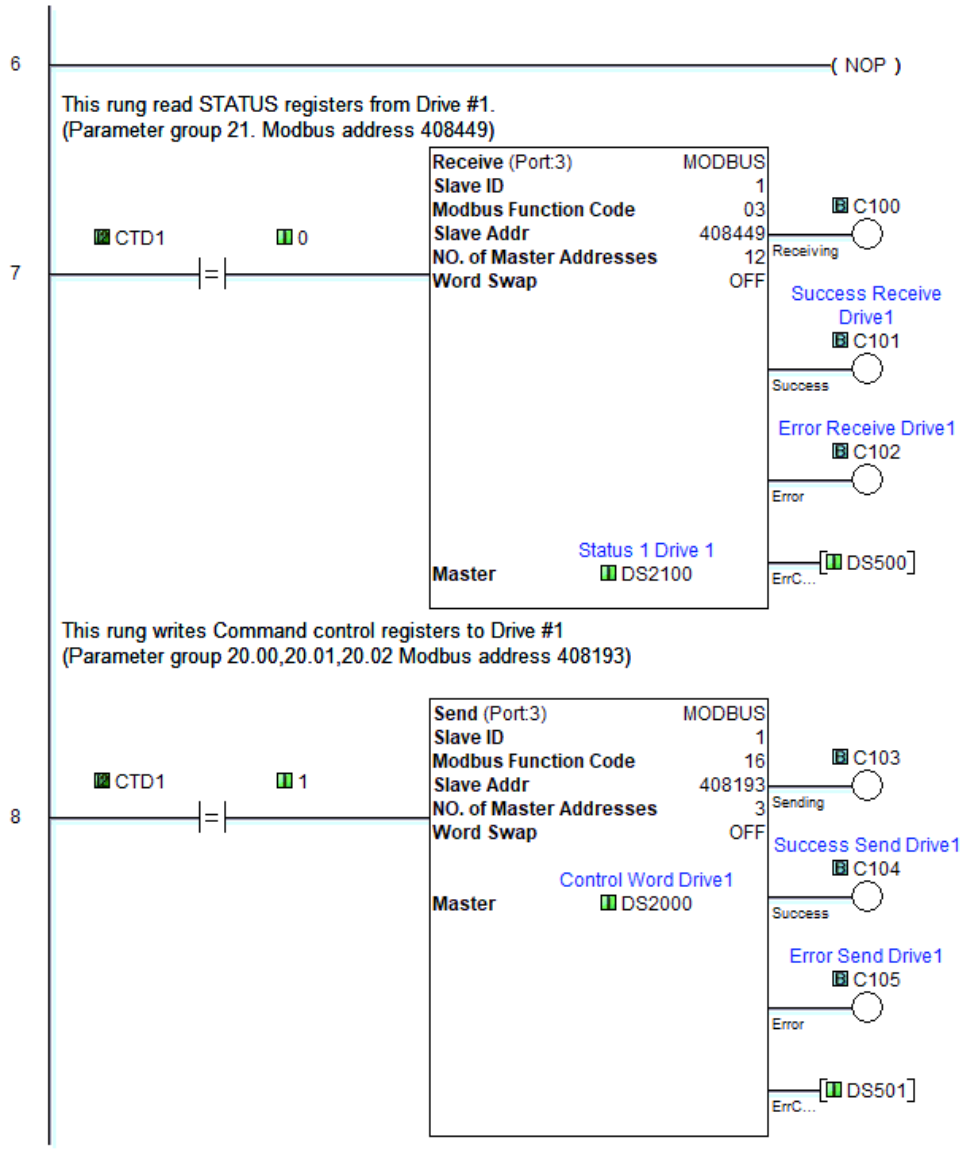
Main Program(Page 2 of 7)



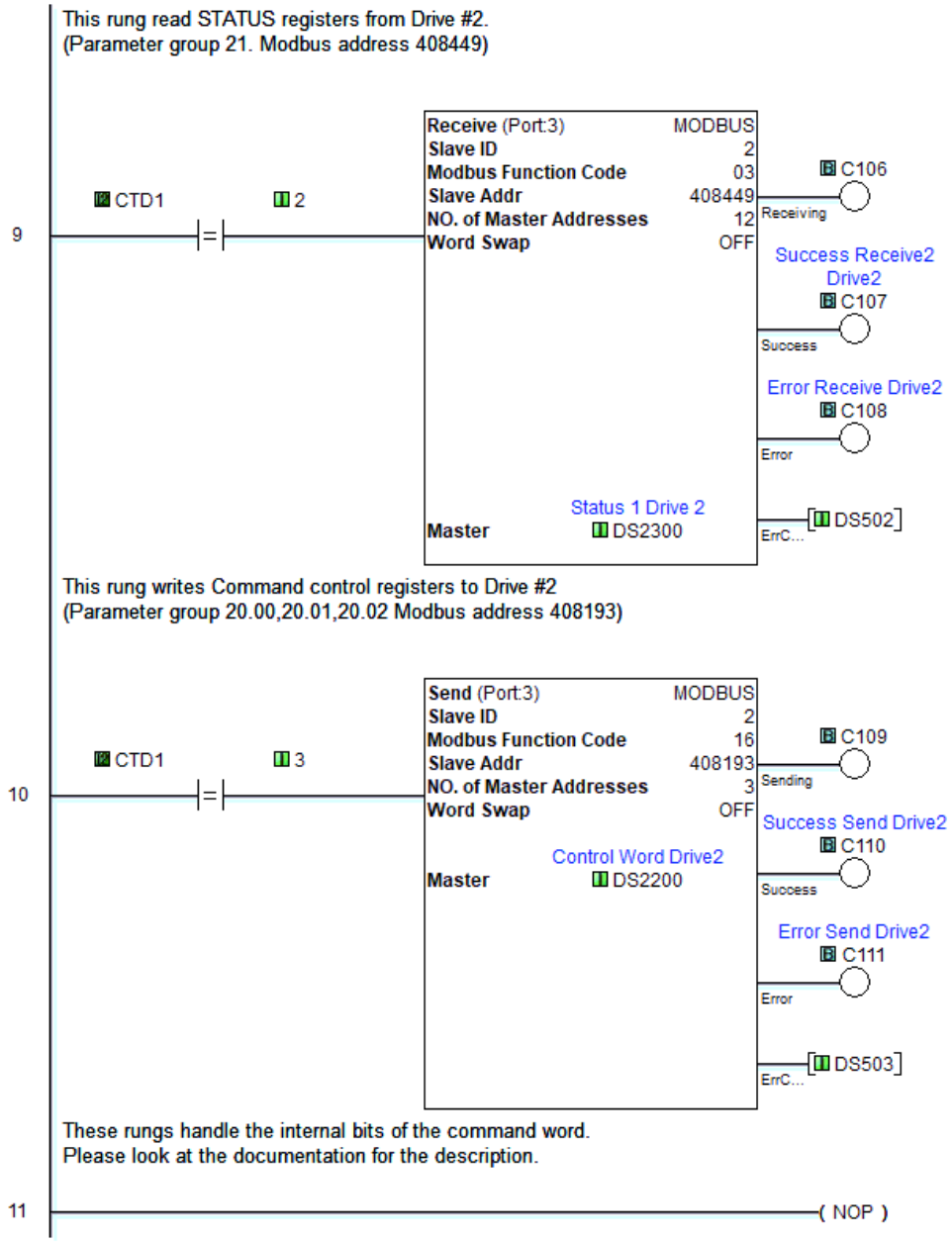
Page 2 of 7 (Total Pages)

CLICK GS20 MODBUSRTU

Main Program(Page 3 of 7)

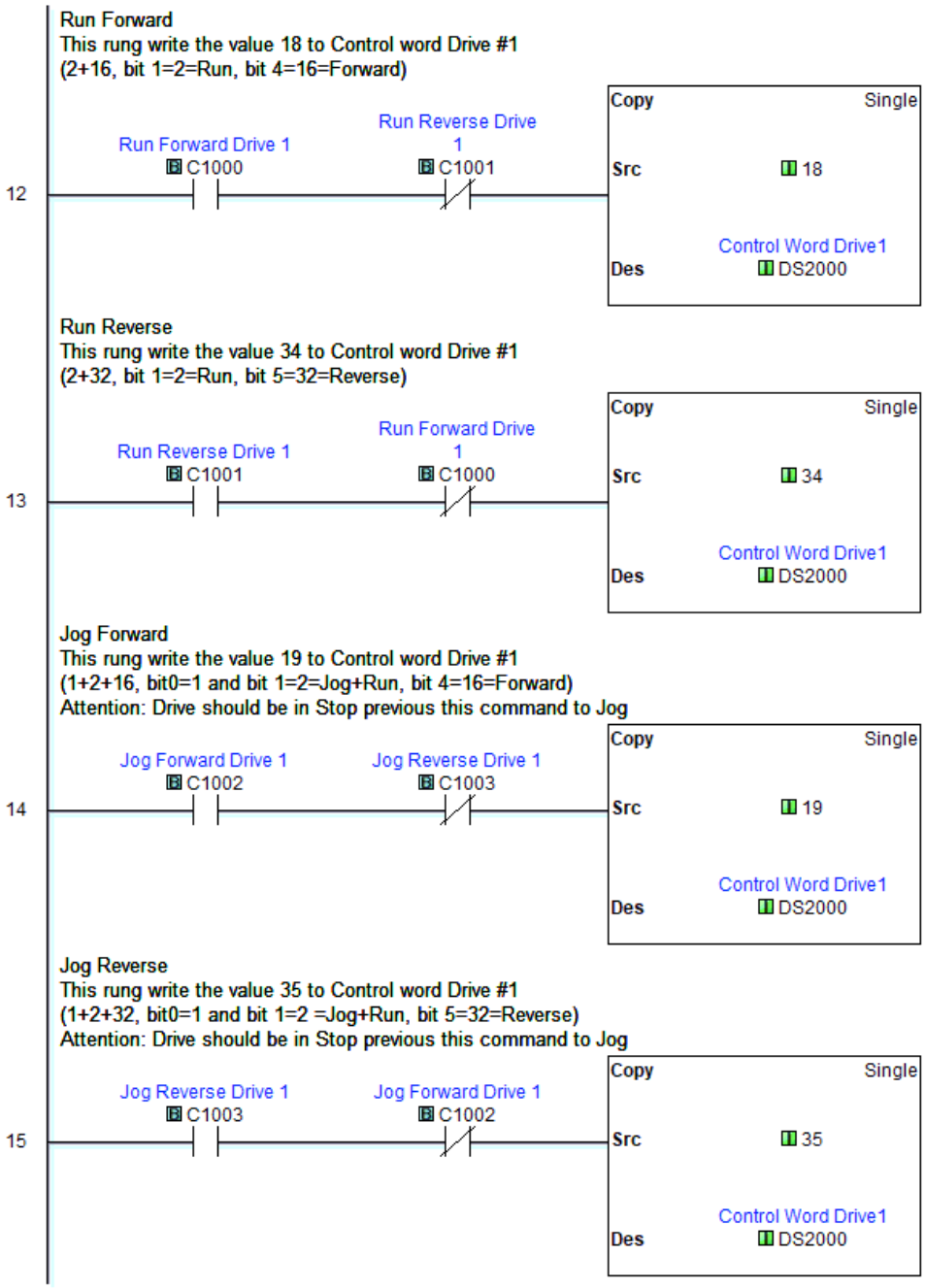


CLICK GS20 MODBUSRTU



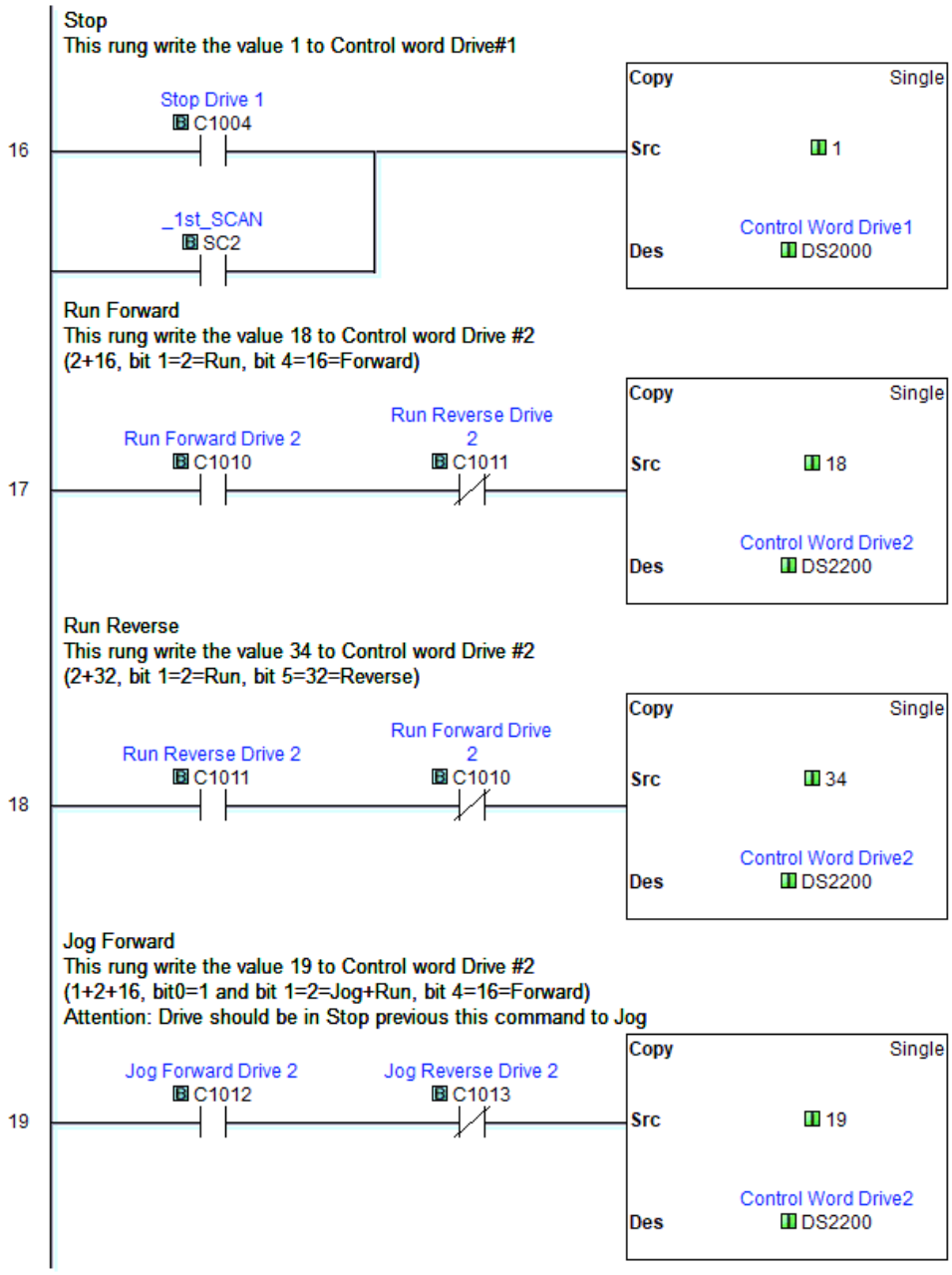
CLICK GS20 MODBUSRTU

Main Program(Page 5 of 7)



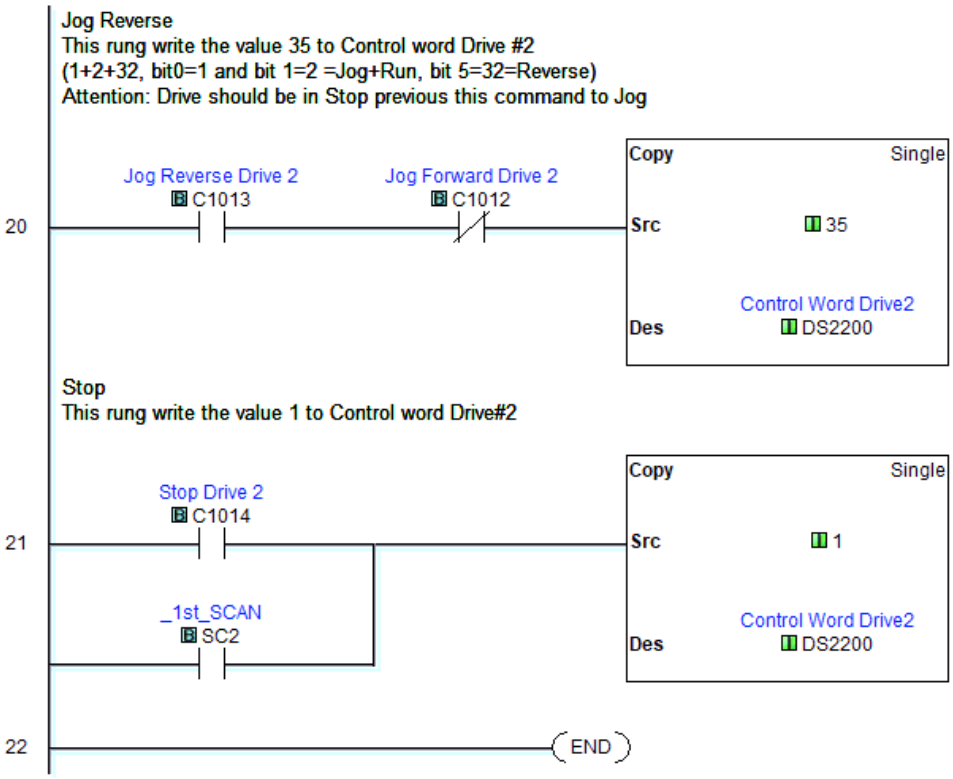
Page 5 of 7 (Total Pages)

CLICK GS20 MODBUSRTU



CLICK GS20 MODBUSRTU

Main Program(Page 7 of 7)



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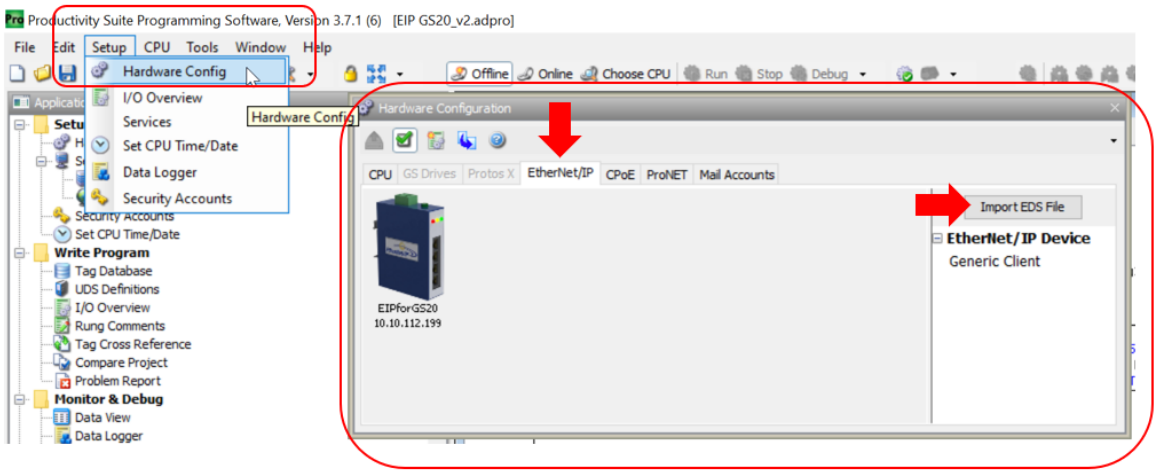
EtherNet/IP Productivity PLC Example

Use the following example to set up a GS20 drive EtherNet/IP configuration.

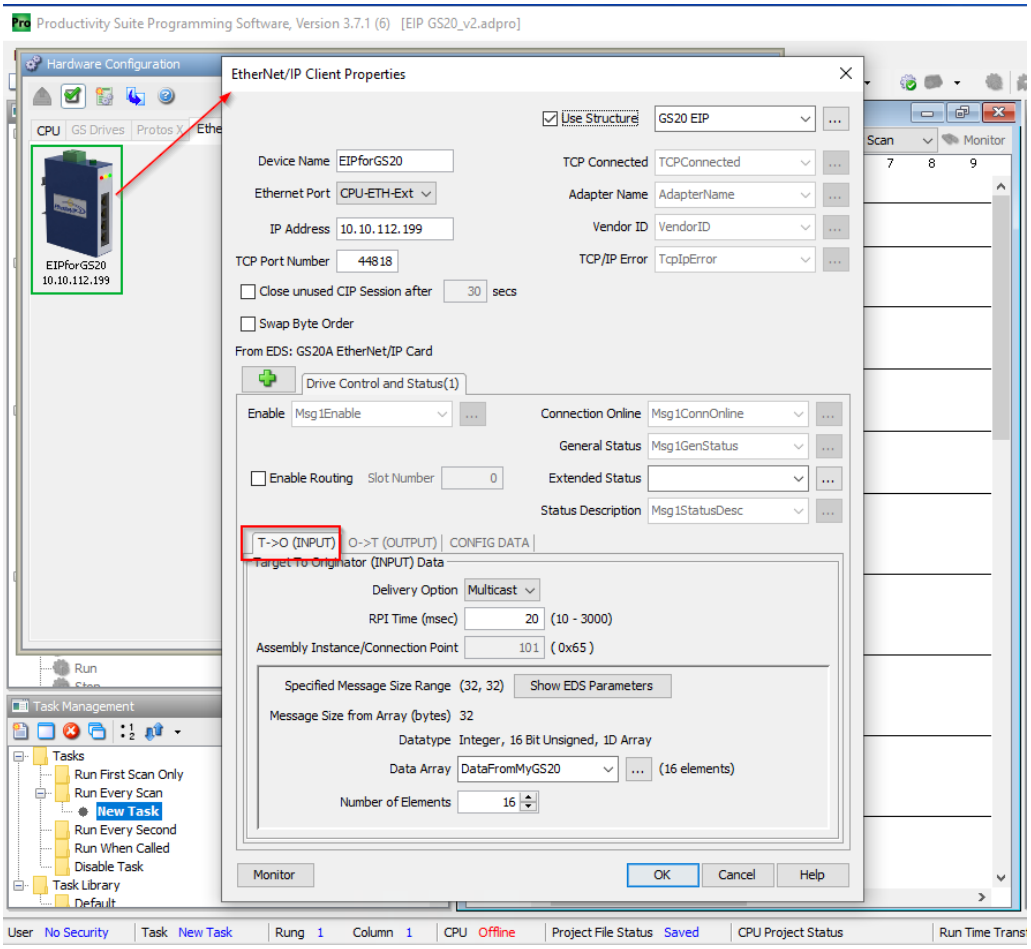
The first steps cover the hardware configuration setup, followed by the ladder logic code. This PLC example uses the GS20 EDS file for easy and quick configuration. The PLC program and EDS file can be downloaded from the GS20 support page.

https://support.automationdirect.com/products/gs20.html

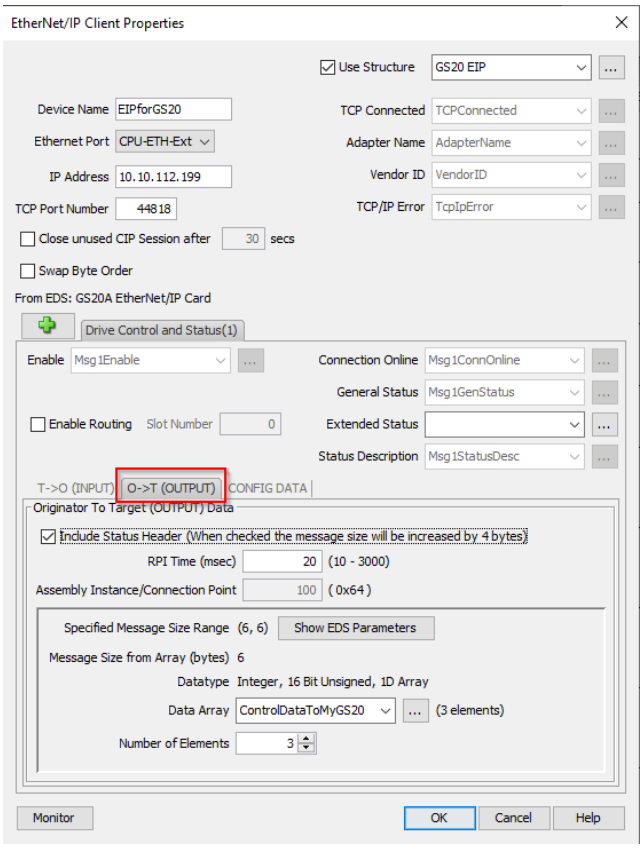
Step 1



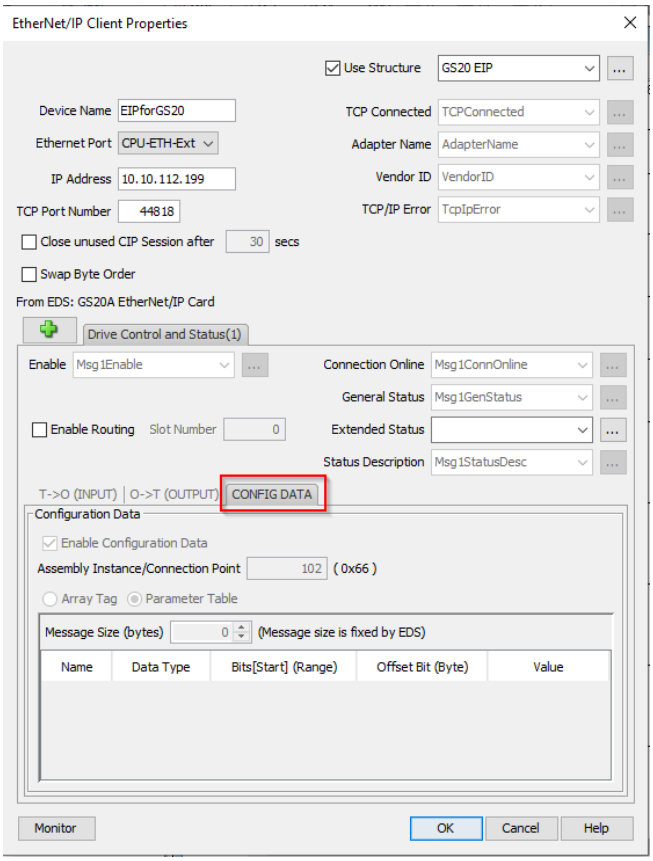
Step 2



Step 3


EtherNet/IP Client Properties
Use Structure
GS20 EIP
Device Name
EIPforGS20
Ethernet Port
CPU-ETH-Ext
IP Address
10.10.112.199
TCP Port Number
44818
Close unused CIP Session after
30
secs
Swap Byte Order
From EDS: GS20A EtherNet/IP Card
Drive Control and Status(1)
Enable
Msg1Enable
Enable Routing
Slot Number
0
TCP Connected
TCPConnected
Adapter Name
AdapterName
Vendor ID
VendorID
TCP/IP Error
TcpIpError
Connection Online
Msg1ConnOnline
General Status
Msg1GenStatus
Extended Status
Status Description
Msg1StatusDesc
T->O (INPUT)
O->T (OUTPUT)
CONFIG DATA
Originator To Target (OUTPUT) Data
Include Status Header (When checked the message size will be increased by 4 bytes)
RPI Time (msec)
20
(10 - 3000)
Assembly Instance/Connection Point
100
(0x64)
Specified Message Size Range (6, 6)
Show EDS Parameters
Message Size from Array (bytes) 6
Datatype Integer, 16 Bit Unsigned, 1D Array
Data Array
ControlDataToMyGS20
(3 elements)
Number of Elements
3
Monitor
OK
Cancel
Help

Step 4


EtherNet/IP Client Properties
Use Structure
GS20 EIP
Device Name
EIPforGS20
Ethernet Port
CPU-ETH-Ext
IP Address
10.10.112.199
TCP Port Number
44818
Close unused CIP Session after
30
secs
Swap Byte Order
From EDS: GS20A EtherNet/IP Card
Drive Control and Status(1)
Enable
Msg1Enable
Enable Routing
Slot Number
0
TCP Connected
TCPConnected
Adapter Name
AdapterName
Vendor ID
VendorID
TCP/IP Error
TcpIpError
Connection Online
Msg1ConnOnline
General Status
Msg1GenStatus
Extended Status
Status Description
Msg1StatusDesc
T->O (INPUT)
O->T (OUTPUT)
CONFIG DATA
Configuration Data
Enable Configuration Data
Assembly Instance/Connection Point
102
(0x66)
Array Tag
Parameter Table
Message Size (bytes)
0
(Message size is fixed by EDS)
Name
Data Type
Bits[Start] (Range)
Offset Bit (Byte)
Value
Monitor
OK
Cancel
Help

Use the following ladder logic code for GS20 ethernet communications.

Task: New Task Project: EIP GS20_v2.adpro Page 1 of 7

1 2 3 4 5 6 7 8 9 10

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do we assume any responsibility for them in your
application.

1 ———————————————————————————

11

1> ————————(NOP)

1 2 3 4 5 6 7 8 9 10

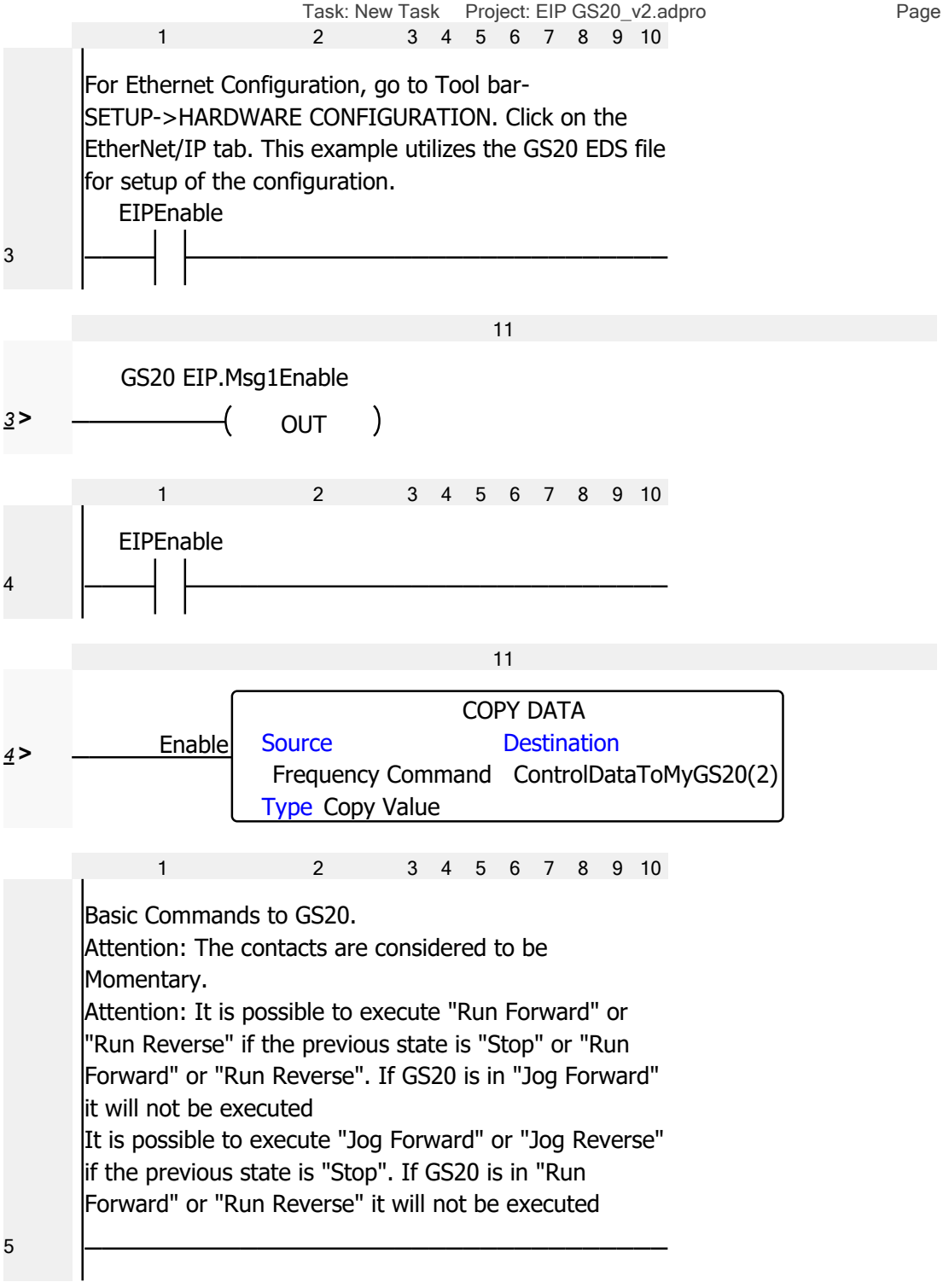
This example section shows comms in GS20 with
EtherNet/IP implicit
The configuration for the GS20 Drive is done in
"Hardware Config" under the tab "Ethernet/IP"
When enabled the PLC and Drive will continuously
exchange data.
When using Ethernet/IP the names of registers
(Input/Output) are related to the PLC.
Data input means input from the PLC (output from
Drive). Data output means output from the PLC (input
from Drive)
Please read the documentation for Ethernet/IP card
GS20: P0.20=8/P0.21=5 or P0.30=8/P0.31=5
P9.74=1 (EIP)

2 ———————————————————————————

11

2> ————————(NOP)

Productivity1000



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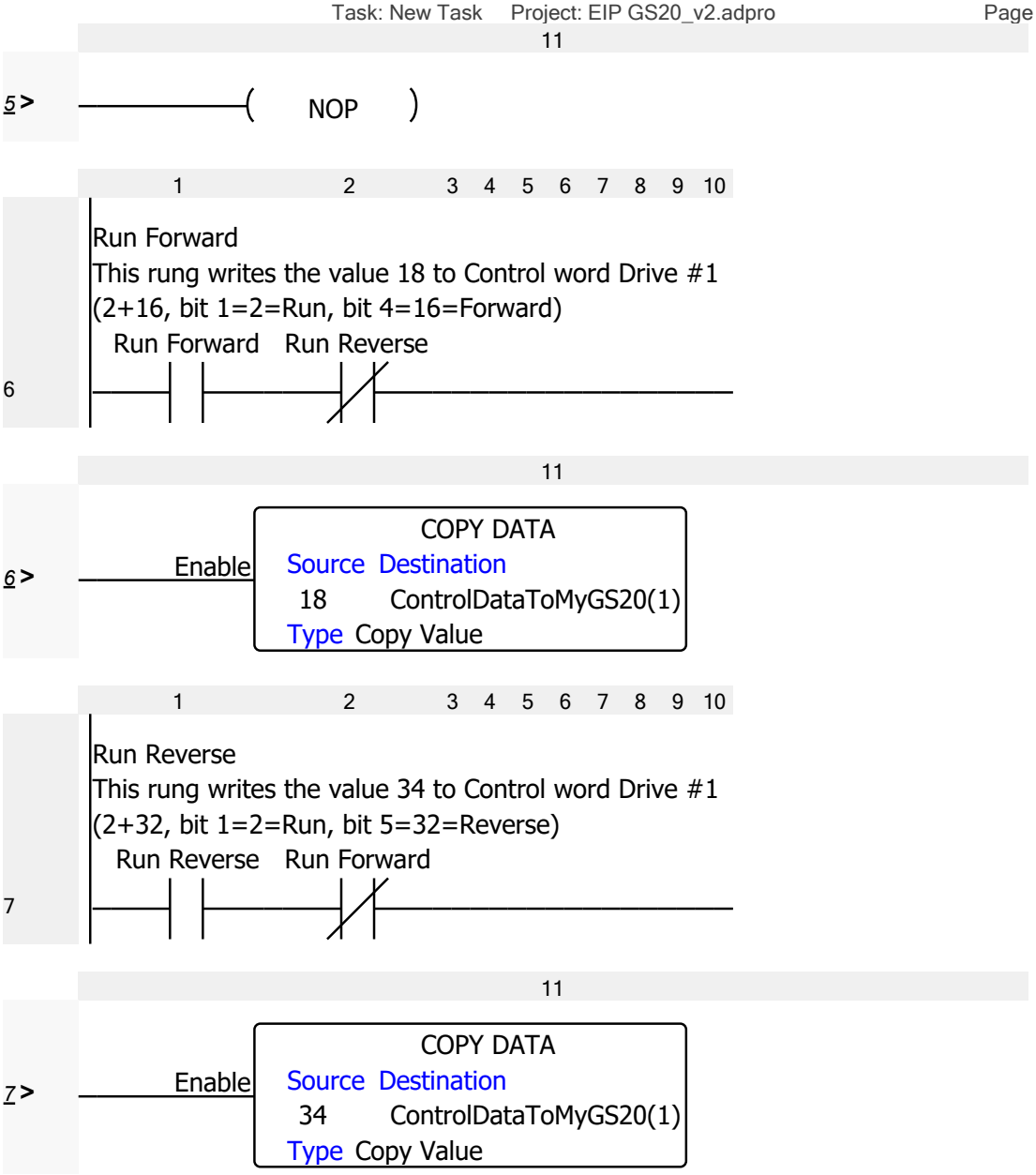
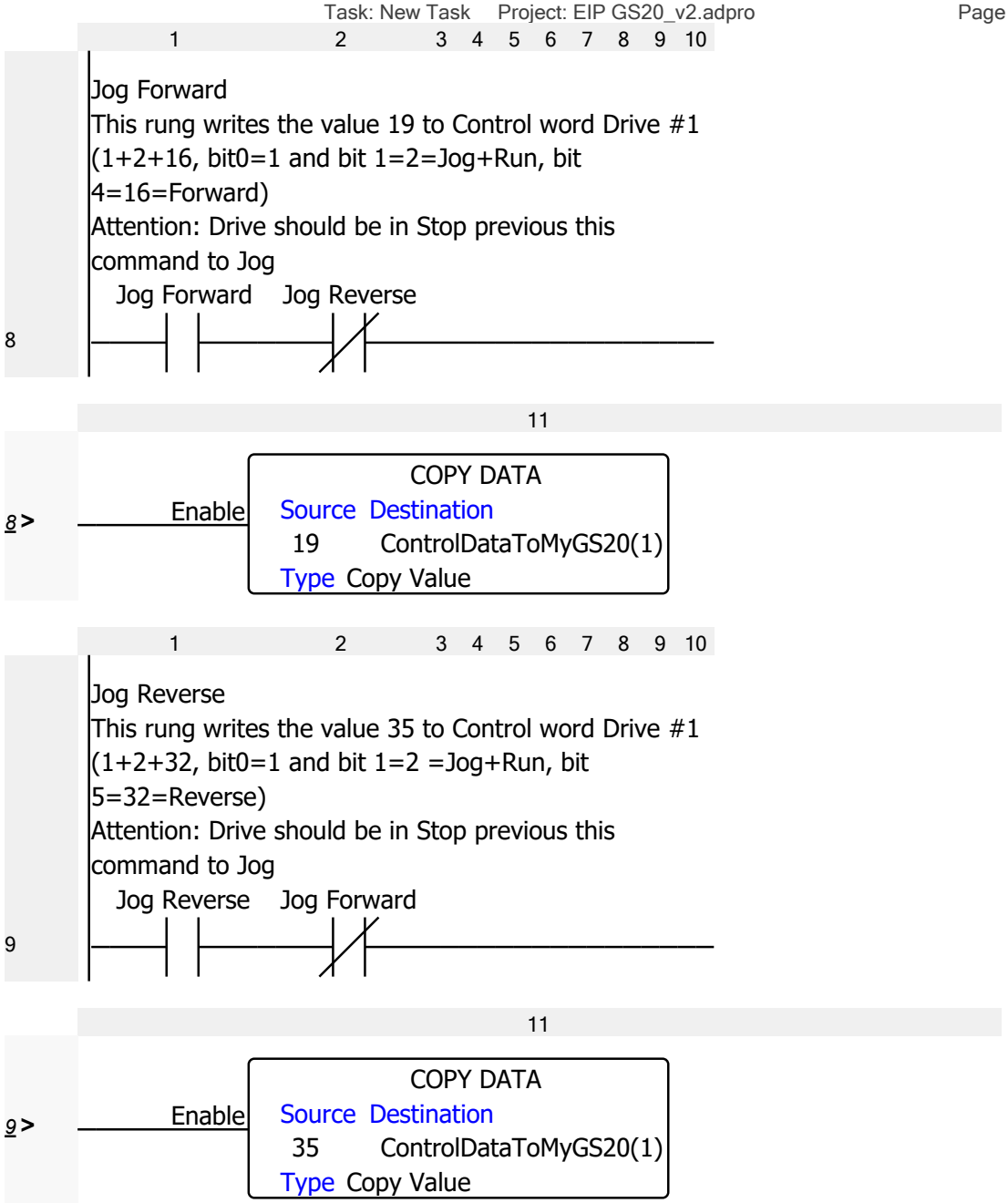

11
5>
NOP
1 2 3 4 5 6 7 8 9 10
Run Forward
This rung writes the value 18 to Control word Drive #1
(2+16, bit 1=2=Run, bit 4=16=Forward)
Run Forward
Run Reverse
6
11
6>
Enable
COPY DATA
Source Destination
18 ControlDataToMyGS20(1)
Type Copy Value
1 2 3 4 5 6 7 8 9 10
Run Reverse
This rung writes the value 34 to Control word Drive #1
(2+32, bit 1=2=Run, bit 5=32=Reverse)
Run Reverse
Run Forward
7
11
7>
Enable
COPY DATA
Source Destination
34 ControlDataToMyGS20(1)
Type Copy Value



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Task: New Task Project: EIP GS20_v2.adpro Page 5 of 7

1 2 3 4 5 6 7 8 9 10

Stop
This rung writes the value 1 to Control word Drive#2

10 Stop

10.1 First Scan Bit

11

10 > Enable

COPY DATA

Source	Destination
1	ControlDataToMyGS20(1)

Type Copy Value

1 2 3 4 5 6 7 8 9 10

This rung unpacks the block to the individual registers

11

11

11 > Enable

COPY DATA

Source	Destination
DataFromMyGS20(1)	GS20 Status 1
DataFromMyGS20(2)	GS20 Status 2
DataFromMyGS20(3)	Frequency command F
DataFromMyGS20(4)	Output Frequency H
DataFromMyGS20(5)	Output Current A
DataFromMyGS20(6)	DC-BUS Voltage U
DataFromMyGS20(7)	Output Voltage E
DataFromMyGS20(8)	Motor RPM
DataFromMyGS20(9)	Scale Frequency Low word
DataFromMyGS20(10)	Scale Frequency High word
DataFromMyGS20(11)	Power Factor angle
DataFromMyGS20(12)	% Load
DataFromMyGS20(13)	PID Setpoint
DataFromMyGS20(14)	PID feedback signal

Type Copy Value

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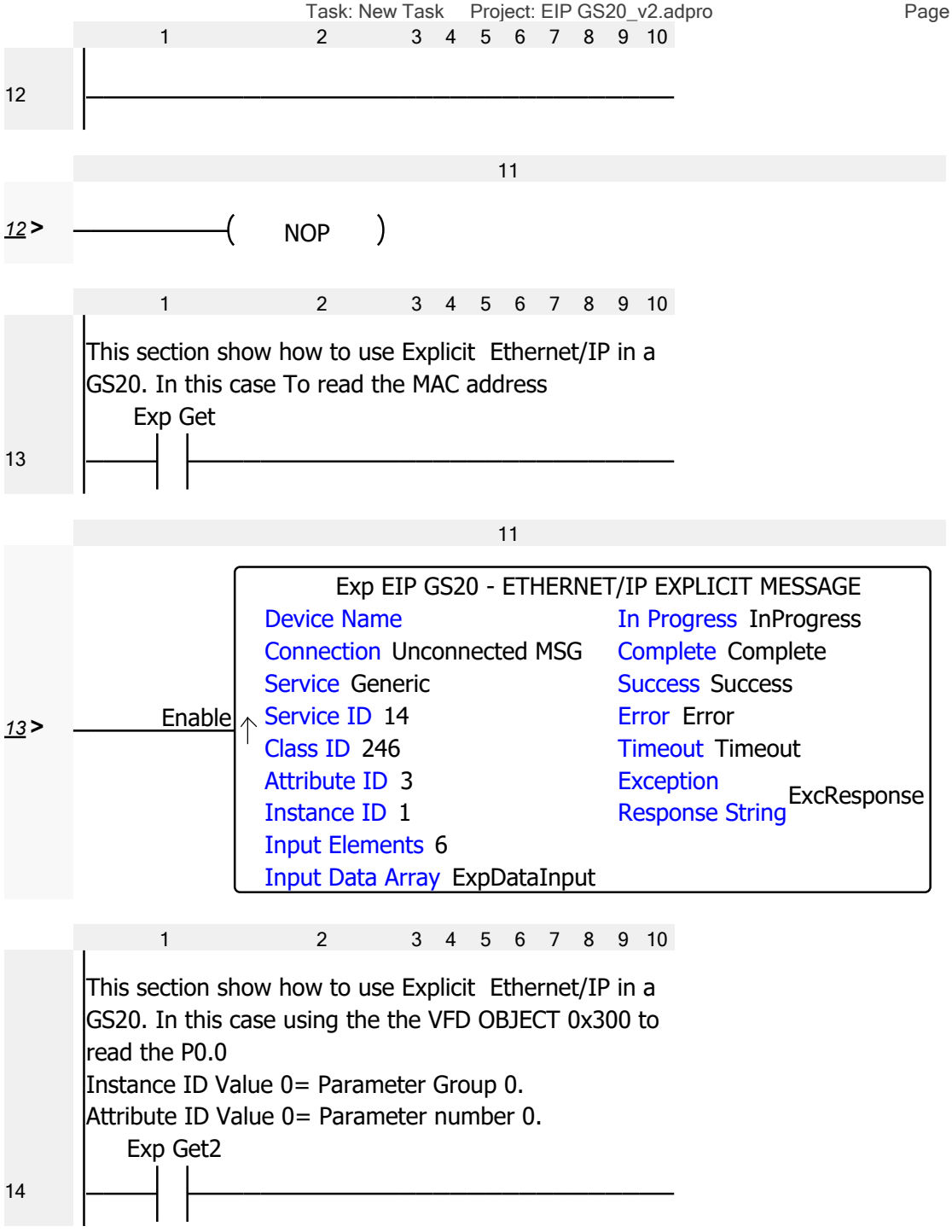
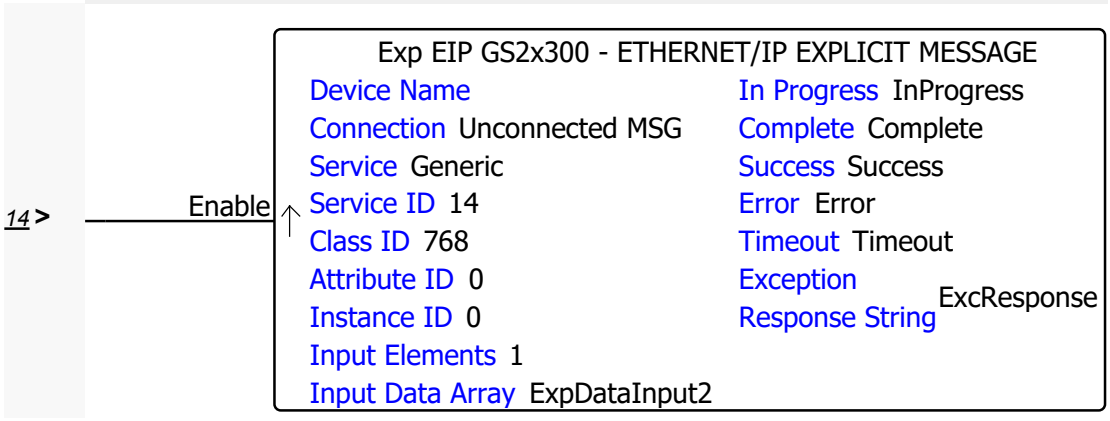

1 2 3 4 5 6 7 8 9 10
12
11
12 > NOP
1 2 3 4 5 6 7 8 9 10
This section show how to use Explicit Ethernet/IP in a GS20. In this case To read the MAC address
Exp Get
13
11
13 > Enable
Exp EIP GS20 - ETHERNET/IP EXPLICIT MESSAGE
Device Name
Connection Unconnected MSG
Service Generic
Service ID 14
Class ID 246
Attribute ID 3
Instance ID 1
Input Elements 6
Input Data Array ExpDataInput
In Progress InProgress
Complete Complete
Success Success
Error Error
Timeout Timeout
Exception
Response String ExcResponse
1 2 3 4 5 6 7 8 9 10
This section show how to use Explicit Ethernet/IP in a GS20. In this case using the the VFD OBJECT 0x300 to read the P0.0
Instance ID Value 0= Parameter Group 0.
Attribute ID Value 0= Parameter number 0.
Exp Get2
14

11



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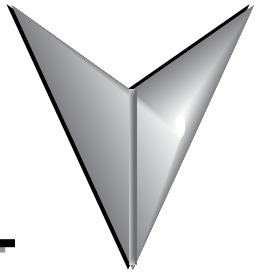
PAGE

Safe Torque Off Function



Appendix

E

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Introduction

Safe Function Failure Rate

Refer to the table below for relevant safe torque off performance and standards.

Item	Definition	Standard	Performance
SFF	Safe Torque Off	IEC61508	STO1-SCM: 88.35% STO2-SCM: 88.2%
HFT (Type A Subsystem)	Hardware Fault Tolerance	IEC61508	1
SIL	Safe Integrity Level	IEC61508	SIL 2
		IEC62061	SILCL 2
PFH	Average Frequency of Dangerous Failure [h-1]	IEC61508	1.36×10^{-9}
PFD_{av}	Probability of Dangerous Failure on Demand	IEC61508	5.99×10^{-6}
PTI	Proof Test Interval	IEC61508	1 year
Category	Category	ISO13849-1	Category 3
PL	Performance Level	ISO13849-1	d
$MTTF_d$	Mean Time to Dangerous Failure	ISO13849-1	High
DC	Diagnostic Coverage	ISO13849-1	Low
For more information on the above performance levels, please refer to the appropriate standard.			

Safe Torque Off Terminal Function Description

The Safe Torque Off (STO) function turns off the power supplied to the motor through the hardware, so that the motor cannot produce torque. This method of removing power from the motor is considered an emergency power off, also known as "coast to stop."

The Safe Torque Off function utilizes two independent hardware circuits to control the motor current drive signal, and thus turns off the inverter power module output in order to achieve the status of safe stop. In normal E-stop situations, both circuits will be opened (using a dual-channel safety relay, etc.). To restart the drive, the Reset input must be turned ON and the Run command must be cycled from low to high. **If only one of the circuits is opened during an E-stop, the drive considers this an STLx fault and power must be cycled to the drive to clear the error**.

If unknown STO faults occur, the on-board +24V might be getting shorted to ground (+24V to SCM).

STO Terminal Function Descriptions		
Terminals	**Function**	**Description**
+24V	When the STO function is not used, you can disable the STO function by shorting STO1 and STO2 with + 24V.	Output voltage range: +24V ± 10% Output voltage capacity: 100 mA
STO1	Signal input for STO function channel 1	**STO1–SCM / STO2–SCM** Rated input voltage: +24 VDC ± 10%; maximum input voltage: +30 VDC ± 10% Rated input current: 6.67 mA ± 10% **STO activation mode** Input voltage level: 0 VDC < STO1–SCM and STO2–SCM < 5 VDC STO response time: ≤ 20 ms (time required for STO1 / STO2 to operate until the drive stops outputting) **STO cut-off mode** Input voltage level: 11 VDC < STO1–SCM and STO2–SCM < 30 VDC
STO2	Signal input for STO function channel 2	
SCM	Reference ground for STO1 and STO2 signal	

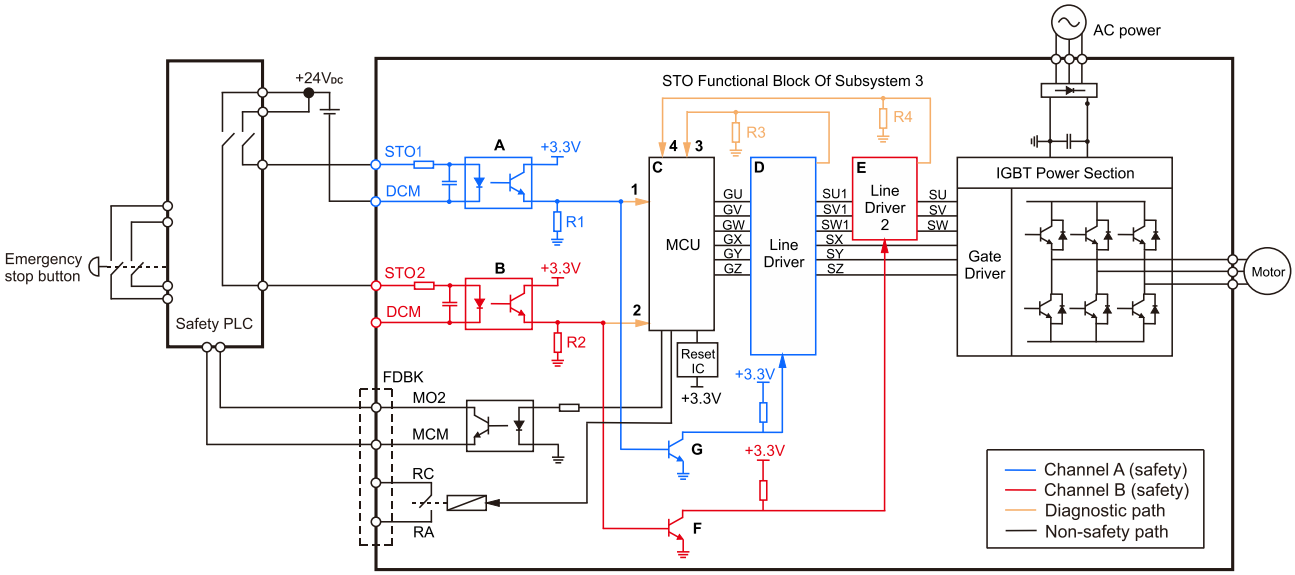
Operation Conditions Description						
Signal	***Channel***	***STO Input Status***				
STO Signal	STO1~SCM	ON	ON	OFF	OFF	x
	STO2~SCM	ON	OFF	ON	OFF	x
Driver Output Status		Ready	STL2 Mode (Torque Output Off)	STL1 Mode (Torque Output Off)	STO Mode (Torque Output Off)	STL3 Mode (Torque Output Off)
Error Displayed on Keypad		No error displayed	STL2	STL1	STO	STL3
Response Time		n/a	≤20ms			
Method of Reset		n/a	Cycle power to drive	Cycle power to drive	Press RESET directly	Cannot reset; Internal Drive failure
Definitions • STO = Channel 1 and 2 operate simultaneously and enter Safe Torque Off • STL1 = Channel 1 operates • STL2 = Channel 2 operates • STL3 = There is an error detected in the internal loop of channel 1 or channel 2 • STO1-SCM/STO2-SCM ON = STO1-SCM/STO2-SCM inputs a power supply > 11VDC • STO1-SCM/STO2-SCM OFF = STO1-SCM/STO2-SCM inputs a power supply < 5VDC						
STO alarm is the expected method of Emergency Stop. Both channels open at the same time.						

Internal STO Circuit Wiring Diagrams

The GS20(X) series provides a Safe Torque Off (STO) function. The GS20(X) uses dual-channel STO1 and STO2 signal inputs to turn off IGBT switching, further preventing the generation of motor torque in order to achieve a safe stop.

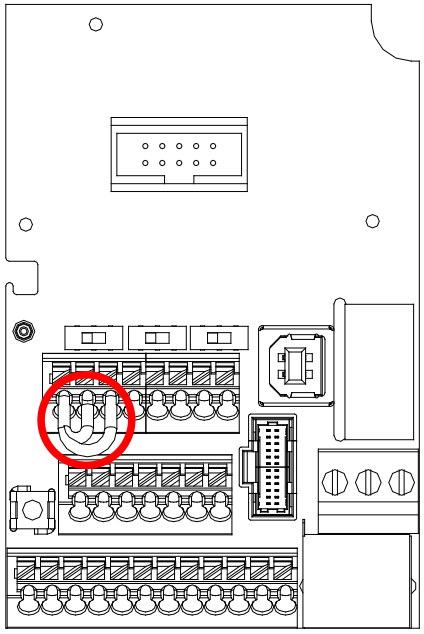
The GS20(X) Safe Torque Off function meets the following international standards:

- *ISO 13849-1: 2015 Category 3 PL d*
- *IEC 61508 SIL2*
- *EN 62061 SIL CL 2*
- *EN 60204-1 Category 0*



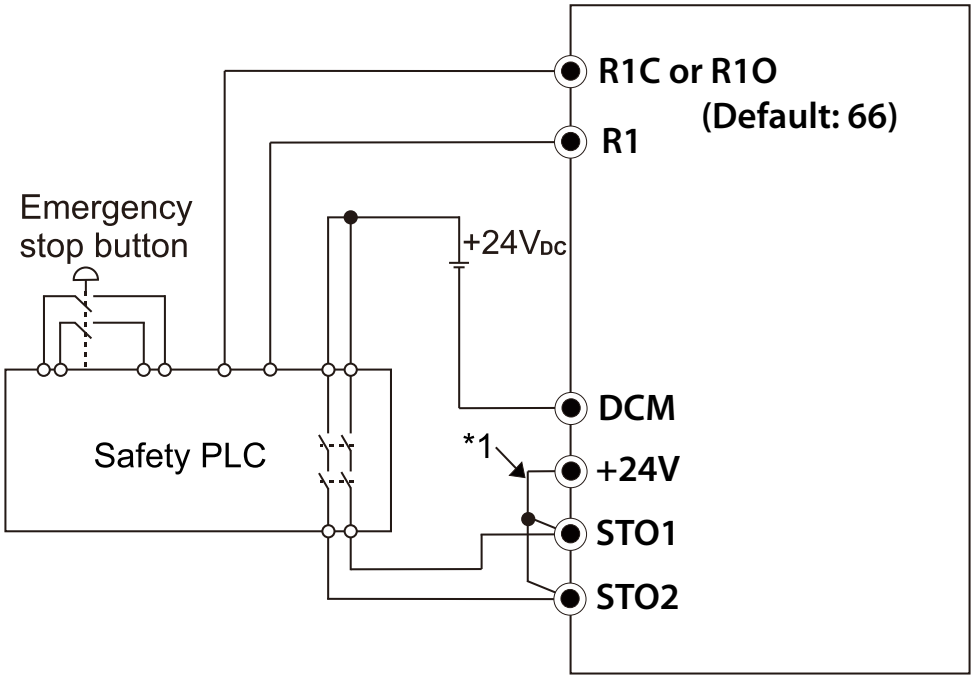
Control Loop Wiring

The illustration below shows the internal circuit diagram of the safe control loop. The terminals of the safe control loop + 24V-STO1-STO2 are short-circuited together with the jumper wire at the factory.



Refer to the safe control loop wiring diagram below:

1) Remove the jumper wire from +24V-STO1-STO2.
2) The wiring is shown below. Normally, you must close the ESTOP contact switch, so the drive can output without displaying an error.
3) In STO mode, the switch ESTOP is turned on. The drive stops outputting and the keypad displays STO.



*NOTE: *1 is factory jumper wire shorting +24V-STO1-STO2. To use the Safety function, remove this jumper wire. To disable the Safety function, short-circuit +24V-STO1-STO2 with a jumper wire.*

STO Parameters

Use P06.44 to specify the reset method when an STO alarm occurs.

		Type	Hex Addr	Dec Addr
P06.44	**STO Latch Selection**	♦R/W	062C	41581
Range/Units (Format: 16-bit binary)		Default		
0: STO Latch 1: STO No Latch		0		

Use P06.44 to select STO latch.

- *P06.44 = 0: STO Alarm Latch. After you clear the cause of the STO Alarm, use a Reset command to clear the STO Alarm.*
- *P06.44 = 1: STO Alarm no Latch. After you clear the cause of the STO Alarm, the STO Alarm clears automatically.*

All of the STL1–STL3 errors are "Alarm Latch" mode (in STL1–STL3 mode, the P06.44 function is not available).

		Type	Hex Addr	Dec Addr
P02.35	**External Operation Control Selection after Reset and Reboot**	♦R/W	0223	40548
Range/Units (Format: 16-bit binary)		Default		
0: Disable 1: Drive runs if the RUN command remains after reset or reboot.		0		

P02.35 allows the drive to resume running after a reset or reboot if an external control is still commanding it to RUN.

Setting value 1:

- *Situation 1: After the drive is powered up and the external terminal for RUN stays ON, the drive runs.*
- *Situation 2: After clearing a detected fault and while the external terminal for RUN stays ON, you can run the drive by pressing the RESET key.*

NOTE: When Safe Torque Off (STO) alarms STL1 or STL2 are activated, a power cycle is required to reset the drive. When P02.35 is set to 1, the drive will start on power-up while performing this reset condition.

		Type	Hex Addr	Dec Addr
P02.13	**Multi-function Output 1 (R1)**	♦R/W	020D	40526
Range/Units (Format: 16-bit binary)		Default		
66: SO output logic A 68: SO output logic B		11		

Use P02.13 to set the STO functions of multi-function terminal R1.

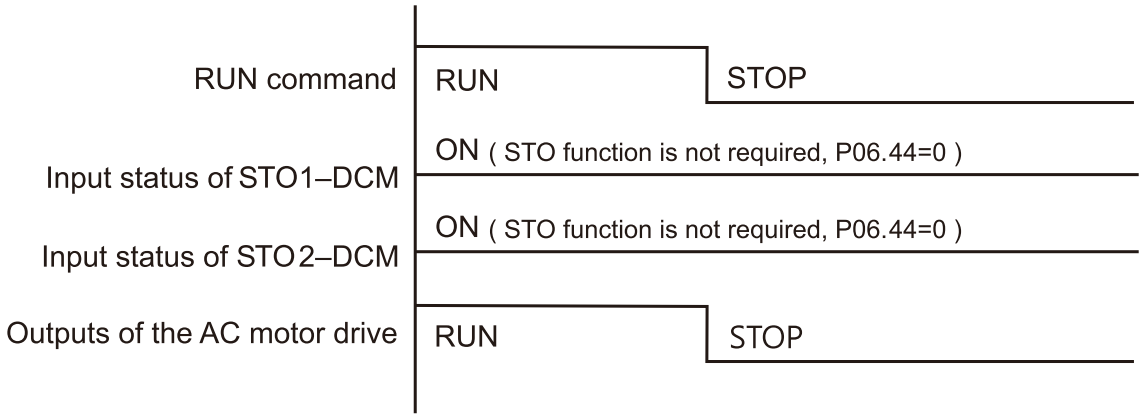
Drive Status	Safety Output
–	NO (P02.13=66)
Normal Run	open
STO	close
STL1~STL3	close

Timing Diagram Description

The following timing diagrams show the status of relevant signals under different conditions.

Normal operation status

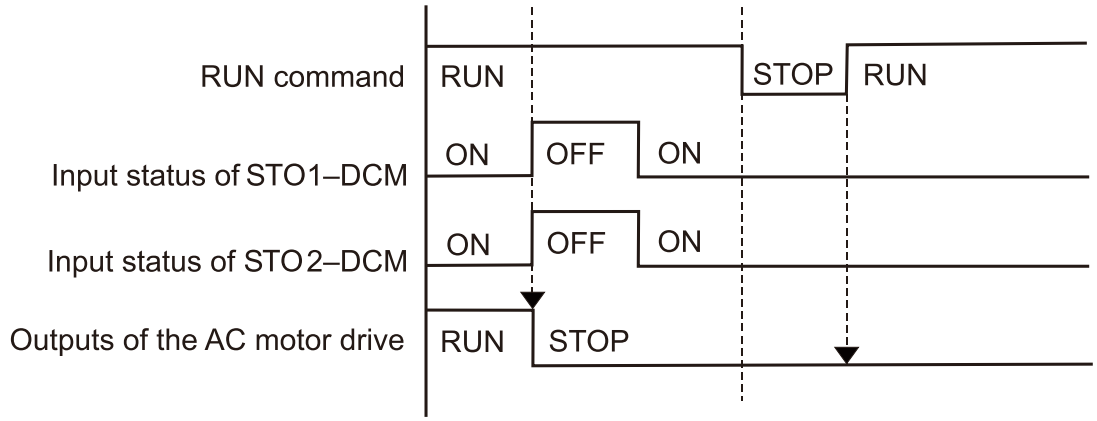
When STO1–SCM and STO2–SCM are ON (STO function is not required), the drive executes Operating or Output Stop according to RUN command.



STO, P06.44=0, P02.35=0

(External operation control selection after reset / reboot, 0=disable)

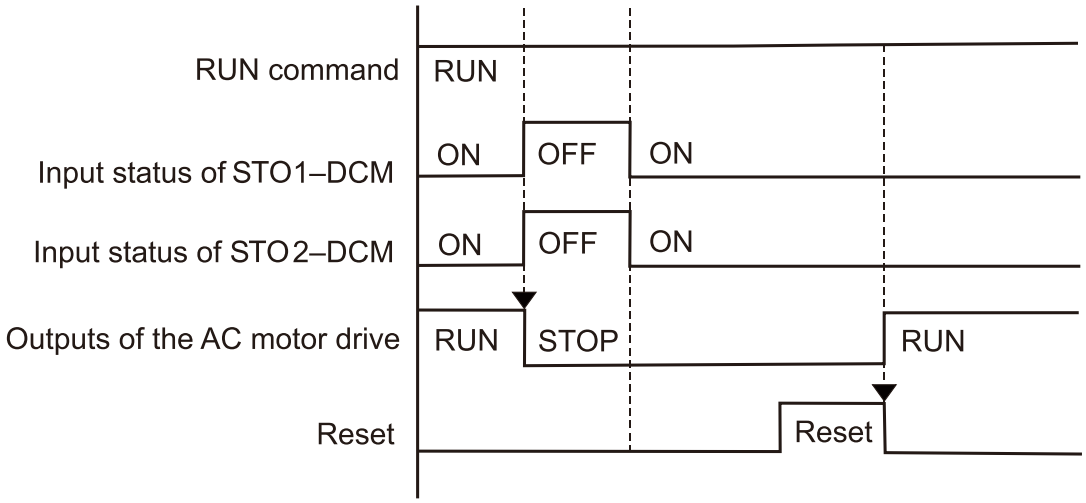
When both STO1–SCM and STO2–SCM are OFF during operation (STO function is required), the drive stops outputting when it enters safe mode regardless of whether the RUN command is in ON or OFF status.



STO, P06.44=0, P02.35=1

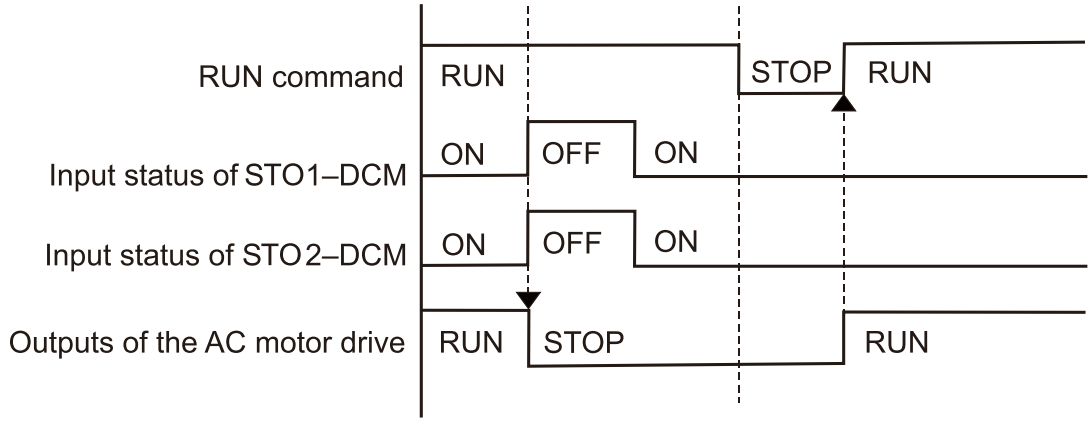
(External operation control selection after reset / reboot, 1= drive runs if the RUN command remains after reset or reboot)

The action is the same as in the previous example; however, because P02.35=1, if the RUN command remains after reset, the drive immediately executes the RUN command again.



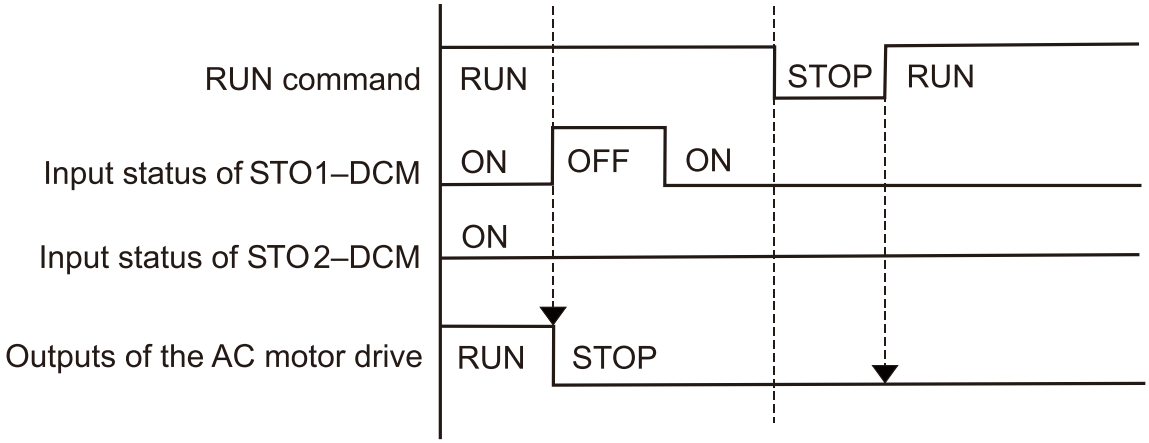
STO, P06.44=1

When both of STO1–SCM and STO2–SCM are OFF during operation (STO function is required), the drive stops outputting. When the STO1 / STO2 status is restored (ON), the STO alarm clears automatically. The drive outputs when the RUN command is executed again.



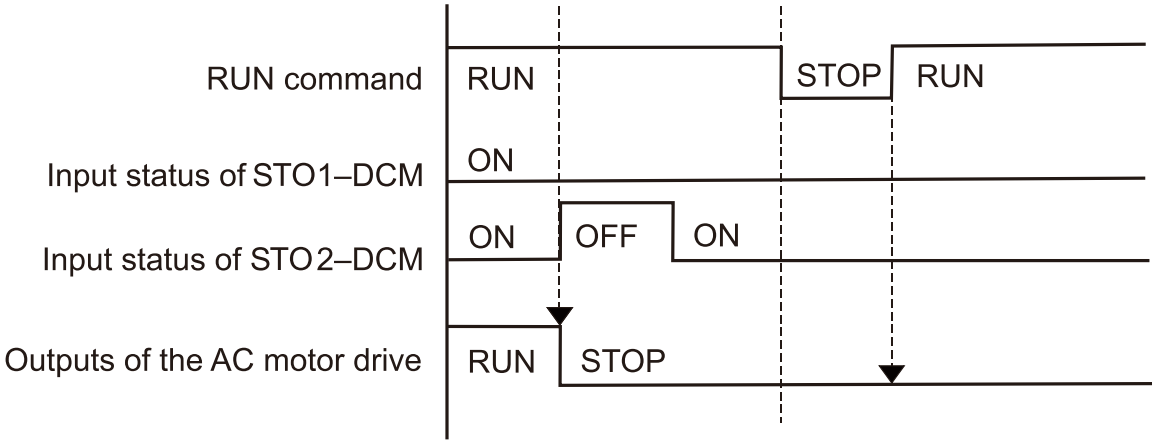
STL1, P06.44=0 or 1

When STO1–SCM is OFF during operation (STO function is required) and STO2–SCM is ON (STO function is not required), the drive stops outputting and the keypad shows the STL1 error. However, you cannot reset the STL1 error even if the STO1 status is restored (ON) regardless of the parameter setting. You must cycle the power to reset and to restore the drive to the normal standby state.



STL2, P06.44=0 or 1

When STO1–SCM is ON during operation (STO function is not required) and STO2–SCM is OFF (STO function is required), the drive stops outputting and the keypad shows the STL2 error. However, you cannot reset the STL2 error even if the STO2 status is restored (ON) regardless of the parameter setting. You must cycle the power to reset and to restore the drive to the normal standby state.



Error Code and Troubleshooting Instructions

Error Code Description

Refer to P06.17–P06.22 for the fault record; the relevant STO error codes are 72/76/77/78. The definition is described below.

		Type	Hex Addr	Dec Addr
P06.17	Fault Record 1	Read	0611	41554
P06.18	Fault Record 2	Read	0612	41555
P06.19	Fault Record 3	Read	0613	41556
P06.20	Fault Record 4	Read	0614	41557
P06.21	Fault Record 5	Read	0615	41558
P06.22	Fault Record 6	Read	0616	41559

Range/Units (Format: 16-bit binary)	Default
72: STO Loss (SrL1) 76: STO (Sro) 77: STO Loss 2 (SrL2) 78: STO Loss 3 (SrL3)	0

Error Code	Name	Description
72 (SrL1)	STO Loss 1	STO1–SCM1 internal loop detection error
76 (SrO)	Safe Torque Off	Safe Torque Off function active
77 (SrL2)	STO Loss 2	STO2–SCM2 internal loop detection error
78 (SrL3)	STO Loss 3	STO1–SCM1 and STO2–SCM2 internal loop detection error

Troubleshooting Instructions

Refer to the following instructions for troubleshooting when STO / STL1 / STL2 / STL3 appear on the keypad (refer to Fault Codes in Chapter 6 for details).

STO Fault Codes

ID Number	Keypad Display	Description
72	SrL 1	STO1–SCM1 internal loop detection error.

Cause	Corrective Action
STO1 and SCM1 short circuit lines are not connected.	Re-connect the short circuit line.
Hardware failure	After you make sure all the wiring is correct, if STL1 fault still exists after cycling the power, contact AutomationDirect technical support..
Poor connection of the IO card	1) Check if the PIN of the IO card is broken. 2) Check if the IO card connects to the control board correctly, and if the screws are tightened well.
The IO card does not match the version of the control board	Contact AutomationDirect technical support.

<table>
<tr><th colspan="3">STO Fault Codes (continued)</th></tr>
<tr><th>ID Number</th><th>Keypad Display</th><th>Description</th></tr>
<tr><td>76</td><td>Sro</td><td>Safe Torque Off function active.
<table>
<tr><th>Cause</th><th>Corrective Action</th></tr>
<tr><td>The switch action of STO1/SCM1 and STO2/SCM2 (OPEN)</td><td>Reset the switch (ON) and cycle the power.</td></tr>
<tr><td>Poor connection of the IO card</td><td>1) Check if the PIN of the IO card is broken.
2) Check if the IO card connects to the control board correctly, and if the screws are tightened well.</td></tr>
<tr><td>The IO card does not match the version of the control board</td><td>Contact AutomationDirect technical support.</td></tr>
</table></td></tr>
<tr><td>77</td><td>SrL2</td><td>STO2–SCM2 internal loop detection error.
<table>
<tr><th>Cause</th><th>Corrective Action</th></tr>
<tr><td>STO2 and SCM2 short circuit lines are not connected</td><td>Re-connect the short circuit line.</td></tr>
<tr><td>Hardware failure</td><td>After you make sure all the wiring is correct, if STL2 fault still exists after cycling the power, contact AutomationDirect technical support.</td></tr>
<tr><td>Poor connection of the IO card</td><td>1) Check if the PIN of the IO card is broken.
2) Check if the IO card connects to the control board correctly, and if the screws are tightened well.</td></tr>
<tr><td>The IO card does not match the version of the control board</td><td>Contact AutomationDirect technical support.</td></tr>
</table></td></tr>
<tr><td>78</td><td>SrL3</td><td>STO1–SCM1 and STO2–SCM2 internal loop detection error.
<table>
<tr><th>Cause</th><th>Corrective Action</th></tr>
<tr><td>STO1 and SCM1, or STO2 and SCM2 short circuit lines are not connected</td><td>Re-connect the short circuit line.</td></tr>
<tr><td>Hardware failure</td><td>After you make sure all the wiring is correct, if STL3 fault still exists after cycling the power, contact AutomationDirect technical support.</td></tr>
<tr><td>Poor connection of the IO card</td><td>1) Check if the PIN of the IO card is broken.
2) Check if the IO card connects to the control board correctly, and if the screws are tightened well.</td></tr>
<tr><td>The IO card does not match the version of the control board</td><td>Contact AutomationDirect technical support.</td></tr>
</table></td></tr>
</table>

Test and Fault Confirmation

After wiring the STO circuit in accordance with the wiring diagram, follow the steps below to verify that the STO and related detection functions work normally.

1) When the drive is powered on, make sure that the STO1–SCM and STO2–SCM voltage falls between 11–30 VDC. At this time, the drive should enter Standby mode and wait for RUN command. There is no error displayed on the keypad.
2) Press RUN on the keypad and use the emergency button or other method to make the STO1–SCM and STO2–SCM voltage fall between 0–5 VDC. At the same time, after the output frequency is reached, the drive should enter Torque Stop mode STO and stop outputting voltage. The keypad displays the STO error, and the response time of the STO1 and STO2 signals to cause the drive to stop outputting voltage should be ≤ 20 ms. Then restore the STO1–SCM and STO2–SCM voltage to 11–30 VDC, and press RESET button on the keypad to clear the STO error. The drive should enter Standby mode and wait for RUN command.
3) Press RUN on the keypad and use the emergency button or other method to make the STO1–SCM voltage fall between 0–5 VDC, and the STO2–SCM voltage remain between 11–30 VDC after the output frequency is reached. At this time, the drive should enter Torque Stop mode STL1 and stop outputting voltage. The keypad displays the STL1 error, and the response time of STO1 signals to cause the drive to stop outputting voltage should be ≤ 20 ms. Then restore the STO1–SCM voltage to 11–30 VDC. However, pressing RESET button on the keypad cannot clear the STL1 error. You must cycle the power to the drive. Make sure that the STO1–SCM and STO2–SCM voltage falls between 11–30 VDC and then cycle the power to the drive, then the STL1 error is cleared. The drive should enter Standby mode and wait for RUN command.
4) Press RUN on the keypad and use the emergency button or other method to make the STO2–SCM voltage fall between 0–5 VDC, and the STO1–SCM voltage remain between 11–30 VDC after the output frequency is reached. At this time, the drive should enter Torque Stop mode STL2 and stop outputting voltage. The keypad displays the STL2 error, and the response time of the STO2 signals to cause the drive to stop outputting voltage should be ≤ 20 ms. Then restore the STO2–SCM voltage to 11–30 VDC. However, pressing RESET button on the keypad cannot clear the STL2 error. You must cycle the power to the drive. Make sure that the STO1–SCM and STO2–SCM voltage falls between 11–30 VDC and then cycle the power to the drive, then the STL2 error is cleared. The drive should enter Standby mode and wait for RUN command.
5) If you can conduct these four steps normally in sequence with no other error, then the Safe Torque Off function loop is normal. However, if you get a different result or if STL3 occurs, then the Safe Torque Off function loop does not work normally. Refer to the Error Code and Troubleshooting section for details.

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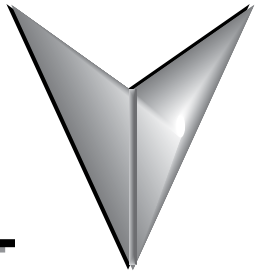
PID Control



APPENDIX

F

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Function of PID Control

GS20(X) series AC drives can be used to control an automated process by the Proportional-Integral-Derivative (PID) control method.

NOTE: A PID Configuration Spreadsheet tool is available for download from the drive item page support resources section.

What Does PID Control Accomplish?

The primary benefit of PID control is that it acheives and maintains the desired steady-state condition of a process better and more smoothly than does ON-OFF control.

The GS20(X) drive PID algorithm constantly assesses the amount and rate of change of the quantity being controlled (Process Variable) and its deviation (Process Error) from the desired steady-state value (Setpoint). The GS20(X) drive then variably adjusts its frequency output as much or as little as needed to keep the Process Variable as close as possible to the Setpoint.

Simple ON-OFF control systems, on the other hand, continually bounce back and forth above and below the Setpoint value, but cannot maintain the Process Variable at the Setpoint value.

PID Control Analogy

PID controllers are all around us. Many times we don't realize that we are the PID controller in a control loop. For example, the driver of a car is the PID controller for the car's speed.

PID Control System Variables:

- *Desired Speed ≈ Setpoint*
- *Actual Speed ≈ Process Variable*
- *Gas Pedal ≈ Control Variable*
- *Speedometer ≈ Feedback*

Proportional Control: The farther away you are from your Desired Speed, the more you press the gas pedal. If you did this starting from a stand-still, you would floor it and probably shoot far past the Desired Speed. Once the speed "settled in," you would never hold exactly at your Desired Speed because the difference between Desired and Actual Speed would get very small and you only have so much control over the pedal and your foot; not enough to hold the perfect speed consistently. So, Proportional Control adjusts the output based on the *difference* between the Setpoint and Process Variable much more accurately in a fine-tuned way.

Integral Control: If your Desired Speed is 70mph and your car consistently goes 69mph, you will realize that you need to press the gas pedal a little more (to overcome wind resistance, a hill, etc.). The longer you are under the Desired Speed, the more gas you give the car. That is fundamentally what Integral Control does; adjust the output based on *how long* the system is away from the setpoint.

Derivative Control: In the situation above, assume that you start going up a hill. The car's Actual Speed gets farther away from the Desired Speed, so the Proportional Control makes you press the gas pedal more. The longer the speed stays below setpoint, Integral Control makes you press the gas even more. Now assume that your car tops the hill and starts going downhill. Your speed suddenly gets faster (the error between Desired Speed and Actual Speed), so Proportional causes you to slightly let off the gas. But Integral still keeps adding to the pedal (since you still haven't reached Desired Speed). Your internal Derivative Control sees that you are rapidly approaching the Desired Speed, so you begin to let off the gas quickly. That is Derivative Control; it adds or subtracts to the Control Variable based on *how quickly* the system is approaching (or leaving) the setpoint.

Common Applications for PID Control

1) *Flow control: A flow sensor is used to feed back the flow rate in a pipe, and the GS20(X) drive PID adjusts its output frequency to the pump that forces the liquid or gas throught that pipe.*
2) *Level control: A level sensor is used to feed back the liquid level in a resevoir or tank, and the GS20(X) drive PID adjusts its output frequency to the pump that fills or empties that tank.*
3) *Pressure control: A pressure sensor is used to feed back the pressure in a tank, and the GS20(X) drive PID adjusts its output frequency to the pump that pressurizes or vacuums that tank.*
4) *Speed control: A speed sensor is used to feed back the shaft speed of a motor or machine driven by that motor, and the GS20(X) drive PID adjusts its output frequency to that motor.*
5) *Temperature control: A thermocouple or thermistor is used to feed back the temperature of an area or device, and the GS20(X) drive PID adjusts its output frequency to the fan that affects that temperature.*

Definition of PID Loop "Directions"

Please note that the following nomenclature describes how the GS20(X) PID system operates, which may differ from the operation of some other PID systems.

Forward-Acting PID Loop (Heating Loop) (Negative-Feedback Loop)

The terms "Forward-Acting," "Direct-Acting," "Heating," and "Negative-Feedback" are used to describe a PID loop that can be used to control processes such as pressure, heating, and flow (among others).

- *Greater Output Frequency (Hz) drives the Process Variable (PV) upward toward the Setpoint (SP)*
- *GS20(X) drive frequency output increases if the Process Error is negative (SP>PV)*

Reverse-Acting PID Loop (Cooling Loop) (Positive-Feedback Loop)

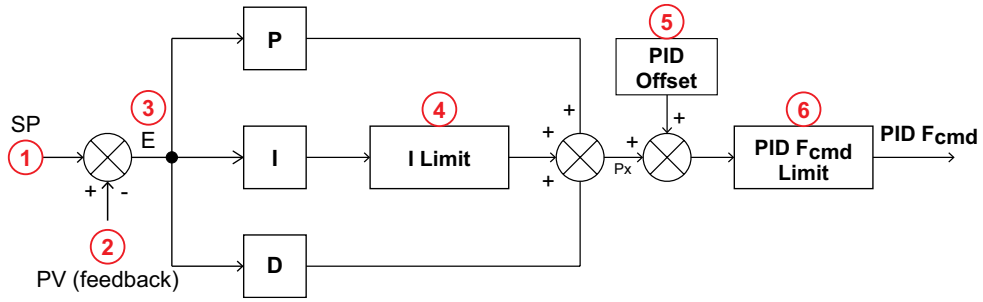
The terms "Reverse-Acting," "Cooling," and "Positive-Feedback" are used to describe a PID loop that can be used to control applications such as cooling.

- *Greater Output Frequency (Hz) drives the Process Variable (PV) downward toward the Setpoint (SP)*
- *GS20(X) drive frequency output increases if the Process Error is positive (SP<PV)*

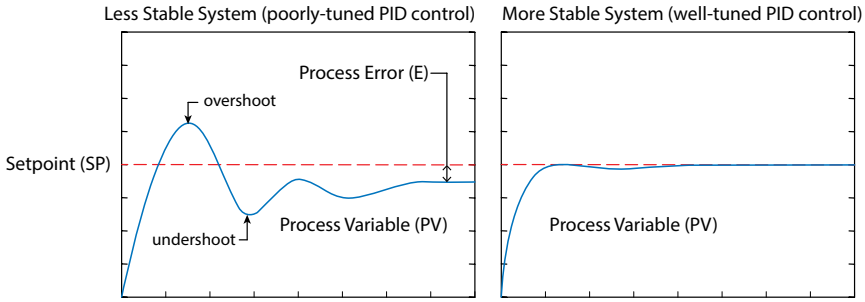
PID Control Overview

PID control is a closed output and feedback loop for the purpose of automatically controlling a portion of a process to a specific condition by utilizing a target setpoint and the process's actual condition as feedback to the controller. You determine the setpoint and let the system reach that setpoint using the process's conditional feedback and the PID control system.

- *P = Proportional control (also known as "Gain")*
- *I = Integral control (also known as "Reset")*
- *D = Derivative control (also known as "Rate")*
- *Process Variable (PV) = the quantity being measured and controlled*
- *Setpoint (SP) (also known as Target Value) = the desired value of the Process Variable*
- *Error (E) = the difference between the Setpoint and the Process Variable*



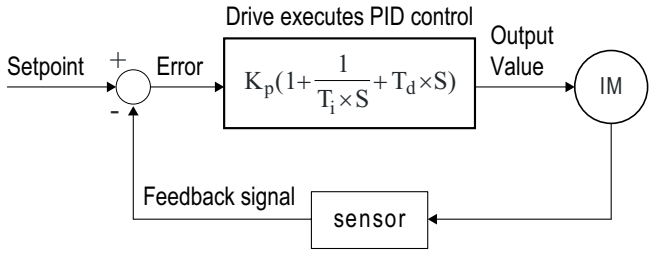
1) *Setpoint: -100% to +100% (PID Setpoint Gain + PID Setpoint Offset)*
2) *Feedback: -100% to +100% (Feedback Gain)*
3) *Error: -100% to +100% (in percent change)*
4) *I Limit: 0~150% (Upper Limit for Integral Time P08.04)*
5) *PID Offset: P08.16 determines how the PID Offset will be controlled; by P08.17, or by an Analog Input (P03.00, P03.01)*
6) *PID F_{cmd} Limit: See P01.10, P01.11*



Since a PID controller relies only on the measured Process Variable, instead of knowledge of the underlying process, it is applicable to a broad variety of system processes. By tuning the three parameters of the model, a PID controller can deal with specific process requirements. The response of the controller can be described in terms of its responsiveness to an error, the degree to which the system overshoots a setpoint, and the degree of any system oscillation. The use of the PID algorithm does not guarantee optimal control of the system or even its stability.

Some applications may require using only one or two terms to provide the appropriate system control. This is achieved by setting the other parameters to zero. A PID controller is called a PI, PD, P, or I controller in the absence of the other respective control actions. PI controllers are fairly common, since Derivative action is sensitive to measurement noise, whereas the absence of an Integral term may prevent the system from reaching its target value.

Concept of GS20(X) PID Control & Tuning



K_p: Proportional Gain (P) T_i: Integral Time (I) T_d: Derivative Value (D) S: Operator

When ***GS20(X) drive PID is enabled by P08.00 [PID Action/Mode]***, P08.65 "reflects" the PID Setpoint Source determined by what is set in P00.20 (Remote) or P00.30 (Local), and what Mode the Drive is in, i.e. Remote or Local Mode. PID control operates with the feedback signal as reflected by P08.65 either 0~10V voltage or 4~20mA current.

Proportional Gain (P)

The first parameter of GS20(X) PID control is *Proportional Gain (P08.01)*.

The GS20(X) drive's frequency output is proportional to the Process Error (when the GS20(X) is configured for PID control). If only the Proportional Gain control component is used, the controller will not be able to get the Process Variable to exactly match the Setpoint at steady-state.

For a given process, if the Proportional Gain value is set too low, the control action will be too sluggish. If the Proportional Gain value is set too high, the control action will be unstable. To find the correct setting for Proportional Gain, set the Integral Time (I) and Derivative Value (D) to zero (0). Begin tuning the process with a low Proportional Gain value, and increase the Proportional value until the system becomes unstable. When instability is reached, reduce the Proportional value slightly until the system becomes stable (smaller values reduce system gain).

Integral Time (I)

The second parameter of GS20(X) PID control is *Integral Time (P08.02)*.

The GS20(X) drive's frequency output compensation due to the integral component is proportional to the integral of the Process Error. To eliminate the steady-state Process Error, an "integral component" needs to be added to the controller.

The Integral Time (I) decides the relation between integral component and Process Error. The integral component will be increased even if the error is small. It gradually increases the controller output to eliminate the error until it is 0.

Begin tuning with a higher number for Integral Time (100.0 is max; 1.0 is default), and slowly move to a smaller number until you reach the setpoint with minimized overshoot/undershoot. Tuning is normally done utilizing the GSoft2 software scope function (or an oscilloscope) to monitor the Process Variable as you incrementally change the Integral Time value until the Setpoint is satisfactorily maintained.

- *Overshoot: The Process Variable moves further past the Setpoint than desired.*
- *Undershoot: The Process Variable does not reach the desired Setpoint.*

Refer to "Tuning Example for PID Control" on page F–7 of this appendix for more PID tuning information.

Derivative Value (D)

The third parameter of GS20(X) PID control is *Derivative Value (P08.03)*.

The GS20(X) drive's frequency output compensation due to the derivative component is proportional to the derivative of the Process Error. Derivative Value (D)control is performed based on the quickness of changes in the Process Error.

When the Proportional Gain (P) and Integral Time (I) control components are set to eliminate the Process Error so that the system runs at steady state, outside forces may suddenly cause oscillation or instability within the system. Without a Derivative Value component, the control output may be too sluggish to quickly respond to these sudden changes. The derivative component can suppress these effects by acting before the error occurs.

Begin tuning with a high Derivative Value and reduce the value to the point of system instability. Then increase the Derivative Value until the control output regains stability. Stability can be tested by moving between two wide-spread setpoint values.

Since Derivative Control is performed based on sudden changes in Process Error, it is a very sensitive control. Therefore, it may also react to extraneous signals and noise, and can easily lead to unstable system control. Derivative control is not normally required for the control of processes such as flow, pressure and temperature.

Refer to "Tuning Example for PID Control" on page F–7 of this appendix for more PID tuning information.

Proportional Integral Control (PI)

When processes are controlled by Proportional Gain only, Process Error cannot be eliminated entirely. Proportional + Integral control (PI) can be used to eliminate Process Error incurred by the targeted value changes and the constant external disturbances. However, if the I action is excessively powerful, it will delay the responding correction, and will allow unstable system operation.

Proportional Derivative Control (PD)

In deciding when to use Proportional-Derivative Control, we need to understand how the system would react as a Proportional-Integral-Derivative system. When a Process Error due to a disturbance in the process occurs in a controlled system, the system sees a greater load than the derivative has provided energy to control. If that Process Error is small, the system PV can oscillate if the Proportional Gain and the Integral Time are being applied to the system too often within a small length of time. To prevent this type of system reaction, the use of Proportional and Derivative (PD) alone may be warranted. The use of Proportional Gain *and* the feed-forward action of the Derivative Value can result in a faster-acting operation to stabilize the system.

Proportional Integral Derivative Control (PID)

When choosing to use Proportional-Integral-Derivative (sometimes called PID) control, the Integral Time is utilized to provide better control of the Process Error while the Derivative Value is used to restrain PV oscillation.

Tuning Example for PID Control

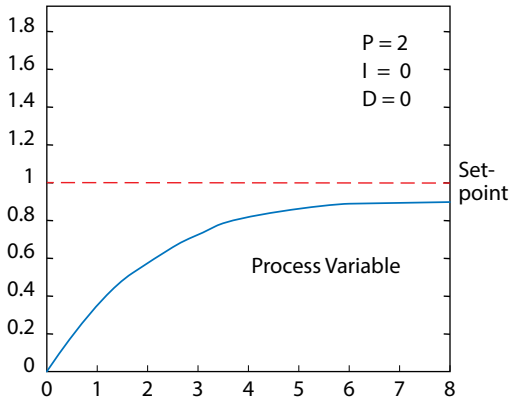
The PID settings should be adjusted, or "tuned," with the controlled process in actual operation while monitoring the actual Process Variable. The tuning can be done using the GSoft2 software scope function, or with an oscilloscope.

We recommend starting by first adjusting the Proportion Gain only, with the Integral Time and Derivative Value set to zero. The following hypothetical example illustrates PID tuning with settings as shown:

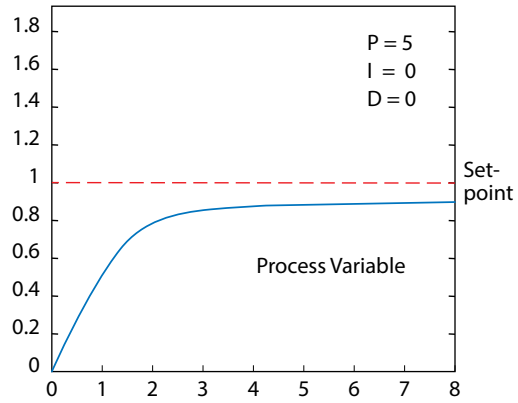
- *P = Proportional Gain = GS20(X) drive parameter P08.01,*
- *I = Integral Time = GS20(X) drive parameter P08.02,*
- *D = Derivative Value = GS20(X) drive parameter P08.03.*

Proportional Gain: Adjust the P setting so that the PV response is neither too sluggish, nor too fast, and without excessive overshoot or undershoot. (Process error cannot be eliminated by P)

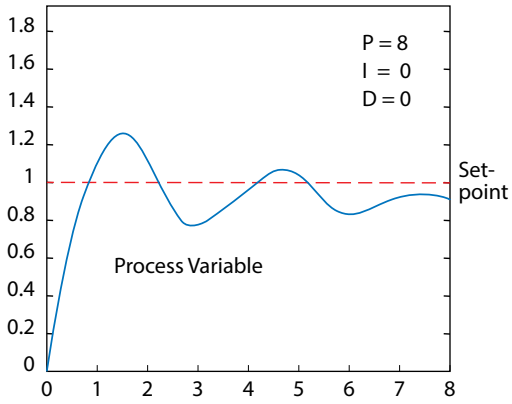
Sluggish PV response; process error



More practical PV response; process error



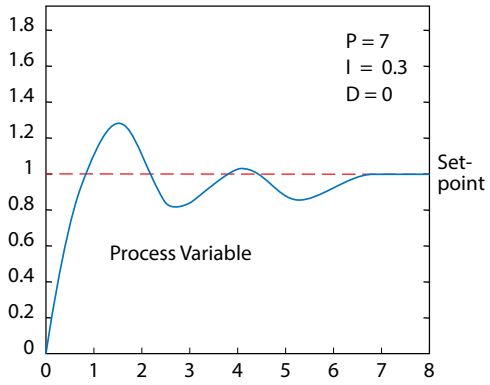
Overshoot & undershoot; process error

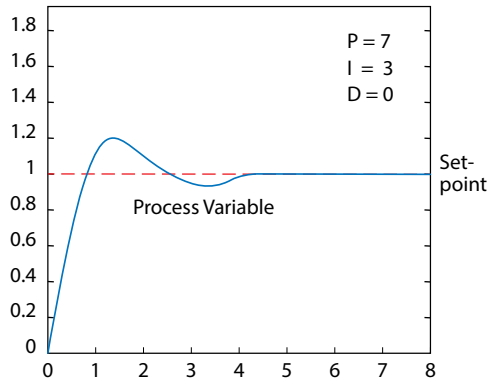


(Example continued next page)

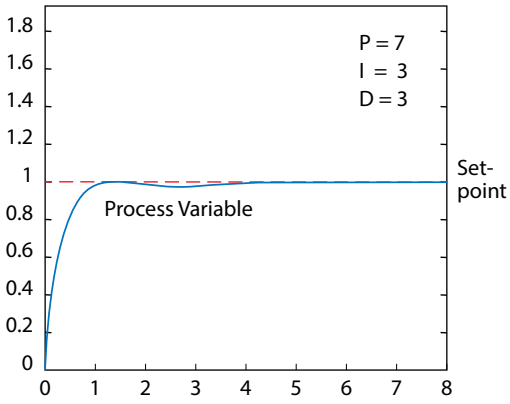
PID Tuning Example (continued)

Integral Time: Adjust the I setting to minimize over/undershoot, and to eliminate the process error.





Derivative Value: Adjusting the D setting may not be neccessary for all processes, but it can be particularly helpful in reducing over/undershoot and instability that may be caused by sudden changes in the system input variable.



DURApulse GS20/GS20-GS2mode Parameters Involved in PID Control

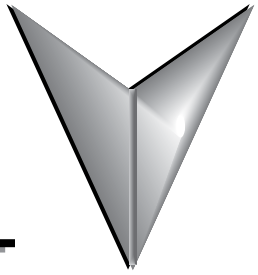
The following GS20(X) AC drive parameters are often involved in setting up PID control.

NOTE: The information provided herein is applicable only to the PID function. For fully detailed parameter information and for the complete set of parameters, please refer to "Chapter 4: AC Drive Parameters."

DURApulse GS20(X) & GS2 PID Parameter Comparisons – Summary			
GS20(X) PID Parameter		GS20-GS2 Mode PID Parameter	
P08.00	Terminal selection of PID feedback	**P7.00**	Input Terminal for PID Feedback
P08.01	Proportional gain (P)	**P7.20**	Proportional Control
P08.02	Integral time (I)	**P7.21**	Integral Control
P08.03	Differential time (D)	**P7.22**	Derivative Control
P08.04	Upper limit of integral control	**P7.23**	Upper Bound for Integral Control
P08.05	PID output command limit (positive limit)	**P7.25**	PID Output Frequency Limit
P08.06	PID feedback value by communication protocol	**n/a**	
P08.07	PID delay time	**P7.24**	Derivative Filter Time Constant
P08.08	Feedback signal detection time	**P7.26**	Feedback Signal Detection Time
P08.09	Feedback signal fault treatment	**P7.27**	PID Feedback Loss
P08.10	Sleep frequency	**n/a**	
P08.11	Wake-up frequency	**n/a**	
P08.12	Sleep time	**n/a**	
P08.13	PID feedback signal error deviation level	**P3.18**	PID Deviation Level
P08.14	PID feedback signal error deviation detection time	**P3.19**	PID Deviation Time
P08.15	PID feedback signal filter time	**n/a**	
P08.16	PID compensation selection	**n/a**	
P08.17	PID compensation	**n/a**	
P08.18	Sleep mode function setting	**n/a**	
P08.19	Wake-up integral limit	**n/a**	
P08.20	PID mode selection	**n/a**	
P08.21	Enable PID to change the operation direction	**n/a**	
P08.22	Wake-up delay time	**n/a**	
P08.23	PID control flag	**n/a**	
P08.26	PID output command limit (reverse limit)	**n/a**	
P08.27	Acceleration / deceleration time for PID command	**n/a**	
P08.29	Frequency base corresponding to 100.00% PID	**n/a**	
P08.31	Proportional gain 2	**n/a**	
P08.32	Integral time 2	**n/a**	
P08.33	Differential time 2	**n/a**	
P08.65	PID target value source	**P7.02**	PID Setpoint Source
P08.66	PID target value setting	**n/a**	
P08.67	Master and auxiliary reverse running cutoff frequency	**n/a**	
P08.68	PID deviation limit	**n/a**	
P08.69	Integral separation level	**n/a**	
P08.70	Smart start-up level	**n/a**	
P08.71	Smart start-up frequency command	**n/a**	
P08.72	Smart start-up acceleration time	**n/a**	
P08.75	PID2 parameter switch condition	**n/a**	
P08.76	PID2 parameter switch deviation 1	**n/a**	
P08.77	PID2 parameter switch deviation 2	**n/a**	
P08.78	Allowed reverse running time after start-up	**n/a**	
n/a	Use GS20 PLC to program this function	**P7.01**	PV 100% Value

DURAPULSE GS20(X) & GS2 PID Parameter Comparisons (continued)			
GS20(X) PID Parameter		***GS20-GS2 Mode PID Parameter***	
n/a	Use GS20 PLC to program this function	♦ ***P7.10***	Keypad PID Setpoint
n/a	Use GS20 PLC to program this function	♦ ***P7.11***	PID Multi-setpoint 1
n/a	Use GS20 PLC to program this function	♦ ***P7.12***	PID Multi-setpoint 2
n/a	Use GS20 PLC to program this function	♦ ***P7.13***	PID Multi-setpoint 3
n/a	Use GS20 PLC to program this function	♦ ***P7.14***	PID Multi-setpoint 4
n/a	Use GS20 PLC to program this function	♦ ***P7.15***	PID Multi-setpoint 5
n/a	Use GS20 PLC to program this function	♦ ***P7.16***	PID Multi-setpoint 6
n/a	Use GS20 PLC to program this function	♦ ***P7.17***	PID Multi-setpoint 7
P00.04	User Display (Can be set to display PID values)	♦ ***P8.00***	User display
P00.03	Start-up display Selection	***n/a***	
P00.25	User-defined characteristics (COEFF ATT)	***n/a***	
P00.26	User-defined maximum value (COEFF MAX)	***n/a***	
P00.27	User-defined value (COEFF SET)	***n/a***	
P02.01 - P02.07	Multi function inputs selections: 71: Disable PID function, force PID output return to 0 72: Disable PID function, retain the output value before disabled 73: Force PID integral gain return to 0, disable integral 74: Reverse PID feedback	***P03.02 - P03.05***	Multi function inputs selections: 03: Multi-Speed/PID SP Bit 1 04: Multi-Speed/PID SP Bit 2 05: Multi-Speed/PID SP Bit 3 17: PID Disable (N.O.) 18: PID Disable (N.C.)
P02.13, P02.16, P02.17	Multi function outputs selections: 15: PID feedback error (P08.13, P08.14)	***P03.11 - P03.12***	Discrete Output Config 10: PID Deviation Alarm
P03.00, P03.01	Multi function analog input selections: 4: PID target value 5: PID feedback signal 13: PID compensation value	***P04.00***	Frequency config to AI. 02: Freq by AI 0-10V 03: Freq by AI 4-20mA 04: Freq by AI 0-20mA 05: Freq by RS-485
P03.20	Multi function Analog output selections. 0: Output frequency 1: Frequency command 9: AI1 10: AI2 21: RS-485	***P04.11***	Analog Output Config. 02: PV

GS2 to GS20 Conversion



Appendix

G

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Replacement of GS2 Drives with GS20

The GS20 drive series can be used to replace any GS2 model drive. This appendix will detail the hardware and software changes that need to be considered before converting an existing GS2 drive application to a GS20 drive application. The GS20 drive provides many additional features and functions over the GS2 drive. However, the GS20 drive can be converted to "GS2 mode" which will convert the parameter set to be virtually identical to a GS2 drive.

The following sections will guide you through the process of converting to GS20:

1) Choosing a compatible GS20 model
2) Reviewing the mounting dimension differences
3) Reviewing the fusing guidelines
4) Reviewing the Main wiring specifications
5) Reviewing the Control wiring specifications
6) Reviewing GS2 accessories
7) Converting Parameter structure and GS2 mode (optional)
8) Converting your GS2 GSoft parameter file to a GS20 GSoft2 file

GS2

GS20

Step 1: Choosing a Compatible GS20 Model

Use the following reference chart to identify the appropriate GS20 model that should be used to replace an existing GS2 model. Compatible models provide equivalent or higher output amp ratings for variable torque modes.

NOTE: GS2-20P5, GS2-21P0, GS2-22P0, and GS2-23P0 single-phase applications MUST use the applicable GS21 model to ensure adequate rated output current. A 3-phase GS23-2xxx drive is only rated for approximately 50% of the rated 3-phase output current when used with a single phase input.

GS2 to GS20 Compatibility				
GS2 Model		***GS2 Output VT Amp Rating***	***Compatible GS20 Model***	***GS20 Output VT Amp Rating***
GS2-10P2		1.6	GS21-10P2	1.8
GS2-10P5		2.5	GS21-10P5	2.7
GS2-11P0		4.2	GS21-11P0	5.5
GS2-20P5	Single Phase	2.5	GS21-20P5	3.2
	Three Phase	2.5	GS23-20P5	3.2
GS2-21P0	Single Phase	5.0	GS21-21P0	5.0
	Three Phase	5.0	GS23-21P0	5.0
GS2-22P0	Single Phase	7.0	GS21-22P0	8.5
	Three Phase	7.0	GS23-22P0	8.5
GS2-23P0	Single Phase	10.0	GS21-23P0	12.5
	Three Phase	10.0	GS23-23P0	12.5
GS2-25P0		17.0	GS23-25P0	19.5
GS2-27P5		25.0	GS23-27P5	27.0
GS2-41P0		3.0	GS23-41P0	3.0
GS2-42P0		4.0	GS23-42P0	4.6
GS2-43P0		5.0	GS23-43P0	6.5
GS2-45P0		8.2	GS23-45P0	10.5
GS2-47P5		13.0	GS23-47P5	15.7
GS2-4010		18.0	GS23-4010	20.5
GS2-51P0		1.7	GS23-51P0	2.1
GS2-52P0		3.0	GS23-52P0	3.6
GS2-53P0		4.2	GS23-53P0	5.0
GS2-55P0		6.6	GS23-55P0	8.0
GS2-57P5		9.9	GS23-57P5	11.5
GS2-5010		12.2	GS23-5010	15.0

Step 2: Reviewing the Mounting Dimension Differences

Compatible GS20 frame sizes are different from the equivalent GS2 drive. All GS20 models are smaller in height and width than the equivalent GS2 model, however some GS20 models may be up to 12mm deeper.

If your existing GS2 drive is panel mounted, new mounting holes will need to be installed for GS20 as the footprints are not the same. Refer to the GS20 dimension drawings in Chapter 2 for exact dimensions of mounting holes. GS20 also offers a mounting plate for top entry/exit and a mounting kit for dinrail. See Appendix A: Accessories for details.

Use the following chart to quickly identify the dimension differences in the comparable models.

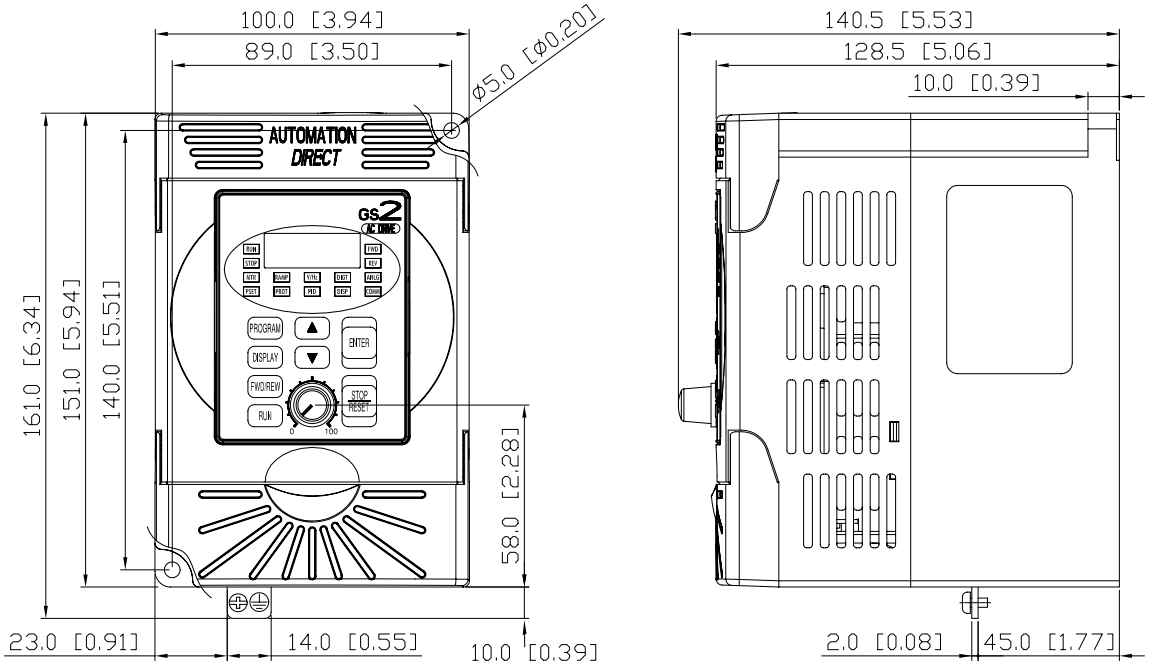
NOTE: Ensure the depth of the compatible GS20 model will fit in the existing location for replacement. Models noted with an asterisk (*) in the table below are deeper than their GS2 counterparts.

GS2 to GS20 Dimensions Comparison (Units = mm)								
GS2 Model		***GS2 Height***	***GS2 Width***	***GS2 Depth***	***GS20 Model***	***GS20 Height***	***GS20 Width***	***GS20 Depth***
GS2-10P2		161	100	140.5	GS21-10P2	128	68	96
GS2-10P5		161	100	140.5	GS21-10P5	128	68	125
GS2-11P0		161	100	140.5	GS21-11P0*	157	87	152
GS2-20P5	Single Phase	161	100	140.5	GS21-20P5	128	68	125
	Three Phase	161	100	140.5	GS23-20P5	128	68	110
GS2-21P0	Single Phase	161	100	140.5	GS21-21P0*	142	72	143
	Three Phase	161	100	140.5	GS23-21P0*	128	68	143
GS2-22P0	Single Phase	161	100	140.5	GS21-22P0*	157	87	152
	Three Phase	161	100	140.5	GS23-22P0	142	72	143
GS2-23P0	Single Phase	235	125	189.5	GS21-23P0	157	87	152
	Three Phase	235	125	189.5	GS23-23P0	157	87	152
GS2-25P0		235	125	189.5	GS23-25P0	157	87	152
GS2-27P5		235	125	189.5	GS23-27P5	207	109	154
GS2-41P0		161	100	140.5	GS23-41P0*	128	68	143
GS2-42P0		161	100	140.5	GS23-42P0*	142	72	143
GS2-43P0		161	100	140.5	GS23-43P0*	157	87	152
GS2-45P0		235	125	189.5	GS23-45P0	157	87	152
GS2-47P5		235	125	189.5	GS23-47P5	207	109	154
GS2-4010		235	125	189.5	GS23-4010	207	109	154
GS2-51P0		161	100	140.5	GS23-51P0*	128	68	143
GS2-52P0		161	100	140.5	GS23-52P0*	142	72	143
GS2-53P0		161	100	140.5	GS23-53P0*	157	87	152
GS2-55P0		235	125	189.5	GS23-55P0	157	87	152
GS2-57P5		235	125	189.5	GS23-57P5	207	109	154
GS2-5010		235	125	189.5	GS23-5010	207	109	154
** These models are deeper than their GS2 counterparts.*								

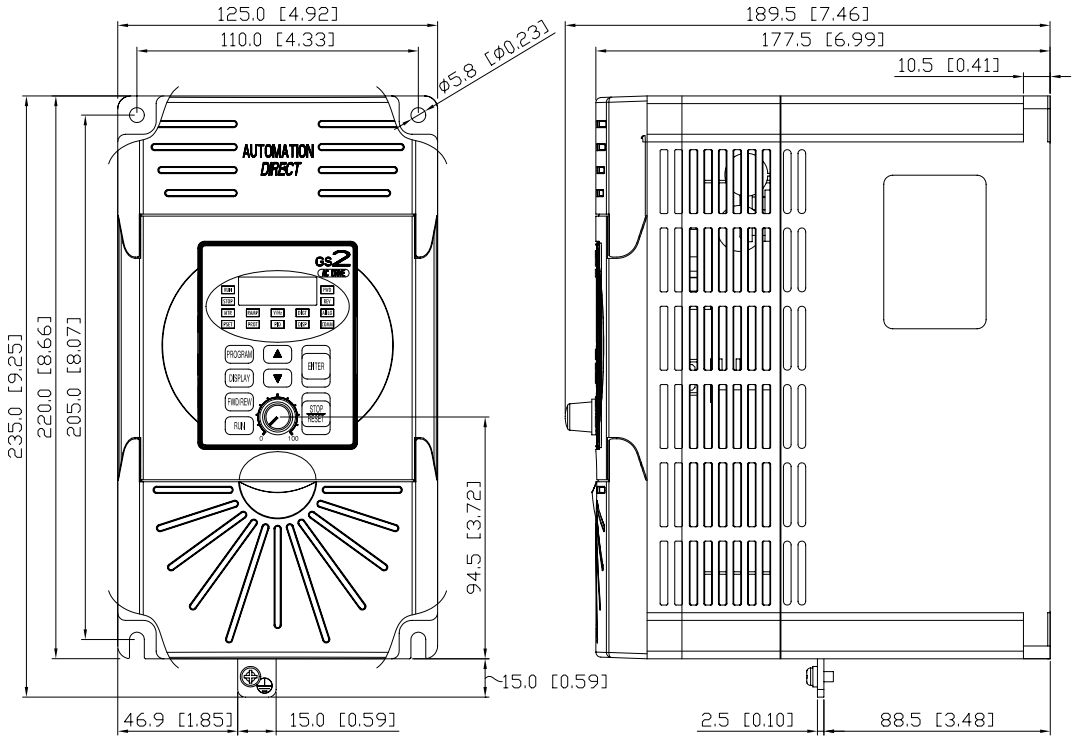
GS2 Dimension Drawings

Units = mm [inch]

GS2-10P2, 10P5, 11P0, 20P5, 21P0, 22P0, 41P0, 42P0, 43P0, 51P0, 52P0, 53P0



GS2-23P0, 25P0, 27P5, 45P0, 47P5, 4010, 55P0, 57P5, 5010



Step 3: Reviewing the Fusing Guidelines

Fusing for the GS20 drives is significantly different than the equivalent GS2 model. Fuse changes are required to adequately protect the semiconductor components of the GS20 drive or to prevent nuisance faults.

Review the following chart to identify required Class T or High Speed J fusing changes before replacing a GS2 drive.

NOTE: These fuse ratings are to protect the semiconductor devices of the drive. Branch fuse circuitry is still required to protect the motor load.

GS2 to GS20 Fusing Guideline							
GS2 Model		***GS2 Input Amp Rating***	***GS2 Fuse Rating***	***GS20 Model***	***GS20 Input Amp Rating***	***GS20 Fuse Rating***	***High-Speed Class J Fuses***
GS2-10P2		6.0	20	GS21-10P2	6.8	10	JHL10
GS2-10P5		9.0	20	GS21-10P5	10.1	10	JHL10
GS2-11P0		16.0	20	GS21-11P0	20.6	25	JHL25
GS2-20P5	Single Phase	6.3	20	GS21-20P5	8.3	15	JHL15
	Three Phase	3.2	10	GS23-20P5	3.8	15	JHL15
GS2-21P0	Single Phase	11.5	30	GS21-21P0	11.3	20	JHL20
	Three Phase	6.3	20	GS23-21P0	6.0	20	JHL20
GS2-22P0	Single Phase	15.7	45	GS21-22P0	18.5	35	JHL35
	Three Phase	9.0	25	GS23-22P0	9.6	35	JHL35
GS2-23P0	Single Phase	27.0	60	GS21-23P0	27.5	50	JHL50
	Three Phase	12.5	40	GS23-23P0	15.0	50	JHL50
GS2-25P0		19.6	60	GS23-25P0	23.4	80	JHL80
GS2-27P5		28.0	100	GS23-27P5	32.4	60	JHL60
GS2-41P0		4.2	10	GS23-41P0	3.3	15	JHL15
GS2-42P0		5.7	15	GS23-42P0	5.1	20	JHL20
GS2-43P0		6.0	20	GS23-43P0	7.2	25	JHL25
GS2-45P0		8.5	30	GS23-45P0	11.6	45	JHL45
GS2-47P5		14.0	50	GS23-47P5	17.3	35	JHL35
GS2-4010		23.0	70	GS23-4010	22.6	45	JHL45
GS2-51P0		2.4	6	GS23-51P0	2.4	6	JHL6
GS2-52P0		4.2	10	GS23-52P0	4.2	10	JHL10
GS2-53P0		5.9	15	GS23-53P0	5.8	10	JHL10
GS2-55P0		7.0	15	GS23-55P0	9.3	20	JHL20
GS2-57P5		10.5	20	GS23-57P5	13.4	25	JHL25
GS2-5010		12.9	30	GS23-5010	17.5`	30	JHL30

Step 4: Reviewing the Main Power Wiring Specifications

Main Power Wire Sizing

Review the following wire size charts to ensure the existing main power wiring on a GS2 drive is compatible with the GS20 model. In some cases, larger wiring may not fit in the GS20 main power wiring terminals and could require intermediate terminal blocks

GS20 Main power terminals are designed for ring lugs. See GS20 wiring specifications in Chapter 2 for more details.

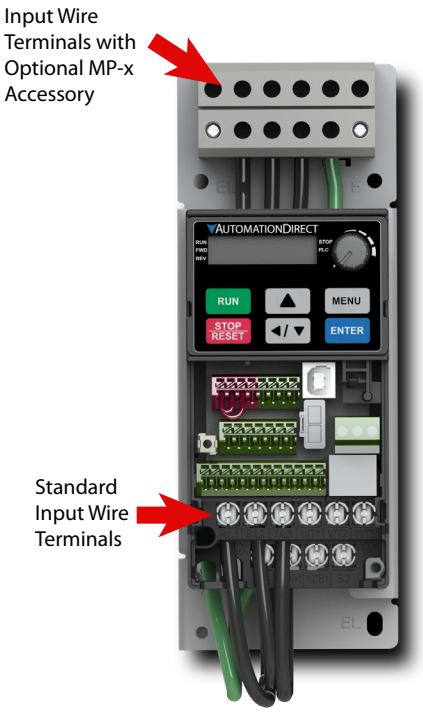
GS2 to GS20 Wiring Comparison				
GS2 Model		***GS2 Main Power Terminals Wiring Size***	***GS20 Model***	***GS20 Main Power Terminals Maximum Wiring Size***
GS2-10P2		12-14	GS21-10P2	14
GS2-10P5		12-14	GS21-10P5	14
GS2-11P0		12	GS21-11P0	8
GS2-20P5	Single Phase	12-14	GS21-20P5	14
	Three Phase	12-14	GS23-20P5	14
GS2-21P0	Single Phase	12-14	GS21-21P0	12
	Three Phase	12-14	GS23-21P0	14
GS2-22P0	Single Phase	12	GS21-22P0	8
	Three Phase	12-14	GS23-22P0	12
GS2-23P0	Single Phase	8	GS21-23P0	8
	Three Phase	8-12	GS23-23P0	8
GS2-25P0		8-10	GS23-25P0	8
GS2-27P5		8	GS23-27P5	8
GS2-41P0		12-14	GS23-41P0	14
GS2-42P0		12-14	GS23-42P0	12
GS2-43P0		12-14	GS23-43P0	8
GS2-45P0		8-14	GS23-45P0	8
GS2-47P5		8-12	GS23-47P5	8
GS2-4010		8-10	GS23-4010	8
GS2-51P0		12-14	GS23-51P0	14
GS2-52P0		12-14	GS23-52P0	12
GS2-53P0		12-14	GS23-53P0	8
GS2-55P0		8-14	GS23-55P0	8
GS2-57P5		8-14	GS23-57P5	8
GS2-5010		8-14	GS23-5010	8

Main Power Wire Routing

GS2 drives are designed for TOP ENTRY input power wiring. GS20 Drives are designed for BOTTOM entry power wiring. Ensure the input cable length can accommodate this change. The Mounting plate accessories (GS20A-MP-AB or GS20A-MP-C in Appendix A) can be used to allow TOP ENTRY power wiring for the GS20. Please note, this accessory will require a longer height dimension and add to the depth dimension.

GS2 Input Wiring Routing

GS20 Wiring Routing with Optional Mounting Plate



GS20 Drive with Optional Mounting Plate

Step 5: Reviewing the Control Wiring Specifications

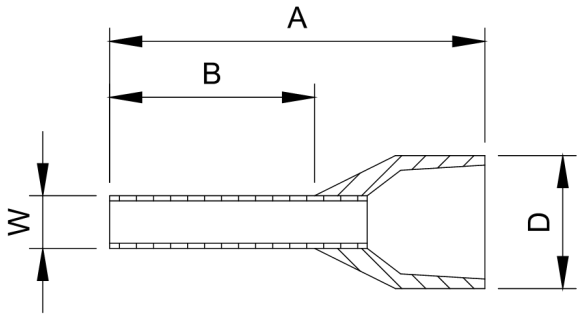
Control Wire Sizing

For control wiring, the GS2 drive uses screw terminals that accommodate a large range of control wiring sizes. GS20 drive control wiring terminals are screwless "Spring-type" and designed for a MAXIMUM of 18awg wire or 20awg wire with ferrules. Ensure the existing GS2 application control wiring is not larger than 18awg and has enough length to add ferrule connectors (if desired).

Wiring Specifications					
Terminal	***Wiring Type***	***Stripping Length (mm)***	***Maximum Wire Guage***	***Minimum Wire Gauge***	***Tightening Torque (kg·cm [lb·in])***
Relay	**Solid**	**6-7**	1.31 mm^2 (16 AWG)	0.21 mm^2 (24 AWG)	5 kg·cm (4.3 lb·in)
	Strand				
Control	**Solid**	**9**	0.82 mm^2 (18 AWG)	0.21 mm^2 (24 AWG)	n/a (spring terminals)
	Strand				
	Stranded with ferrules with plastic sleeves		0.5 mm^2 (20 AWG)		

Recommended models or dimensions for ferrule terminals

Wire Gauge	***Manufacturer***	***Model Name***	***A (MAX)***	***B (MAX)***	***D (MAX)***	***W (MAX)***
0.25 mm2 [24 AWG]	PHOENIX CONTACT	AI 0,25- 8 YE	12.5	8	2.6	1.1
0.34 mm2 [22 AWG]	PHOENIX CONTACT	AI 0,34- 8 TQ	12.5	8	3.3	1.3
0.5 mm2 [20 AWG]	PHOENIX CONTACT	AI 0,5 - 8 WH	14	8	3.5	1.4
	Z+F	V30AE000006	14	8	2.6	1.15



Control I/O terminals

GS20 includes compatible I/O to accommodate existing GS2 drive I/O. However, the I/O specifications differ slightly.

- *GS20 digital inputs are configured to NPN sourcing by default and can be wired in a source configuration. This criteria should match the configuration of an existing GS2 drive digital input wiring.*
- *GS20 has only 1 relay type digital output compared with 2 relay outputs (R1/R2) on the GS2 drive. GS20 digital outputs DO1 or DO2 can be used in place of R2, but you must ensure the field device does not exceed the voltage/current limits of these outputs (DC only). If limits are exceeded, use an intermediate relay. If using GS2 mode, Relay2 output configuration is tied to D01. D02 can not be used.*
- *GS20 analog input AI2 is identical to GS2 Analog input AI. A dip switch and parameter change is necessary to convert between voltage and current mode.*

Review the following chart to ensure I/O field devices do not exceed the GS20 I/O ratings. Check field I/O devices carefully to ensure compatibility with GS20 I/O. Ensure existing field devices wired to GS2 are compatible with GS20 specifications.

GS2 to GS20 I/O Terminal Comparisons						
I/O Type	***GS2 I/O #***	***GS2 I/O Terminals***	***I/O Specifications***	***GS20 I/O #***	***GS20 I/O Terminals***	***I/O Specifications***
Discrete Outputs-Relay type	2	R1/R1C/R1O R2/R2C/R2O	120VAC/24VDC @5A or 230VAC @2.5A	1	R1/R1C/ R1O	Resistive Load; 3A (N.O.) / 3A (N.C.) 250VAC 5A (N.O.) / 3A (N.C.) 30VDC
Discrete Outputs-Photo Coupler Type	0	N/A	N/A	2	DO1/DO2 DOC	Max 48VDC 50mA
Discrete Inputs	6	DI1–DI6 DCM	Input Voltage Range: 4–12V Min ON Current: 22mA max Max OFF Current: 1.1 mA	7	DI1–DI7 DCM	+24V +/- 10%, 100mA ON: Activation current 3.3 mA ≥ 11VDC OFF: Cut-off voltage ≤ 5VDC
Analog Inputs	1	AI +10V	0–10V or 0–20mA or 4–20mA +10VDC (10mA max load)	2	AI1 AI2 +10V	0–10V or -10V–10V 0–10V or 0–20mA or 4–20 mA +10.5 +/- 0.5 VDC/20mA
Analog Output	1	A0 ACM	0 to +10V Output (2mA max load)	1	A01 ACM	Max output current: 2mA Max load: 5k**Ω**

For further information on GS20 I/O (including additional functionality), see Control Circuit Wiring Terminals in Chapter 2.

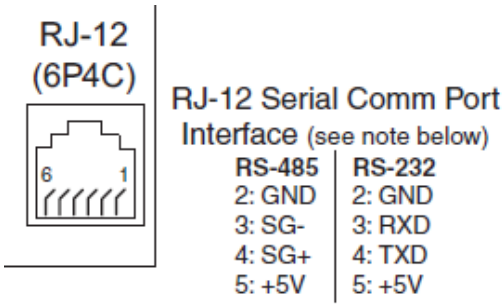
Wiring Locations

Use the following chart to determine where to land GS2 I/O wiring on the GS20 drive.

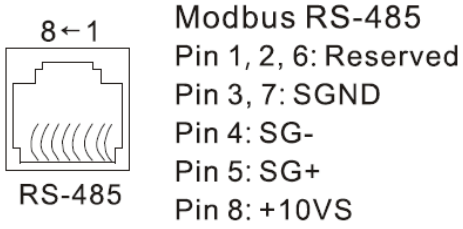
GS2 I/O Wiring to GS20		
I/O Type	***GS2 I/O Terminal***	***Equivalent GS20 I/O Terminal***
Discrete Outputs	R10	R10
	R1C	R1C
	R1	R1
	R20	DO1*
	R2C	DO1*
	R2	DO1*
Discrete Inputs	DI1	FWD
	DI2	REV
	DI3	DI3
	DI4	DI4
	DI5	DI5
	DI6	DI6
	DCM	DCM
Analog Input	AI	AI2
	+10V	+10V
Analog Output	A0	A01
	ACM	ACM
** If using GS20 outputs DO1 or DO2 to replace the GS2 R2 output, ensure the field devices do not exceed the lmits of the output. If limits are exceeded, use DO1/DO2 to activate an intermediate relay.* *If using GS2 mode, Relay2 output configuration is tied to DO1. DO2 can not be used.*		

Communications

GS20 contains an onboard RJ45 port that is compatible with the GS2 RJ12 port. No changes are required with the physical cable connection. Ensure the communication settings in the GS20 drive are configured as needed for an existing RS485 network. A separate Type B USB port is available on the GS20 drive to connect to GSoft2 for parameter and firmware changes.



GS2 Communications Port



GS20 Communications Port

Step 6: Review GS2 Accessories

Braking Resistors, Reactors, and Filters

Depending on the GS2 model, optional accessories may not be compatible with GS20 drives. Check any existing braking resistor, RF filter, line reactor, or EMI filter specifications to ensure they match the recommended specifications for the GS20 drive that is being used. If the accessory ratings do not match, the accessories must be replaced.

See Appendix A: Accessories to view the GS20 accessory ratings.

GS-EDRV100

The GS-EDRV100 ethernet interface module is used with GS2 drives to connect to an ethernet network. This module is compatible with GS20 drives when the drive is in GS2 mode **ONLY**.

To use GS20 default mode with ethernet, the GS20A-CM-ENETIP communication card is needed.

Step 7: Converting Parameter Structure and GS2 Mode (Optional)

The GS20 drive has an enhanced feature set (~ 630 Parameters) compared to the GS2 drive (~130 parameters). Use the full GS20 parameter set to gain the most functionality and performance from the drive. Parameter excel spreadsheet comparison tables can be accessed on the GS20 support page (https://support.automationdirect.com/products/gs20.html).

If you prefer the GS2 parameter set, the GS20 drive can be configured to run in "GS2 mode"- See Option 2 below. This converts the drive to use an identical parameter set to GS2. In GS2 mode, the following options are not supported:

- *GS20 accessory communication cards (GS20A-BPS, GS20A-CM-ENETIP).*
- *I/O points DI7, DO, DO2,AI1*

Option 1 – Configure GS20 Default Parameters from an Existing G2 Parameter Set:

This option will keep the default GS20 parameter set and configure it with the values from an existing GS2 drive.

The following table shows the existing GS20 parameter set and the equivalent GS2 parameters, noting differences in operation where applicable.

Configure each of the applicable GS20 parameters to match the same value in the equivalent GS2 parameter. Leave the remaining GS20 parameters at default.

This process can be done via the drive keypad or via GSoft2 software. After this is done once, the configuration can be saved and downloaded on all subsequent drives via GSoft2 or via the optional GS4-KPD keypad.

NOTE: A downloadable Gsoft2 GS20 configuration set to a GS2-10P5 defaults can be accessed on the GS20 support page (https://support.automationdirect.com/products/gs20.html).

GS20 to GS2 Parameter Table

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P00.00	GS20 Model ID-Identity Code	Read	~	P9.42	Manufacturer Model Information	
P00.02	Restore to Default	R/W	0	P9.07 P9.08	Parameter Lock Restore to Default	GS20 P00.02 = 1 for Parameter lock GS20 P00.02 = 9,10,11, or 12 to Restore to Default
P00.04	User Display	♦R/W	3	P8.00	User Defined Display Function	
P00.05	Coefficient Gain in Actual Output Frequency Display (H Page scale)	♦R/W	1.00	P8.01	Frequency Scale Factor	
P00.06	Firmware version	Read	~	P9.39	Firmware Version	
P00.11	Speed (Velocity) Control mode	R/W	0	P2.00	Volts/Hertz Settings	In addtion, See GS20 Parameters P01.43 and P13.00
P00.17	Carrier frequency	R/W	4	P2.08	PWM Carrier Frequency	
P00.20	Master frequency command source (AUTO, REMOTE)	♦R/W	0	P4.00	Source of Frequency Command	Selections function differently. Keypad Stop is covered in GS20 P00.32
P00.22	Stop method	♦R/W	0	P1.00	Stop Methods	

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P00.32	Digital keypad STOP function	♦R/W	0	P3.00	Source of Operation Command	Keypad stop is separate parameter from Operation command.
P01.00	Maximum operation frequency	R/W	60.00 / 50.00	P0.04	Motor Maximum RPM	Use this parameter to set max operation of drive, not RPM
P01.01	Motor 1 Fbase	R/W	60.00 / 50.00	P0.02	Motor Base Frequency	
P01.02	Motor 1, Rated Voltage (Nameplate)	R/W	220.0 440.0 575.0	P0.00	Motor Nameplate Voltage	
P01.03	Motor 1, Mid-point frequency 1	R/W	3.00	P2.04	Mid-point Frequency	
P01.04	Motor 1, Mid-point voltage 1	♦R/W	11.0 22.0 40.0	P2.05	Mid-point Voltage	
P01.07	Motor 1, Minimum output frequency	R/W	0.50	P2.06	Min. Output Frequency	
P01.08	Motor 1, Minimum output voltage	♦R/W	1.0 2.0 16.7	P2.07	Min. Output Voltage	
P01.10	Output frequency upper limit	♦R/W	599.00	P6.15	Upper Bound of Output Frequency	
P01.11	Output frequency lower limit	♦R/W	0.00	P6.16	Lower Bound of Output Frequency	
P01.12	Acceleration time 1	♦R/W	10.00 10.0	P1.01	Acceleration Time 1	
P01.13	Deceleration time 1	♦R/W	10.00 10.0	P1.02	Deceleration Time 1	
P01.14	Acceleration time 2	♦R/W	10.00 10.0	P1.05	Acceleration Time 2	
P01.15	Deceleration time 2	♦R/W	10.00 10.0	P1.06	Deceleration Time 2	
P01.18	Acceleration time 4	♦R/W	10.00 10.0	P1.08	Accel 1 to Accel 2 frequency transition	Set Accel 4 the same as Accel time 2 to function same as GS2 P1.08/09
P01.19	Deceleration time 4	♦R/W	10.00 10.0	P1.08	Accel 1 to Accel 2 frequency transition	Set Decel 4 the same as Decel time 2 to function same as GS2 P1.08/09
P01.22	JOG frequency	♦R/W	6.00	P5.00	Jog	
P01.23	TRANS ACC/DEC1-4 Switch frequency between first and fourth Accel./Decel.	♦R/W	0.00	P1.08 P1.09	Accel 1 to Accel 2 frequency transition Decel 2 to Decel 1 frequency transition.	Switch frequency must be same for Accel and Decel. There is no equivalent GS2 P1.09. The freq switch is between Accel/Decel 1 and 4.
P01.24	S-curve for acceleration begin time 1	♦R/W	0.20 0.2	P1.03	Accel S-curve	
P01.25	S-curve for acceleration arrival time 2	♦R/W	0.20 0.2	P1.03	Accel S-curve	
P01.26	S-curve for deceleration begin time 1	♦R/W	0.20 0.2	P1.04	Decel S-curve	

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P01.27	S-curve for deceleration arrival time 2	♦R/W	0.20 0.2	P1.04	Decel S-curve	
P01.28	Skip frequency 1 (upper limit)	R/W	0.00	P1.10	Skip Frequency 1	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.29	Skip frequency 1 (lower limit)	R/W	0.00	P1.10	Skip Frequency 1	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.30	Skip frequency 2 (upper limit)	R/W	0.00	P1.11	Skip Frequency 2	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.31	Skip frequency 2 (lower limit)	R/W	0.00	P1.11	Skip Frequency 2	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.32	Skip frequency 3 (upper limit)	R/W	0.00	P1.12	Skip Frequency 3	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.33	Skip frequency 3 (lower limit)	R/W	0.00	P1.12	Skip Frequency 3	GS2 P1.17 Skip Band Freq-not needed due to upper/lower limits
P01.43	V/F curve selection	R/W	0	P2.00	Volts/Hertz Settings	In addition, See GS20 Parameters P00.11 and P13.00
P01.44	Auto-acceleration and auto-deceleration setting	♦R/W	0	P6.06	Auto Adjustable Accel/Decel	
P02.03	Multi-function input command 3 (DI3)	R/W	1	P3.02	Multi-function Input (DI3)	
P02.04	Multi-function input command 4 (DI4)	R/W	2	P3.03	Multi-function Input (DI4)	
P02.05	Multi-function input command 5 (DI5)	R/W	3	P3.04	Multi-function Input (DI5)	
P02.06	Multi-function input command 6 (DI6)	R/W	4	P3.05	Multi-function Input (DI6)	
P02.13	Multi-function output 1 (R1)	♦R/W	11	P3.11	Multi-Function Output Terminal 1	
P02.17	Multi-function output 3 (DO2)	♦R/W	0	P3.12	Multi-Function Output Terminal 2	GS20 DO2 is a transistor output, not a relay output. Ensure DO2 is adequeate to supply enough current for field device
P02.22	Desired frequency reached 1	♦R/W	60.00 / 50.00	P3.16	Desired Frequency	
P02.35	External operation control selection after fault reset and reboot	♦R/W	0	P6.30	Line Start Lockout	
P03.01	Analog input selection (AI2)	♦R/W	0	P4.00	Source of Frequency Command	
P03.04	Analog input bias (AI2)	♦R/W	0	P4.02	Analog Input Offset	GS20 Bias/Gain calculations do not match GS2. Different settings may be needed. See GS20 P03 Parameter details for more info

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P03.08	Positive / negative bias mode (AI2)	♦R/W	0	P4.01	Analog Input Offset Polarity	GS20 Bias/Gain calculations do not match GS2. Different settings may be needed. See GS20 P03 Parameter details for more info
P03.10	Reverse setting when analog signal input is negative frequency	♦R/W	0	P4.04	Analog Input Reverse Motion Enable	
P03.12	Analog input gain (AI2)	♦R/W	100.0	P4.03	Analog Input Gain	GS20 Bias/Gain calculations do not match GS2. Different settings may be needed. See GS20 P03 Parameter details for more info
P03.19	Signal loss selection for analog input 4-20 mA	♦R/W	0	P4.05	Loss of ACI Signal (4-20mA)	
P03.20	Multi-function output (A01)	♦R/W	0	P4.11	Analog Output Signal	
P03.21	Analog output gain (A01)	♦R/W	100.0	P4.12	Analog Output Gain	
P04.00	1st step speed frequency	♦R/W	0.00	P5.01	Multi-Speed 1	
P04.01	2nd step speed frequency	♦R/W	0.00	P5.02	Multi-Speed 2	
P04.02	3rd step speed frequency	♦R/W	0.00	P5.03	Multi-Speed 3	
P04.03	4th step speed frequency	♦R/W	0.00	P5.04	Multi-Speed 4	
P04.04	5th step speed frequency	♦R/W	0.00	P5.05	Multi-Speed 5	
P04.05	6th step speed frequency	♦R/W	0.00	P5.06	Multi-Speed 6	
P04.06	7th step speed frequency	♦R/W	0.00	P5.07	Multi-Speed 7	
P05.01	Induction Motor 1, Full-load amps	R/W	Model dependent	P0.01	Motor Nameplate Amps	
P05.03	Induction Motor 1, Rated speed (rpm)	♦R/W	1710	P0.03	Motor Base RPM	
P06.01	Over-voltage stall prevention	♦R/W	380.0 760.0 975.0	P6.05	Over-Voltage Stall Prevention	
P06.03	Over-current stall prevention during acceleration (OCA)	♦R/W	180	P6.10	Over-Current Stall Prevention during Acceleration	
P06.04	Over-current stall prevention during operation (OCN)	♦R/W	180	P6.11	Over-Current Stall Prevention during Operation	
P06.06	Over-torque detection selection (motor 1)	♦R/W	0	P6.07	Over-Torque Detection Mode	
P06.07	Over-torque detection level (motor 1)	♦R/W	120	P6.08	Over-Torque Detection Level	

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P06.08	Over-torque detection time (motor 1)	♦R/W	0.1	P6.09	Over-Torque Detection Time	
P06.13	Electronic thermal relay selection 1 (motor 1)	♦R/W	2	P6.00	Electronic Thermal Overload Relay	
P06.17	Fault record 1	Read	0	P6.31	Present Fault Record	
P06.18	Fault record 2	Read	0	P6.32	Second Most Recent Fault Record	
P06.19	Fault record 3	Read	0	P6.33	Third Most Recent Fault Record	
P06.20	Fault record 4	Read	0	P6.34	Fourth Most Recent Fault Record	
P06.21	Fault record 5	Read	0	P6.35	Fifth Most Recent Fault Record	
P06.22	Fault record 6	Read	0	P6.36	Sixth Most Recent Fault Record	
P07.01	DC brake current level	♦R/W	0	P1.18	DC Injection Current Level	
P07.02	DC brake time at start-up	♦R/W	0.0	P1.20	DC Injection during Start-up	
P07.03	DC brake time at STOP	♦R/W	0.0	P1.21	DC Injection during Stopping	
P07.04	DC brake frequency at STOP	♦R/W	0.00	P1.22	Start-point for DC Injection	
P07.06	Restart after momentary power loss	♦R/W	0	P6.02	Momentary Power Loss	
P07.07	Allowed power loss duration	♦R/W	2.0	P6.12	Maximum Allowable Power Loss Time	
P07.08	Base Block time	♦R/W	0.5	P6.13	Base-Block Time for Speed Search	
P07.09	Current limit of speed tracking	♦R/W	100	P6.14	Maximum Speed Search Current Level	
P07.11	Number of times of restart after fault	♦R/W	0	P6.01	Auto Restart after Fault	
P07.23	Automatic voltage regulation (AVR) function	♦R/W	0	P6.04	Auto Voltage Regulation	
P07.26	Torque compensation gain (V/F and SVC control mode)	♦R/W	1	P2.02	Auto-torque Boost	
P07.27	Slip compensation gain (V/F and SVC control mode)	♦R/W	0.00 (Default value is 1.00 in SVC mode)	P2.01	Slip Compensation	
P08.00	Terminal selection of PID feedback	♦R/W	0	P7.00	Input Terminal for PID Feedback	
P08.01	Proportional gain (P)	♦R/W	1.00	P7.20	Proportional Control	
P08.02	Integral time (I)	♦R/W	1.00	P7.21	Integral Control	
P08.03	Differential time (D)	♦R/W	0.00	P7.22	Derivative Control	
P08.04	Upper limit of integral control	♦R/W	100.0	P7.23	Upper Bound for Integral Control	

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P08.05	PID output command limit (positive limit)	♦R/W	100.0	P7.25	PID Output Frequency Limit	
P08.07	PID delay time	♦R/W	0.0	P7.24	Derivative Filter Time Constant	
P08.08	Feedback signal detection time	♦R/W	0.0	P7.26	Feedback Signal Detection Time	
P08.09	Feedback signal fault treatment	♦R/W	0	P7.27	PID Feedback Loss	
P08.13	PID feedback signal error deviation level	♦R/W	10.0	P3.18	PID Deviation Level	
P08.14	PID feedback signal error deviation detection time	♦R/W	5.0	P3.19	PID Deviation Time	
P08.65	PID target value source	♦R/W	0	P7.02	PID Setpoint Source	
P09.00	Communication address	♦R/W	1	P9.00	Communication Address	
P09.01	COM1 transmission speed	♦R/W	9.6	P9.01	Transmission Speed	
P09.02	COM1 transmission fault treatment	♦R/W	3	P9.03	Transmission Fault Treatment	
P09.03	COM1 time-out detection	♦R/W	0.0	P9.04 P9.05	Time Out Detection Time Out Duration	Set GS20 P09.03 equal to 0 for equivalent of GS P9.04 Disable
P09.04	COM1 communication protocol	♦R/W	15	P9.02	Communication Protocol	
P09.09	Communication response delay time	♦R/W	2.0	P9.05*	Time Out Duration	New paramter not included in GS2. Ensure this timeout setting is adjusted if needed
P09.11	Block transfer 1	♦R/W	0	P9.11	Block Transfer Parameter 1	
P09.12	Block transfer 2	♦R/W	0	P9.12	Block Transfer Parameter 2	
P09.13	Block transfer 3	♦R/W	0	P9.13	Block Transfer Parameter 3	
P09.14	Block transfer 4	♦R/W	0	P9.14	Block Transfer Parameter 4	
P09.15	Block transfer 5	♦R/W	0	P9.15	Block Transfer Parameter 5	
P09.16	Block transfer 6	♦R/W	0	P9.16	Block Transfer Parameter 6	
P09.17	Block transfer 7	♦R/W	0	P9.17	Block Transfer Parameter 7	
P09.18	Block transfer 8	♦R/W	0	P9.18	Block Transfer Parameter 8	
P09.19	Block transfer 9	♦R/W	0	P9.19	Block Transfer Parameter 9	
P09.20	Block transfer 10	♦R/W	0	P9.20	Block Transfer Parameter 10	
P09.21	Block transfer 11	♦R/W	0	P9.21	Block Transfer Parameter 11	
P09.22	Block transfer 12	♦R/W	0	P9.22	Block Transfer Parameter 12	

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
P09.23	Block transfer 13	♦R/W	0	P9.23	Block Transfer Parameter 13	
P09.24	Block transfer 14	♦R/W	0	P9.24	Block Transfer Parameter 14	
P09.25	Block transfer 15	♦R/W	0	P9.25	Block Transfer Parameter 15	
P13.00	Industry-specific parameter application	R/W	00	P2.00	Volts/Hertz Settings	In addtion, See GS20 Parameters P00.11 and P01.43
n/a				P1.09	Decel 2 to Decel 1 frequency transition	No equivalent parameter. See GS20 P01.23
n/a				P1.17	Skip Frequency Band	No equivalent parameter. GS20 has upper/lower parameters for skip frequency settings. Band not needed
n/a				P3.17	Desired Current	No equivalent parameter. Use Onboard PLC to set a desired current and set an output
n/a				P7.01	PV 100% Value	No equivalent parameter.
n/a				P7.10	Keypad PID Setpoint	No equivalent parameter.
n/a				P7.11	PID Multi-setpoint 1	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.12	PID Multi-setpoint 2	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.13	PID Multi-setpoint 3	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.14	PID Multi-setpoint 4	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.15	PID Multi-setpoint 5	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.16	PID Multi-setpoint 6	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P7.17	PID Multi-setpoint 7	No equivalent parameter. Use Onboard PLC to set a PID setpoint based on a given input signal
n/a				P9.26	Serial Comm Speed Reference	Use Command Write Word 2001H (see GS20 P09.04 Parameter details for bit)
n/a				P9.27	Serial Comm RUN Command	Use Command Write Word 2000H (see GS20 P09.04 Parameter details for bit)

DuraPulse GS20 Parameter Summary				GS2 Equivalent Parameters		
GS20 Param.	***Parameter Description***	***R/W***	***GS20 Default***	***GS2 Param.***	***GS2 Parameter Description***	***Note***
n/a				P9.28	Serial Comm Direction Command	Use Command Write Word 2000H (see GS20 P09.04 Parameter details for bit)
n/a				P9.29	Serial Comm External Fault	Use Command Write Word 2002H (see GS20 P09.04 Parameter details for bit)
n/a				P9.30	Serial Comm Fault Reset	Use Command Write Word 2002H (see GS20 P09.04 Parameter details for bit)
n/a				P9.31	Serial Comm JOG Command	Use Command Write Word 2000H (see GS20 P09.04 Parameter details for bit)
n/a				P9.41	GS Series Number	No equivalent parameter.

Option 2- GS2 Mode:

This option describes using GS2 mode and the associated parameter details.

Entering and Exiting "GS2" Mode

GS20 drives that have an equivalent GS2 model (same power and HP rating) have the option of being operated in "GS2 Mode". This allows you to use the new drive in exactly the same role as an older GS2 drive that needs to be replaced, or in conjuction with existing GS2 drives.

Note that all drives will come factory standard with GS20 mode as the default setting.

Enter GS2 Mode

NOTE: To enter GS2 mode, parameters cannot be locked or set to read only, and the PLC must be disabled. If any of these requirements are not met, you will be unable to set P00.02 to 20.

NOTE: Switching to GS2 Mode or back to GS20 Mode will reset all parameters to factory default.

1) Set parameter P00.02=2, to reset to GS2 mode (1st parameter) and press ENTER.
2) Set parameter P00.02=20 to reset to GS2 mode (2nd parameter) and press ENTER.
3) Reboot the drive by cycling power.
4) Configure GS2 parameters per the table on the following pages.

Exit GS2 Mode

1) Set parameter P09.08=20 to reset to GS20 mode (parameters will reset). Press ENTER.
2) Reboot the drive by cycling power.
3) Configure GS20 parameters per the table on the previous pages and in the GS20 User Manual.

Advanced Keypad

The optional accessory GS4-KPD advanced keypad can be used in GS20-GS2 mode. See Appendix A for more information on the GS4-KPD.

The communication protocol for GS4-KPD is RTU 19200, 8, N, 2. Therefore, you must set GS20-GS2 mode communication parameters so as to connect with the digital keypad GS4-KPD. The setting steps are as follows:

1) P09.01 = 2 (19.2kBaud)
2) P09.02 = 3 (8,N,2 RTU)

To control the drive with the GS4-KPD keypad in G20-GS2mode, the following settings are required:

1) P03.00 = 3: Operation determined by RS-485 interface.
2) P04.00 = 5 Frequency determined by RS-485 comm interface

NOTE: The parameter ranges and default values may differ slightly and between GS20 in GS2 mode and actual G2 drives. Verify all parameters.

GS20-GS2 Mode to GS20 Parameter Table

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
		Motor Parameters			
P0.00	Motor Nameplate Voltage	115V/230V: 200/208/220/230/240 460V: 380/400/415/440/460/480 575V: 380 to 637	240 480 575	P01.02	Motor 1, Rated Voltage (Nameplate)
P0.01	Motor Nameplate Amps	Drive Rated Amps X .3 to 1.0	Drive Rated Amps x 1.0	P05.01	Induction Motor 1, Full-load amps
P0.02	Motor Base Frequency	50/60/400	60	P01.01	Motor 1 Fbase
P0.03	Motor Base RPM	375 to 9999 RPM	1750	P05.03	Induction Motor 1, Rated speed (rpm)
P0.04	Motor Maximum RPM	P0.03 to 9999 RPM	P0.03	P01.00	Maximum operation frequency
		Ramp Parameters			
P1.00	Stop Methods	00: Ramp to Stop 01: Coast to Stop	00	P00.22	Stop method
♦ P1.01	Acceleration Time 1	0.1 to 600.0 sec	10.0	P01.12	Acceleration time 1
♦ P1.02	Deceleration Time 1	0.1 to 600.0 sec	30.0	P01.13	Deceleration time 1
P1.03	Accel S-curve	0 to 7	00	P01.24	S-curve for acceleration begin time 1
				P01.25	S-curve for acceleration arrival time 2
P1.04	Decel S-curve	0 to 7	00	P01.26	S-curve for deceleration begin time 1
				P01.27	S-curve for deceleration arrival time 2
♦ P1.05	Acceleration Time 2	0.1 to 600.0 sec	10.0	P01.14	Acceleration time 2
♦ P1.06	Deceleration Time 2	0.1 to 600.0 sec	30.0	P01.15	Deceleration time 2
P1.07	Select method to use 2nd Accel/Decel	00: RMP2 from DI terminal 01: Transition Frequencies P1.08 & P1.09	00	P2.01–P02.07	Multifunction Input Input Command - 8:
P1.08	Accel 1 to Accel 2 frequency transition	0.0 to 400.0 Hz	00	P01.23	Switch Frequency between First and Fourth Accel./Decel.
				P01.18	Acceleration Time 4
				P01.19	Deceleration Time 4

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
P1.09	Decel 2 to Decel 1 frequency transition	0.0 to 400.0 Hz	00	n/a	*accel and decel must be at same frequency and configured between 1st and 4th accel/decel only. No equivalent P01.09 parameter
P1.10	Skip Frequency 1	0.0 to 400.0 Hz	0.0	P01.28	Skip Frequency 1 (Upper Limit)
				P01.29	Skip Frequency 1 (Lower Limit)
P1.11	Skip Frequency 2	0.0 to 400.0 Hz	0.0	P01.30	Skip Frequency 2 (Upper Limit)
				P01.31	Skip Frequency 2 (Lower Limit)
P1.12	Skip Frequency 3	0.0 to 400.0 Hz	0.0	P01.32	Skip Frequency 3 (Upper Limit)
				P01.33	Skip Frequency 3 (Lower Limit)
P1.17	Skip Frequency Band	0.0 to 20.0 Hz	0.0	n/a	
P1.18	DC Injection Current Level	00 to 100 %	00	P07.01	DC brake current level
P1.20	DC Injection during Start-up	0.0 to 5.0 sec	0.0	P07.02	DC brake time at start-up
P1.21	DC Injection during Stopping	0.0 to 25.0 sec	0.0	P07.03	DC brake time at STOP
P1.22	Start-point for DC Injection	0.0 to 60.0 Hz	0.0	P07.04	DC brake frequency at STOP
Volts/Hertz Parameters					
P2.00	Volts/Hertz Settings	00: General Purpose 01: High Starting Torque 02: Fans and Pumps 03: Custom	00	P01.43	V/F curve selection
♦ P2.01	Slip Compensation	0.0 to 10.0	0.0	P07.27	Slip Compensation Gain
♦ P2.02	Auto-torque Boost	00 to 10	00	P07.26	Torque compensation gain (V/F and SVC control mode)
P2.04	Mid-point Frequency	0.1 to 400 Hz	1.5	P01.03	Motor 1, Mid-point frequency 1
P2.05	Mid-point Voltage	115V/230V: 2.0 to 240V 460V: 2.0 to 510V 575V: 2.0 to 637V	10.0 20.0 24.0	P01.04	Motor 1, Mid-point voltage 1
P2.06	Min. Output Frequency	0.1 to 20.0 Hz	1.50	P01.07	Motor 1, Minimum output frequency
P2.07	Min. Output Voltage	115V/230V: 2.0 to 50.0 V 460V: 2.0 to 100.0 V 575V: 2.0 to 130.6 V	10.0 20.0 24.0	P01.08	Motor 1, Minimum output voltage
P2.08	PWM Carrier Frequency	115V/230V/460V: 01 to 15 kHz 575V: 01 to 10 kHz	12 6	P00.17	Carrier frequency:
Digital Parameters					

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
P3.00	Source of Operation Command	00: Operation determined by digital keypad 01: Operation determined by external control terminals, keypad STOP is enabled 02: Operation determined by external control terminals, keypad STOP is disabled 03: Operation determined by RS-485 interface, keypad STOP is enabled 04: Operation determined by RS-485 interface, keypad STOP is disabled	00	P02.00	Two-wire / three- wire operation control
P3.01	Multi-function Input Terminals (DI1 - DI2)	00: DI1 - FWD / STOP, DI2 - REV / STOP 01: DI1 - RUN / STOP, DI2- REV / FWD 02: DI1 - RUN momentary (N.O.) DI2 - REV / FWD DI3 - STOP momentary (N.C.)	00	P02.01	Multi-function input command 1 (FWD/ DI1)- only use if P02.00 = 0
				P02.02	Multi-function input command 2 (REV/DI2) only use if P02.00 = 0
P3.02	Multi-function Input (DI3)	00: External Fault (N.O.) 01: External Fault (N.C.) 02: External Reset 03: Multi-Speed/PID SP Bit 1 04: Multi-Speed/PID SP Bit 2 05: Multi-Speed/PID SP Bit 3 06: Reserved 07: Reserved 08: Reserved 09: Jog 10: External Base Block (N.O.) 11: External Base Block (N.C.) 12: Second Accel/Decel Time 13: Speed Hold 14: Increase Speed 15: Decrease Speed 16: Reset Speed to Zero 17: PID Disable (N.O.) 18: PID Disable (N.C.) 99: Input Disable	00	P02.03	Multi-function input command 3 (DI3)
P3.03	Multi-function Input (DI4)		03	P02.04	Multi-function input command 4 (DI4)
P3.04	Multi-function Input (DI5)		04	P02.05	Multi-function input command 4 (DI5)
P3.05	Multi-function Input (DI6)		05	P02.06	Multi-function input command 4 (DI6)
P3.11	Multi-Function Output Terminal 1	00: AC Drive Running 01: AC Drive Fault 02: At Speed 03: Zero Speed 04: Above Desired Frequency 05: Below Desired Frequency 06: At Maximum Speed 07: Over torque detected 08: Above Desired Current 09: Below Desired Current 10: PID Deviation Alarm	00	P02.13	Multi-function output 1 (R1)
P3.12	Multi-Function Output Terminal 2		01	P02.16	Multi-function output 2 (DO1)- Transisitor output, not relay output..ensure adequante current for field device
♦ P3.16	Desired Frequency	0.0 to 400.0 Hz	0.0	P02.22	Desired frequency reached 1
♦ P3.17	Desired Current	0.0 to <Drive Rated Amps>	0.0	n/a	
♦ P3.18	PID Deviation Level	1.0 to 50.0 %	10.0	P08.13	PID feedback signal error deviation level
♦ P3.19	PID Deviation Time	0.1 to 300.0 sec	5.0	P08.14	PID feedback signal error deviation time

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
		Analog Parameters			
P4.00	Source of Frequency Command	00: Frequency determined by keypad potentiometer 01: Frequency determined by digital keypad up/down 02: Frequency determined by 0 to +10V input on AI terminal with jumpers 03: Frequency determined by 4 to 20mA input on AI terminal with jumpers 04: Frequency determined by 0 to 20mA input on AI terminal with jumpers 05: Frequency determined by RS-232C/ RS-485 communication interface	00	P00.20	Master frequency command source (AUTO, REMOTE)
				P03.01	Analog input selection (AI2)
P4.01	Analog Input Offset Polarity	00: No Offset 01: Positive Offset 02: Negative Offset	00	P03.07	Positive / negative bias mode (AI1)
♦ P4.02	Analog Input Offset	0.0 to 100.0%	0.0	P03.04	Analog input bias (AI2)
♦ P4.03	Analog Input Gain	0.0 to 300.0%	100.0	P03.12	Analog input gain (AI2)
P4.04	Analog Input Reverse Motion Enable	00: Forward Motion Only 01: Reverse Motion Enable	00	P03.10	Reverse setting when analog signal input is negative frequency
P4.05	Loss of ACI Signal (4-20mA)	00: Decelerate to 0Hz 01: Stop immediately and display error code "EF" 02: Continue operation by the last frequency command	00	P03.19	Signal loss selection for analog input 4-20 mA
♦ P4.11	Analog Output Signal	00: frequency Hz 01: Current A 02: PV	00	P03.20	Multi-function output (A01)
♦ P4.12	Analog Output Gain	00 to 200%	100	P03.21	Analog output gain (A01)
		Presets			
♦ P5.00	Jog	0.0 to 400.0 Hz	6.0	P01.22	JOG frequency
♦ P5.01	Multi-Speed 1	0.0 to 400.0 Hz	0.0	P04.00	1st step speed frequency
♦ P5.02	Multi-Speed 2	0.0 to 400.0 Hz	0.0	P04.01	2nd step speed frequency
♦ P5.03	Multi-Speed 3	0.0 to 400.0 Hz	0.0	P04.02	3rd step speed frequency
♦ P5.04	Multi-Speed 4	0.0 to 400.0 Hz	0.0	P04.03	4th step speed frequency
♦ P5.05	Multi-Speed 5	0.0 to 400.0 Hz	0.0	P04.04	5th step speed frequency
♦ P5.06	Multi-Speed 6	0.0 to 400.0 Hz	0.0	P04.05	6th step speed frequency
♦ P5.07	Multi-Speed 7	0.0 to 400.0 Hz	0.0	P04.06	7th step speed frequency
		Protection Parameters			

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
P6.00	Electronic Thermal Overload Relay		00	P06.13	Electronic thermal relay selection 1 (motor 1)
P6.01	Auto Restart after Fault		00	P07.11	Number of times of restart after fault
P6.02	Momentary Power Loss		00	P07.06	Restart after momentary power loss
P6.03	Reverse Operation Inhibit		00	P00.23	Motor direction control
P6.04	Auto Voltage Regulation		00	P07.23	Auto Voltage Regulation
P6.05	Over-Voltage Stall Prevention		00	P06.01	Over-voltage stall prevention
P6.06	Auto Adjustable Accel/Decel		00	P01.44	Auto-acceleration and auto-deceleration setting
P6.07	Over-Torque Detection Mode		00	P06.06	Over-torque detection selection (motor 1)
P6.08	Over-Torque Detection Level		150	P06.07	Over-torque detection level (motor 1)
P6.09	Over-Torque Detection Time		0.1	P06.08	Over-torque detection time (motor 1)
P6.10	Over-Current Stall Prevention during Acceleration	20 to 200%	150	P06.03	Over-current stall prevention during acceleration (OCA)
P6.11	Over-Current Stall Prevention during Operation	20 to 200%	150	P06.04	Over-current stall prevention during operation (OCN)
P6.12	Maximum Allowable Power Loss Time		2.0	P07.07	Allowed power loss duration
P6.13	Base-Block Time for Speed Search		0.5	P07.08	Base Block time
P6.14	Maximum Speed Search Current Level		150	P07.09	Current limit of speed tracking
P6.15	Upper Bound of Output Frequency		400	P01.10	Output frequency upper limit
P6.16	Lower Bound of Output Frequency	0.0 to 400Hz	0.0	P01.11	Output frequency lower limit
P6.30	Line Start Lockout	00: Enable Line Start Lockout 01: Disable Line Start Lockout	00	P02.35	External operation control selection after fault reset and reboot

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
P6.31	Present Fault Record	0: No fault record 1: Over-current during acceleration (ocA) 2: Over-current during deceleration (ocd) 3: Over-current during steady operation (ocn) 4: Ground fault (GFF) 6: Over-current at stop (ocS) 7: Over-voltage during acceleration (ovA) 8: Over-voltage during deceleration (ovd) 9: Over-voltage during constant speed (ovn) 10: Over-voltage at stop (ovS) 11: Low-voltage during acceleration (LvA) 12: Low-voltage during deceleration (Lvd) 13: Low-voltage during constant speed (Lvn) 14: Low-voltage at stop (LvS) 15: Phase loss protection (orP) 16: IGBT overheating (oH1) 18: IGBT temperature detection failure (tH1o) 21: Over load (oL) 22: Electronic thermal relay 1 protection (EoL1) 23: Electronic thermal relay 2 protection (EoL2) 24: Motor PTC overheating (oH3) 26: Over torque 1 (ot1) 27: Over torque 2 (ot2) 28: Under current (uC) 31: EEPROM read error (cF2) 33: U-phase error (cd1) 34: V-phase error (cd2) 35: W-phase error (cd3) 36: cc (current clamp) hardware error (Hd0) 37: oc (over-current) hardware error (Hd1) 40: Auto-tuning error (AUE) 41: PID loss AI2 (AFE) 43: PG feedback loss (PGF2) 48: AI2 loss (ACE) 49: External fault (EF) 50: Emergency stop (EF1) 51: External Base Block (bb) 52: Password is locked (Pcod) 54: Illegal command (CE1) 55: Illegal data address (CE2) 56: Illegal data value (CE3) 57: Data is written to read-only address (CE4) 58: Modbus transmission time-out (CE10) 97: Ethernet Card Timeout (CD10)	00	P06.17	Fault record 1
P6.32	Second Most Recent Fault Record		00	P06.18	Fault record 2
P6.33	Third Most Recent Fault Record		00	P06.19	Fault record 3
P6.34	Fourth Most Recent Fault Record		00	P06.20	Fault record 4
P6.35	Fifth Most Recent Fault Record		00	P06.21	Fault record 5
P6.36	Sixth Most Recent Fault Record		00	P06.22	Fault record 6

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
		PID Parameters			
P7.00	Input Terminal for PID Feedback	00: Inhibit PID operation 01: Forward-acting (heating loop) PID feedback, PV from AVI (0 to + 10V 02: Forward-acting (heating loop) PID feedback, PV from ACI (4 to 20mA) 03: Reverse-acting (cooling loop) PID feedback, PV from AVI (0 to +10V). 04: Reverse-acting (cooling loop) PID feedback, PV from ACI (4 to 20mA).	00	P08.00	Terminal selection of PID feedback
P7.01	PV 100% Value	0.0 to 999	100.0	n/a	
P7.02	PID Setpoint Source	00: Keypad 01: Serial Communications	00	P08.65	PID target value source
♦ P7.10	Keypad PID Setpoint	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.11	PID Multi-setpoint 1	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.12	PID Multi-setpoint 2	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.13	PID Multi-setpoint 3	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.14	PID Multi-setpoint 4	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.15	PID Multi-setpoint 5	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.16	PID Multi-setpoint 6	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.17	PID Multi-setpoint 7	0.0 to 999	0.0	n/a	Use onBoard PLC to move desired PID value when input signal is present
♦ P7.20	Proportional Control	0.0 to 10.0	1.0	P08.01	Proportional gain (P)
♦ P7.21	Integral Control	0.00 to 100.0 sec	1.00	P08.02	Integral time (I)
♦ P7.22	Derivative Control	0.00 to 1.00 sec	0.00	P08.03	Differential time (D)
P7.23	Upper Bound for Integral Control	00 to 100%	100	P08.04	Upper limit of integral control
P7.24	Derivative Filter Time Constant	0.0 to 2.5 sec	0.0	P08.07	PID delay time

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
P7.25	PID Output Frequency Limit	00 to 110%	100	P08.05	PID output command limit (positive limit)
P7.26	Feedback Signal Detection Time	0.0 to 3600 sec.	60	P08.08	Feedback signal detection time
P7.27	PID Feedback Loss	00: Warn and AC Drive Stop 01: Warn and Continue Operation	00	P08.09	Feedback signal fault treatment
		Display Parameters			
♦ P8.00	User Defined Display Function	00: Output Frequency (Hz) 01: Motor Speed (RPM) 02: Output Freq. X P8.01 03: Output Current (A) 04: Motor Output Current (%) 05: Output Voltage (V) 06: DC Bus Voltage (V) 07: PID Setpoint 08: PID Feedback Signal (PV) 09: Frequency Setpoint	00	P00.04	User Display
♦ P8.01	Frequency Scale Factor	0.01 to 160.0	1.0	P00.05	Coefficient Gain in Actual Output Frequency Display (H Page scale)
		Communications Parameters			
P9.00	Communication Address	01 to 254	01	P09.00	Communication address
P9.01	Transmission Speed	00: 4800 baud 01: 9600 baud 02: 19200 baud 03: 38400 baud	01	P09.01	COM1 transmission speed
P9.02	Communication Protocol	00: Modbus ASCII mode 7 data bits,no parity,2 stop bits 01: Modbus ASCII mode 7 data bits,even parity,1 stop bit 02: Modbus ASCII mode 7 data bits,odd parity,1 stop bit 03: Modbus RTU mode 8 data bits,no parity,2 stop bits 04: Modbus RTU mode 8 data bits,even parity,1 stop bit 05: Modbus RTU mode 8 data bits,odd parity,1 stop bit	00	P09.04	COM1 communication protocol
P9.03	Transmission Fault Treatment	00: Display fault and continue operating 01: Display fault and RAMP to stop 02: Display fault and COAST to stop 03: No fault displayed and continue operating	00	P09.02	COM1 transmission fault treatment
P9.04	Time Out Detection	00: Disable 01: Enable	00	P09.03	COM1 time-out detection (0 = disable)
P9.05	Time Out Duration	0.1 to 60.0 seconds	0.5	P09.09	Communication response delay time
♦ P9.07	Parameter Lock	00: All parameters can be set and read 01: All parameters are read-only	00	P00.02	Restore to Default = 1 keypad lock
P9.08	Restore to Default	99: Restores all parameters to factory defaults 20: Restores to GS20 mode	00	P00.02	Restore to Default = 9, 10,11, or 12
♦ P9.11	Block Transfer Parameter 1	P0.00 to P8.01, P9.99	P9.99	P09.11	Block transfer 1

GS20-GS2 Mode Parameters				GS20 Equivalent Parameters	
GS20-GS2 Mode Param.	***GS20-GS2 Mode Parameter Description***	***Range***	***GS20-GS2 Mode Default***	***GS20 Param.***	***GS20 Parameter Description***
♦ P9.12	Block Transfer Parameter 2	P0.00 to P8.01, P9.99	P9.99	P09.12	Block transfer 2
♦ P9.13	Block Transfer Parameter 3	P0.00 to P8.01, P9.99	P9.99	P09.13	Block transfer 3
♦ P9.14	Block Transfer Parameter 4	P0.00 to P8.01, P9.99	P9.99	P09.14	Block transfer 4
♦ P9.15	Block Transfer Parameter 5	P0.00 to P8.01, P9.99	P9.99	P09.15	Block transfer 5
♦ P9.16	Block Transfer Parameter 6	P0.00 to P8.01, P9.99	P9.99	P09.16	Block transfer 6
♦ P9.17	Block Transfer Parameter 7	P0.00 to P8.01, P9.99	P9.99	P09.17	Block transfer 7
♦ P9.18	Block Transfer Parameter 8	P0.00 to P8.01, P9.99	P9.99	P09.18	Block transfer 8
♦ P9.19	Block Transfer Parameter 9	P0.00 to P8.01, P9.99	P9.99	P09.19	Block transfer 9
♦ P9.20	Block Transfer Parameter 10	P0.00 to P8.01, P9.99	P9.99	P09.20	Block transfer 10
♦ P9.21	Block Transfer Parameter 11	P0.00 to P8.01, P9.99	P9.99	P09.21	Block transfer 11
♦ P9.22	Block Transfer Parameter 12	P0.00 to P8.01, P9.99	P9.99	P09.22	Block transfer 12
♦ P9.23	Block Transfer Parameter 13		P9.99	P09.23	Block transfer 13
♦ P9.24	Block Transfer Parameter 14		P9.99	P09.24	Block transfer 14
♦ P9.25	Block Transfer Parameter 15		P9.99	P09.25	Block transfer 15
♦ P9.26	Serial Comm Speed Reference		60.0	n/a	Use Command Write Word 2001H
♦ P9.27	Serial Comm RUN Command		00	n/a	Use Command Write Word 2000H
♦ P9.28	Serial Comm Direction Command		00	n/a	Use Command Write Word 2000H
♦ P9.29	Serial Comm External Fault		00	n/a	Use Command Write Word 2000H
♦ P9.30	Serial Comm Fault Reset		00	n/a	Use Command Write Word 2000H
♦ P9.31	Serial Comm JOG Command		00	n/a	Use Command Write Word 2000H
P9.38	GS20 Firmware Version		#.##		
P9.39	Firmware Version		1.07	P00.06	GS20 Firmware Version
P9.41	GS Series Number		##	n/a	
P9.42	Manufacturer Model Information		##	P00.00	GS20 Model ID-Identity Code

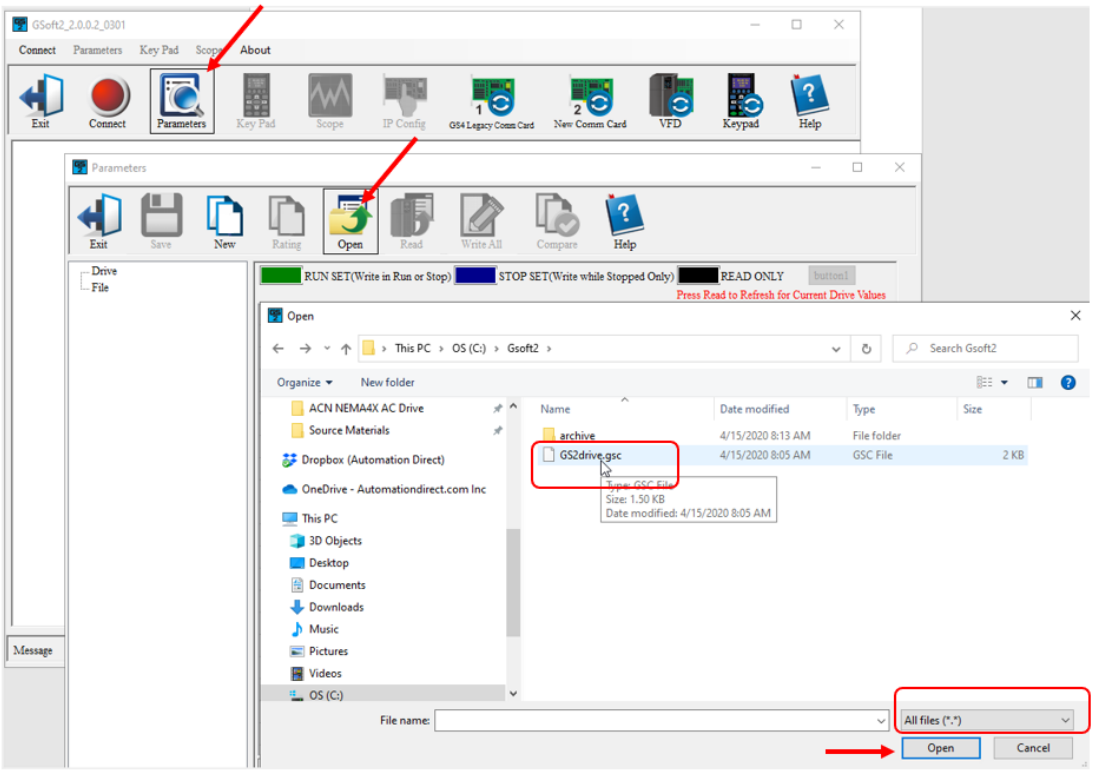
For detailed parameter descriptions, refer to Chapter 4 in the GS2 User Manual at www.automationdirect.com

Step 8: Converting Your GS2 GSoft Parameter File to a GS20 GSoft2 File

If a GS20 drive is configured to GS2 mode, GSoft2 software can utilize an existing GS2 GSoft parameter file. Use the following steps to load a GS2 parameter file into the GS20 drive in GS2 mode

NOTE: See Chapter 7 for instructions on loading free GSoft2 software.

1) Before removing the GS2 drive, use the GSoft software to backup the latest parameter configuration. Save the "*.gsc" file to a local drive. Ensure that the drive version is saved to V1.07. This is required to prevent errors when downloading to the drive from Gsoft2.
2) Open Gsoft2 software. Click Parameter. Click Open. Navigate to the GS2 drive parameter file (*.gsc extension). Note- you may need to select "All Files" from the window for the .GSC files to show up. Click Open.



3) Gsoft2 will convert the file parameters to a GS20 compatible format and display them in the parameters window. Check the parameter values to ensure they match.
4) Connect Gsoft2 to the GS20 drive in GS2 mode, and click "Write All" in the parameter window. See the "Writing Parameters" section of the GSoft2 Help file for more detail.
5) The GS20 drive in GS2 mode will now have the same parameters as your existing GS2 drive.

NOTE: All GS20 in GS2 mode functions may not perform EXACTLY as the GS2 drive. Complete testing for your specific application to confirm drive functionality is the same.

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VTF-46-LM Cut Sheet

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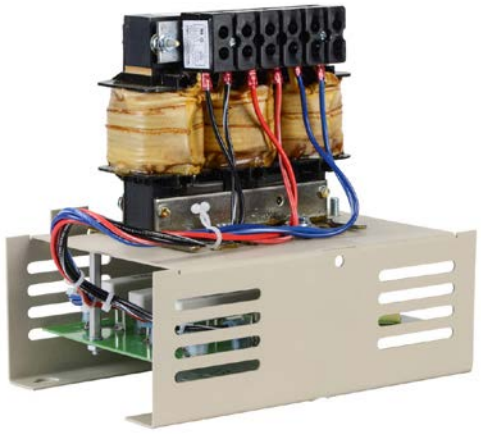

AutomationDirect VTF series drive output filter, 208-600 VAC, 5hp at 208 VAC, 10hp at 460 VAC and 15hp at 575 VAC, 3-phase, 18A, output side only. For use with multiple AC drives.

For complete product information, please see this item on our store at the following link:

https://www.automationdirect.com/pn/VTF-46-LM

Technical Specifications

Brand	AutomationDirect
Item	Drive output filter
Series	VTF
Voltage Rating	208-600 VAC
Horsepower by Voltage	5hp at 208 VAC, 10hp at 460 VAC and 15hp at 575 VAC
Number of Phases	3
Amperage Rating	18A
Orientation	Output side only
For Use With	Multiple AC drives

Agency Approvals

UL Listed File #	E197592
UL Recognized File #	None
UL Hazardous File #	None
CE	None
CSA File #	None
RoHS Status	Meets RoHS Chemical Restrictions - No CE (See RoHS Statement Below)
EU REACH	Vew EU REACH document
Other	RoHS Statement

Warnings and Cautions

Warning	Dangerous Voltage Warning: warns of situations in which a high voltage can cause injury and/or equipment damage. The text next to this symbol describes ways to avoid danger.
Warning	General Warning: warns of situations that can cause physical injury and/or equipment damage by means other than electrical. The text next to this symbol describes ways to avoid the danger.

General Safety Instructions

Warning	Be sure to read, understand, and follow all safety instructions.
Warning	Only qualified electricians should carry out all electrical installation and maintenance work on VTF drive output filters.
Warning	All wiring must be in accordance with the National Electrical Code (NEC) and/or any other codes that apply to the installation site.
Warning	Disconnect all power before working on the equipment. Do not attempt any work on a powered VTF output filter.
Warning	The VTF, VFD, motor, and other connected equipment must be properly grounded.
Warning	The VFD terminals and connected cables are at a dangerously high voltage when power is applied to the VFD, regardless of motor operation.

**All electrical connections must be re-torqued annually.*

Field Wiring

Field Wiring Connection Terminals
Compression type terminals are provided for all line wiring connections. The wire size capacity ranges and tightening torque for the power terminals are listed in the table.

VTF dV/dt Filter Model Number	Current Rating (A)	Wire Size (AWG)	Torque (lb-in)
VTF-46-DE	2	12 - 14	10
VTF-246-CFG	3	12 - 14	10
VTF-246-DGH	4	12 - 14	10
VTF-24-FH	6	12 - 14	10
VTF-246-GJJ	8	12 - 14	10
VTF-246-HKL	12	12 - 14	10
VTF-24-JL	16	4 - 12	20
VTF-46-LM	18	4 - 10	20
VTF-4-M	21	4 - 10	20
VTF-246-KMN	25	4 - 8	20
VTF-46-NP	27	4 - 8	20
VTF-246-LPQ	35	6 - 8	30
VTF-246-MQR	45	6	30
VTF-246-NRS	55	1 - 4	35
VTF-246-PSU	80	1 - 3	35
VTF-246-RUV	110	2/0 - 1/0	50
VTF-246-SVW	130	2/0	50
VTF-246-TWX	160	250 MCM - 3/0	375
VTF-246-UXY	200	two 2/0 - 1	50
VTF-246-VYZ	250	two 2/0	50
VTF-46-ZI	305	two 350 MCM - 3/0	375
VTF-246-XIO	362	two 350 MCM - 4/0	375

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VTF Installation Guide

Automation Direct

automationdirect.com

Version B Part # 31634 October 24, 2022

Installation Instructions

Installation Checklist

- Please see VTF installation drawings for unit dimensions, mounting hole pattern, mounting orientation, wire entry locations, unit weights, and other unit specific installation notes.
- Ensure installation location will not be exposed to direct sunlight, rain or dripping liquids, corrosive liquids or gases, explosive or combustible gases or dust, excessive airborne dirt and dust, or excessive vibration.
- Select mounting area that will allow adequate cooling air and maintenance access.
- Ensure all wiring conforms to the requirements of the National Electric Code (NEC) and\or other applicable electrical codes.
- Ground the VTF to a dedicated system ground to ensure safety and filter performance. Use properly sized grounding conductor.
- Wire the output power terminals of the VFD, T1(U), T2(V), & T3(W) to the input terminals of the VTF: A1, B1 & C1.
- Wire the output power terminals, of the VTF: A2, B2 & C2 to the motor power connections.
- Ensure VFD is set for operating modes and ranges that are compatible with the VTF Output Filter.
- Check entire system thoroughly before energizing and operating any equipment.

When you receive the unit, you should immediately inspect the shipping container and report any damage to the shipping carrier who delivered the unit.

Verify the Application

Make sure the VTF is correct for the application. The current rating of the VTF should be sized to handle the FLA rating of the motor but not to exceed 110% of the VFD output current rating. This output filter is best applied matched closely to the load. The VTF is not selected by the VFD input current rating. When sized and applied to non-regen, standard 6-pulse VFDs, the VTF will limit motor terminal peak input voltage to 150% of the bus voltage with a wire lead length of 1,000 feet and a carrier frequency of 4kHz. Maximum lead length and carrier frequency can vary depending on wire lead type. For best performance, the VTF should be installed within 10 feet of the drive.

Variable Frequency Drive Settings

Make sure that the VFD will be set for operation modes and ranges that are compatible with the VTF:

- Maximum output frequency: 60 Hz
- PWM switching frequency best between 2kHz and 4kHz
- Mode of operation: Do not use filter on 600VAC systems with Dynamic DC braking resistors or Active Front End drives.
- Do not use on overhauling loads without bus voltage control.

Mounting an Open Panel Unit

When mounting an open panel unit in your own enclosure, you must provide an enclosure that is adequately sized and ventilated sufficiently to prevent overheating. The filter is designed with a maximum ambient temperature of 40° C (104°F). If the ambient temperature exceeds this value, for any open or enclosed VTF unit, it is the responsibility of the customer to provide auxiliary cooling to reduce the ambient operating temperature around the VTF filter. Using auxiliary cooling devices such as cooling fans, heat exchangers, or possibly air conditioning units is recommended when required to maintain the proper operating temperature.

The VTF must be mounted, as per the unit installation drawing, on a smooth, solid surface, free from heat, dampness, and condensation. Mounting it oriented as per drawing is important for natural convection cooling. A metal plate is provided to mount the VTF on a composite surface. Please see installation drawings for unit dimensions, mounting orientation, equipment spacing, wire entry locations, and unit weights.

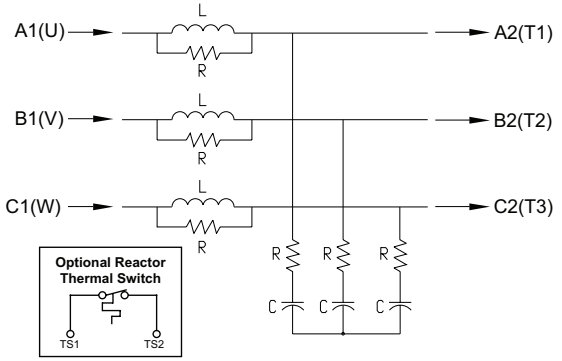
Power Wiring

The conduit and wiring from the output of the VFD to the motor must be routed to the VTF and then to the motor. We recommend a separate dedicated conduit run for each VFD/filter/ motor run unless properly shielded and segregated wiring procedures are practiced. Parasitic and induced capacitance can greatly reduce the effectiveness of the filter performance. Under no circumstances should you wire both control and power wire in the same conduit unless the wire way is specifically designed for this practice. The filter temperature is sensitive to lead wire over sizing. Avoid lead wires more than five times oversized by copper cross sectional area regardless of the material used. Use 75°C copper conductors only or the equivalent, unless the wire connector is marked for Al/Cu, then the use of aluminum wire is permitted. Use only copper conductor on units rated above 80 amps.

Grounding

The VTF filter must be connected to the ground of the premise's wiring system. This can be conducted by identifying a known premise's ground near by the filter or running a special ground dedicated for the application. The ground connection must be made using a wire conductor. Metallic conduit is not a suitable grounding conductor. The integrity of all ground connections should be periodically checked.

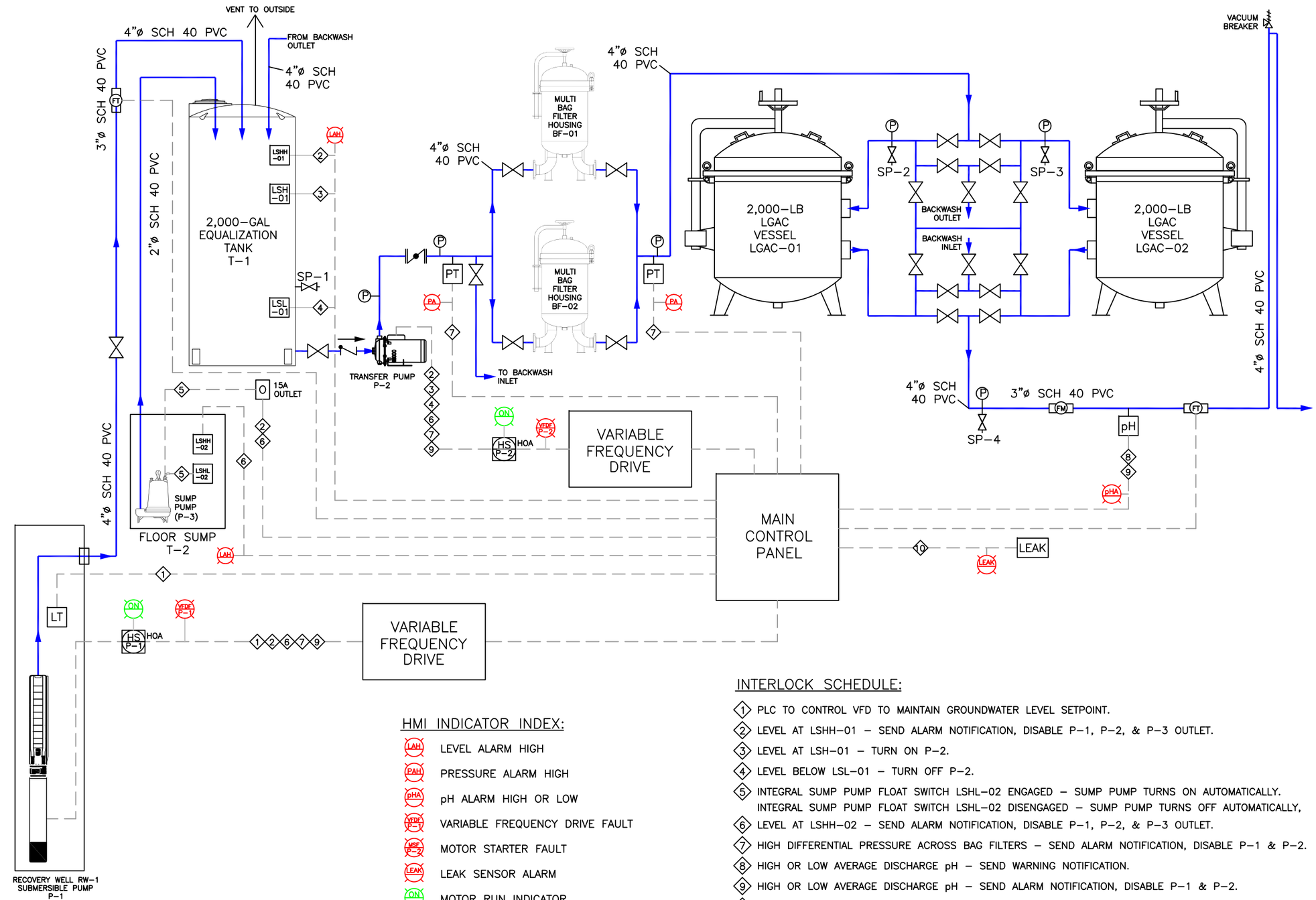
Wiring Diagram



Product Specifications

- Current Rating: 2 - 130 Amps, 208 V - 600 V, .75 - 125 HP
- UL Listed
- Open Construction
- Efficiency > 98%
- Insulation Rating: 600 V Class
- Insulation Class: Class H (180°C or better)
- Maximum Altitude: 2000 m (6,000 ft) Derating necessary above 2000 m
- Lead Length: 1,000 ft
- Ambient Temp: Max 40°C
- For use with three phase VFDs operating at 2kHz-4kHz PWM carrier frequency and with a maximum motor cable size necessary to achieve a 5% voltage drop at 1,000 ft.

6. FIGURES



SYSTEM LEGEND:

- PRESSURE GAUGE
- LEAK — FLOOR LEAK SENSOR
- LS — LEVEL SWITCH
- LT — LEVEL TRANSMITTER
- PT — PRESSURE TRANSMITTER
- pH — pH TRANSMITTER
- FM — FLOW METER/TOTALIZER
- FT — FLOW TRANSMITTER
- BALL VALVE
- BUTTERFLY VALVE
- SP — SAMPLE PORT
- CHECK VALVE
- HS — HMI SWITCH
- CONTROL PANEL INTERLOCK
- ELECTRIC LINE
- AIR FLOW DIRECTION
- WATER FLOW DIRECTION
- ENCLOSURE LIMITS

HMI INDICATOR INDEX:

- LAH — LEVEL ALARM HIGH
- PAH — PRESSURE ALARM HIGH
- pHA — pH ALARM HIGH OR LOW
- VFDF P-1 — VARIABLE FREQUENCY DRIVE FAULT
- MSF P-2 — MOTOR STARTER FAULT
- LEAK — LEAK SENSOR ALARM
- ON — MOTOR RUN INDICATOR

INTERLOCK SCHEDULE:

1. PLC TO CONTROL VFD TO MAINTAIN GROUNDWATER LEVEL SETPOINT.
2. LEVEL AT LSHH-01 – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3 OUTLET.
3. LEVEL AT LSH-01 – TURN ON P-2.
4. LEVEL BELOW LSL-01 – TURN OFF P-2.
5. INTEGRAL SUMP PUMP FLOAT SWITCH LSHL-02 ENGAGED – SUMP PUMP TURNS ON AUTOMATICALLY.
   INTEGRAL SUMP PUMP FLOAT SWITCH LSHL-02 DISENGAGED – SUMP PUMP TURNS OFF AUTOMATICALLY,
6. LEVEL AT LSHH-02 – SEND ALARM NOTIFICATION, DISABLE P-1, P-2, & P-3 OUTLET.
7. HIGH DIFFERENTIAL PRESSURE ACROSS BAG FILTERS – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.
8. HIGH OR LOW AVERAGE DISCHARGE pH – SEND WARNING NOTIFICATION.
9. HIGH OR LOW AVERAGE DISCHARGE pH – SEND ALARM NOTIFICATION, DISABLE P-1 & P-2.
10. FLOOR LEAK SENSOR ACTIVATED – SEND ALARM NOTIFICATION.

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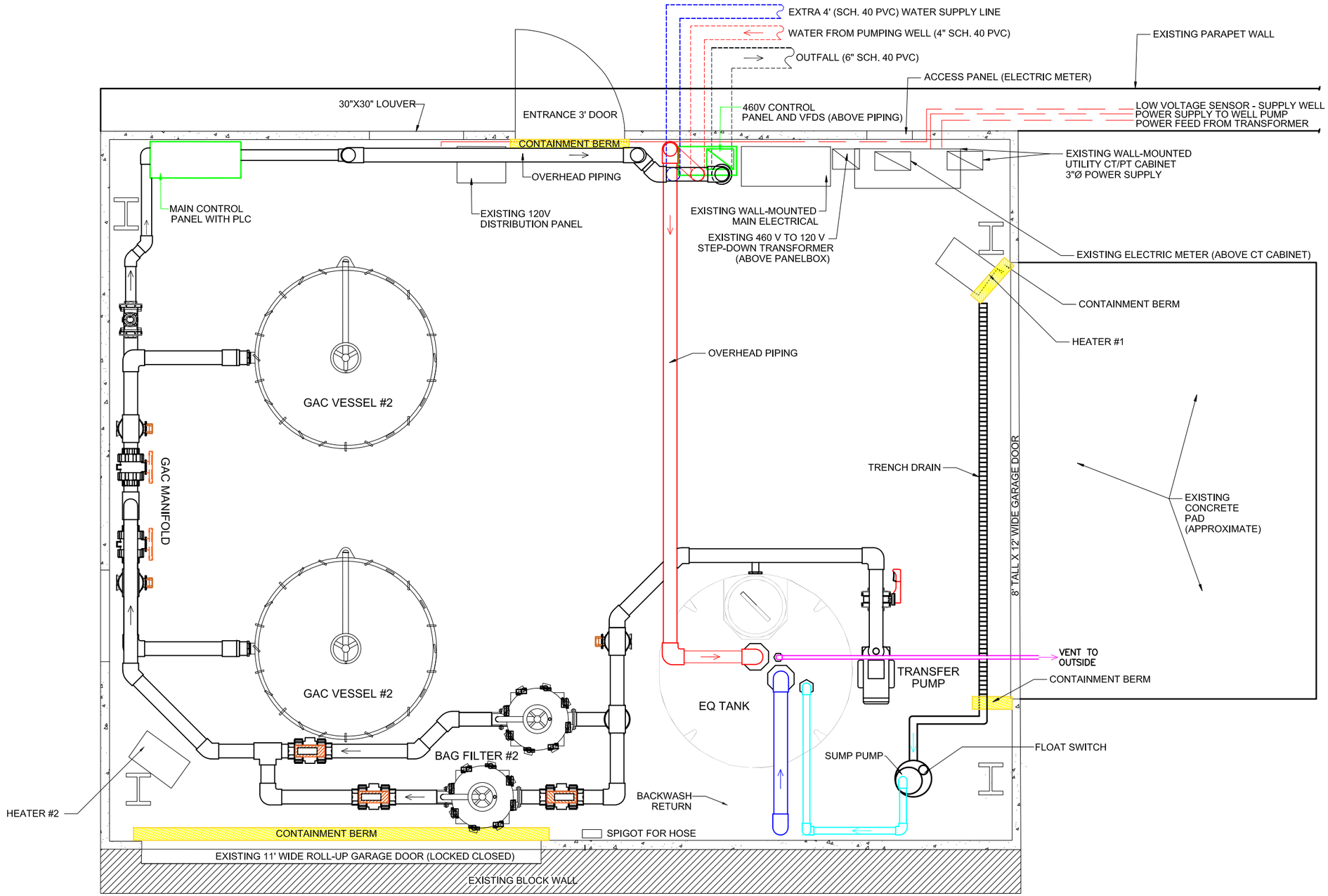
PUMP AND TREAT SYSTEM PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE # 1



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0 3 6
APPROXIMATE SCALE IN FEET

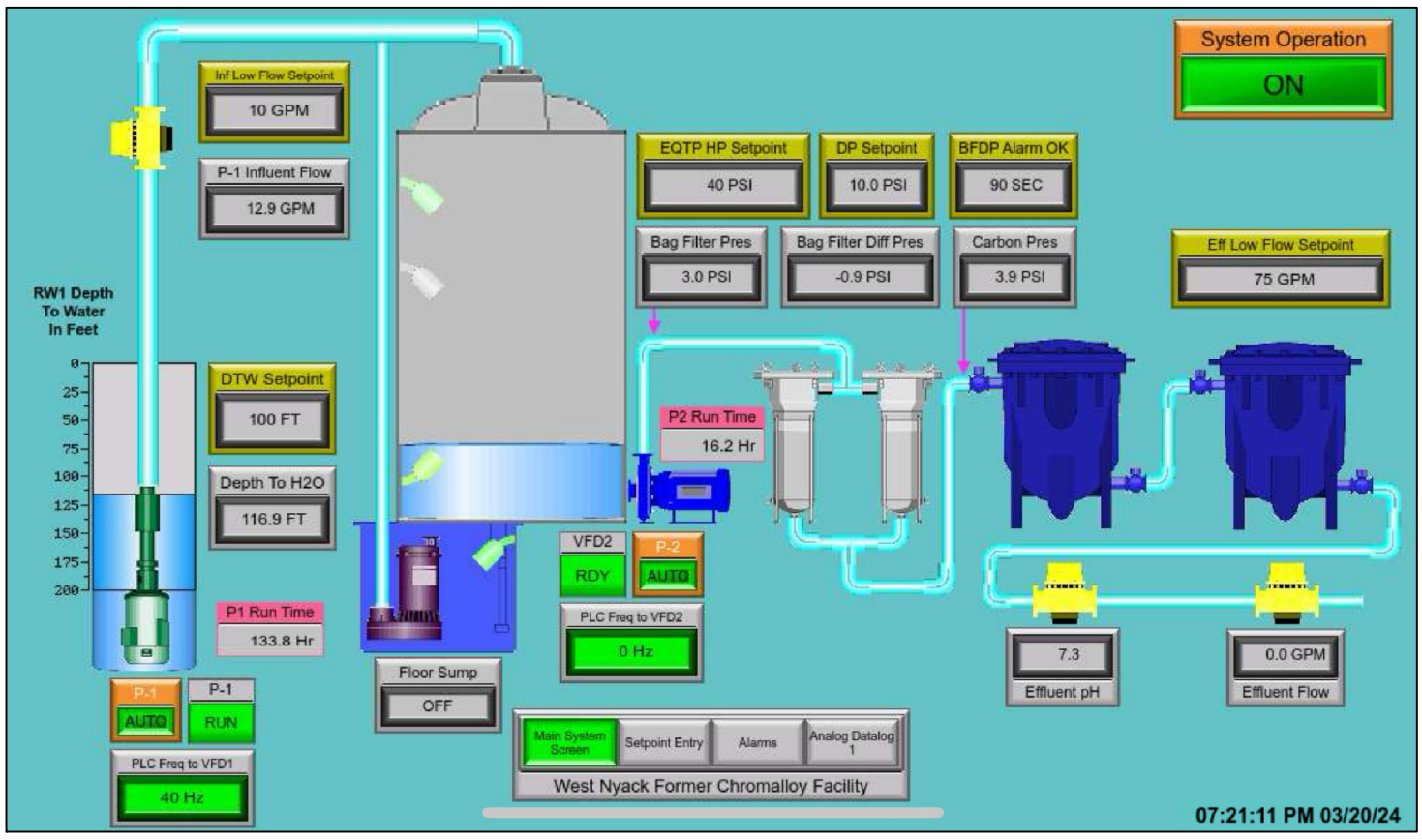
REVISION DATE: 3/22/2024 REVISED BY: JW

FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

PUMP AND TREAT SYSTEM LAYOUT

FIGURE # 2

MAIN SCREEN

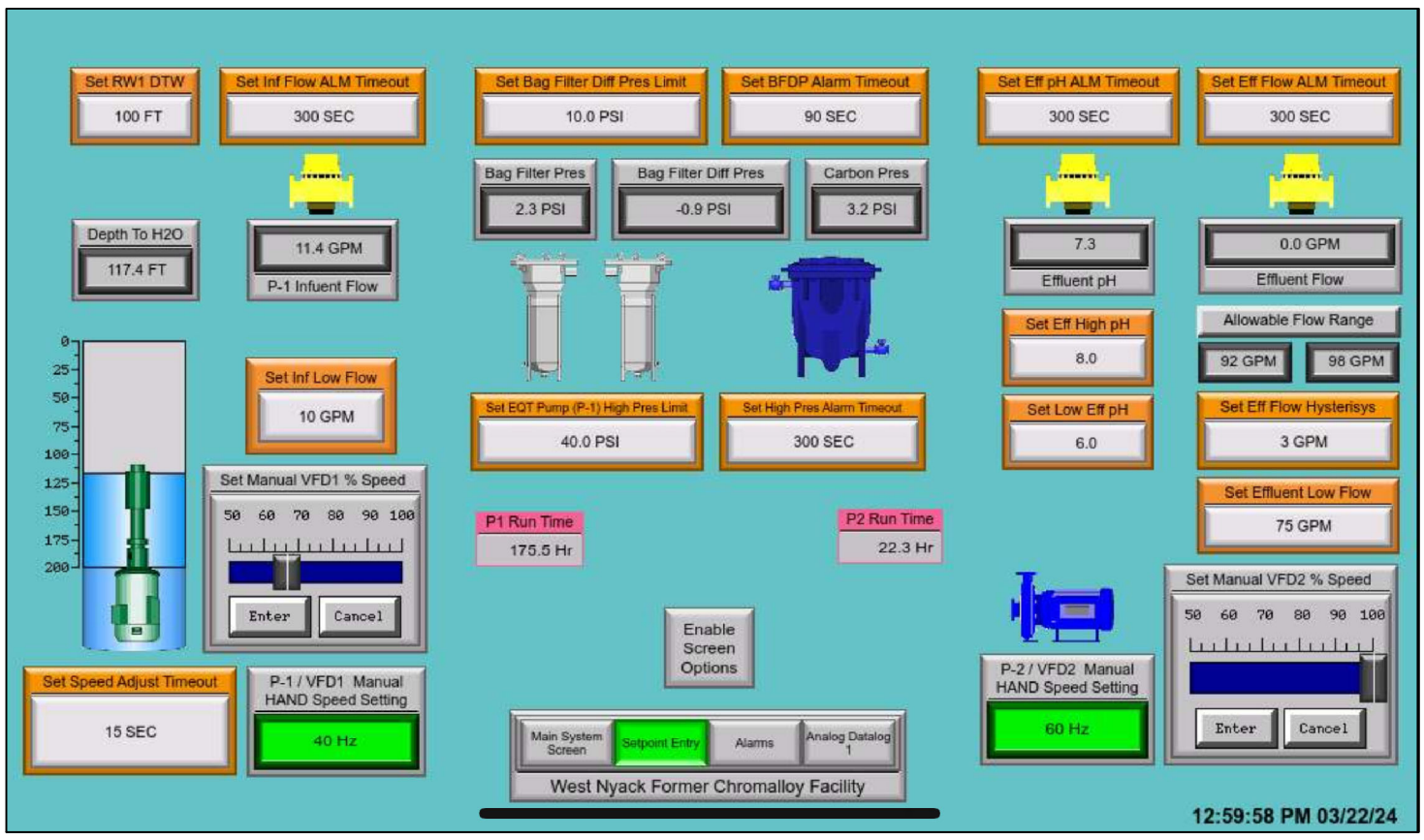


DESCRIPTION: THE HOME SCREEN SHOWS THE CURRENT SYSTEM STATUS IN A SIMPLIFIED PROCESS DIAGRAM.

MAIN SYSTEM SCREEN PROCEDURES:

1. PRESS SYSTEM OPERATION BUTTON TO TOGGLE THE SYSTEM ON AND OFF.
2. PRESS P–1 MODE BUTTON TO TOGGLE PUMP P–1 BETWEEN AUTO AND MANUAL MODE.
3. PRESS P–2 MODE BUTTON TO TOGGLE PUMP P–2 BETWEEN AUTO AND MANUAL MODE.
4. PRESS SETPOINT ENTRY BUTTON TO VIEW SETPOINT ENTRY SCREEN.
5. PRESS ALARMS BUTTON TO VIEW ALARM SCREEN.
6. PRESS ANALOG DATALOG BUTTON TO VIEW DATALOG DATA.

SETPOINT ENTRY SCREEN

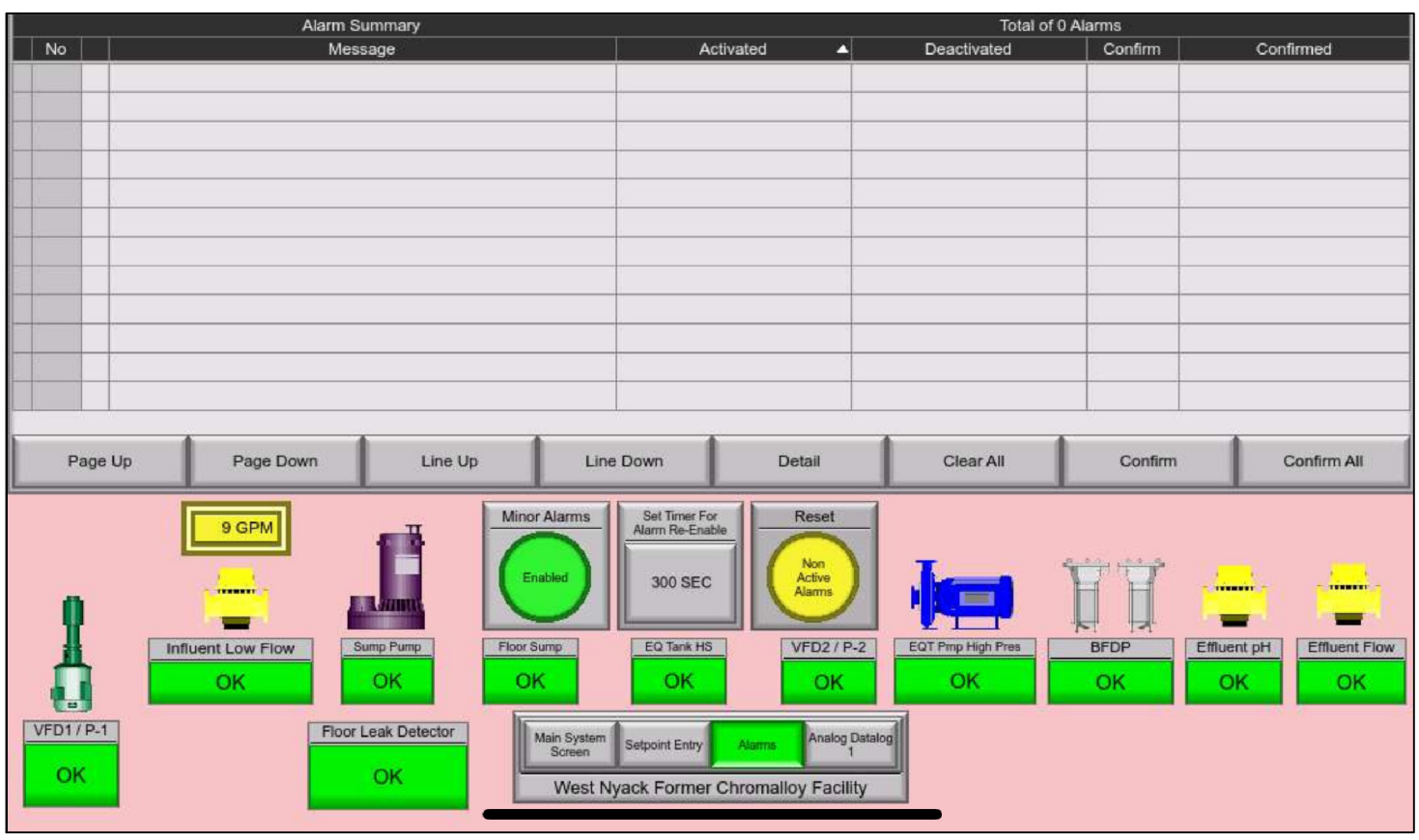


DESCRIPTION: THE SETPOINT ENTRY SCREEN SHOWS THE EDITABLE ALARM AND PROCESS SETPOINTS IN ORANGE ALONG WITH THE CURRENT SYSTEM VALUES.

SETPOINT ENTRY SCREEN PROCEDURES:

1. PRESS SETPOINT BUTTON TO ENTER NEW SETPOINT..
2. PRESS MAIN SYSTEM SCREEN BUTTON TO VIEW MAIN SCREEN.
3. PRESS ALARMS BUTTON TO VIEW ALARM SCREEN.
4. PRESS ANALOG DATALOG BUTTON TO VIEW DATALOG DATA.

ALARM SCREEN



DESCRIPTION: THE ALARM ENTRY SCREEN SHOWS ALL CURRENT ALARM CONDITIONS..

ALARM SCREEN PROCEDURES:

1. PRESS RESET BUTTON TO CLEAR ALARM CONDITION ON HMI.
2. PRESS MAIN SYSTEM SCREEN BUTTON TO VIEW MAIN SCREEN.
3. PRESS SETPOINT ENTRY BUTTON TO VIEW SETPOINT ENTRY SCREEN.
4. PRESS ANALOG DATALOG BUTTON TO VIEW DATALOG DATA.

SYSTEM STARTUP PROCEDURES:

1. ENSURE PROPER ORIENTATION OF ALL CONTROL VALVES.
2. TIGHTLY SEAL ALL FILTER VESSELS.
3. CLOSE ALL SAMPLE PORTS.
4. TURN ON 460V CIRCUIT BREAKER FOR PUMPS P–1 AND P2.
5. TURN ON 120V BREAKER FOR MAIN CONTROL PANEL AND SUMP PUMP.
6. NAVIGATE TO MAIN SYSTEM SCREEN ON HMI AND TURN BOTH P–1 AND P–2 TO AUTO MODE.
7. TURN SYSTEM ON WITH SYSTEM OPERATION BUTTON.

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FORMER CHROMALLOY FACILITY
WEST NYACK, NEW YORK

REVISION DATE: 3/22/2024

REVISED BY: JW

HMI SCREEN DESCRIPTIONS AND SYSTEM STARTUP PROCEDURE

FIGURE # 3

APPENDIX I

ANALYTICAL REPORT

Lab Number:	L2424744
Client:	TRC Solutions 3 Corporate Drive Suite 202 Clifton Park, NY 12065
ATTN:	Justin King
Phone:	(518) 688-3109
Project Name:	FORMER CHROMALLOY
Project Number:	190273.2021.0000
Report Date:	05/13/24

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Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0826), IL (200077), IN (C-MA-03), KY (KY98045), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), OR (MA-1316), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #525-23-122-91930A1).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000

Lab Number: L2424744
Report Date: 05/13/24

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2424744-01	2024-05-06_INFLUENT	WATER	WEST NYACK, NY	05/06/24 09:55	05/06/24
L2424744-02	2024-05-06_EFFLUENT	WATER	WEST NYACK, NY	05/06/24 10:05	05/06/24
L2424744-03	2024-05-06_MID-FLUENT	WATER	WEST NYACK, NY	05/06/24 10:00	05/06/24

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Cristin Walker

Title: Technical Director/Representative Date: 05/13/24

ORGANICS

VOLATILES

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-01
Client ID: 2024-05-06_INFLUENT
Sample Location: WEST NYACK, NY

Date Collected: 05/06/24 09:55
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 1,8260D
Analytical Date: 05/10/24 13:35
Analyst: LAC

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
Methylene chloride	ND		ug/l	2.5	0.70	1
1,1-Dichloroethane	ND		ug/l	2.5	0.70	1
Chloroform	ND		ug/l	2.5	0.70	1
Carbon tetrachloride	ND		ug/l	0.50	0.13	1
1,2-Dichloropropane	ND		ug/l	1.0	0.14	1
Dibromochloromethane	ND		ug/l	0.50	0.15	1
1,1,2-Trichloroethane	ND		ug/l	1.5	0.50	1
Tetrachloroethene	2.4		ug/l	0.50	0.18	1
Chlorobenzene	ND		ug/l	2.5	0.70	1
Trichlorofluoromethane	ND		ug/l	2.5	0.70	1
1,2-Dichloroethane	ND		ug/l	0.50	0.13	1
1,1,1-Trichloroethane	ND		ug/l	2.5	0.70	1
Bromodichloromethane	ND		ug/l	0.50	0.19	1
trans-1,3-Dichloropropene	ND		ug/l	0.50	0.16	1
cis-1,3-Dichloropropene	ND		ug/l	0.50	0.14	1
Bromoform	ND		ug/l	2.0	0.65	1
1,1,2,2-Tetrachloroethane	ND		ug/l	0.50	0.17	1
Benzene	0.53		ug/l	0.50	0.16	1
Toluene	ND		ug/l	2.5	0.70	1
Ethylbenzene	ND		ug/l	2.5	0.70	1
Chloromethane	ND		ug/l	2.5	0.70	1
Bromomethane	ND		ug/l	2.5	0.70	1
Vinyl chloride	0.09	J	ug/l	1.0	0.07	1
Chloroethane	ND		ug/l	2.5	0.70	1
1,1-Dichloroethene	ND		ug/l	0.50	0.17	1
trans-1,2-Dichloroethene	ND		ug/l	2.5	0.70	1
Trichloroethene	190		ug/l	0.50	0.18	1
1,2-Dichlorobenzene	ND		ug/l	2.5	0.70	1

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-01
Client ID: 2024-05-06_INFLUENT
Sample Location: WEST NYACK, NY
Date Collected: 05/06/24 09:55
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
1,3-Dichlorobenzene	ND		ug/l	2.5	0.70	1
1,4-Dichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl tert butyl ether	0.75	J	ug/l	2.5	0.17	1
p/m-Xylene	ND		ug/l	2.5	0.70	1
o-Xylene	ND		ug/l	2.5	0.70	1
cis-1,2-Dichloroethene	6.4		ug/l	2.5	0.70	1
Styrene	ND		ug/l	2.5	0.70	1
Dichlorodifluoromethane	ND		ug/l	5.0	1.0	1
Acetone	ND		ug/l	5.0	1.5	1
Carbon disulfide	ND		ug/l	5.0	1.0	1
2-Butanone	ND		ug/l	5.0	1.9	1
4-Methyl-2-pentanone	ND		ug/l	5.0	1.0	1
2-Hexanone	ND		ug/l	5.0	1.0	1
Bromochloromethane	ND		ug/l	2.5	0.70	1
1,2-Dibromoethane	ND		ug/l	2.0	0.65	1
1,2-Dibromo-3-chloropropane	ND		ug/l	2.5	0.70	1
Isopropylbenzene	1.2	J	ug/l	2.5	0.70	1
1,2,3-Trichlorobenzene	ND		ug/l	2.5	0.70	1
1,2,4-Trichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl Acetate	ND		ug/l	2.0	0.23	1
Cyclohexane	ND		ug/l	10	0.27	1
1,4-Dioxane	ND		ug/l	250	61.	1
Freon-113	ND		ug/l	2.5	0.70	1
Methyl cyclohexane	ND		ug/l	10	0.40	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	117		70-130
Toluene-d8	101		70-130
4-Bromofluorobenzene	110		70-130
Dibromofluoromethane	103		70-130

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-02
Client ID: 2024-05-06_EFFLUENT
Sample Location: WEST NYACK, NY

Date Collected: 05/06/24 10:05
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 1,8260D
Analytical Date: 05/10/24 13:13
Analyst: LAC

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
Methylene chloride	ND		ug/l	2.5	0.70	1
1,1-Dichloroethane	ND		ug/l	2.5	0.70	1
Chloroform	ND		ug/l	2.5	0.70	1
Carbon tetrachloride	ND		ug/l	0.50	0.13	1
1,2-Dichloropropane	ND		ug/l	1.0	0.14	1
Dibromochloromethane	ND		ug/l	0.50	0.15	1
1,1,2-Trichloroethane	ND		ug/l	1.5	0.50	1
Tetrachloroethene	ND		ug/l	0.50	0.18	1
Chlorobenzene	ND		ug/l	2.5	0.70	1
Trichlorofluoromethane	ND		ug/l	2.5	0.70	1
1,2-Dichloroethane	ND		ug/l	0.50	0.13	1
1,1,1-Trichloroethane	ND		ug/l	2.5	0.70	1
Bromodichloromethane	ND		ug/l	0.50	0.19	1
trans-1,3-Dichloropropene	ND		ug/l	0.50	0.16	1
cis-1,3-Dichloropropene	ND		ug/l	0.50	0.14	1
Bromoform	ND		ug/l	2.0	0.65	1
1,1,2,2-Tetrachloroethane	ND		ug/l	0.50	0.17	1
Benzene	0.62		ug/l	0.50	0.16	1
Toluene	ND		ug/l	2.5	0.70	1
Ethylbenzene	ND		ug/l	2.5	0.70	1
Chloromethane	ND		ug/l	2.5	0.70	1
Bromomethane	ND		ug/l	2.5	0.70	1
Vinyl chloride	ND		ug/l	1.0	0.07	1
Chloroethane	ND		ug/l	2.5	0.70	1
1,1-Dichloroethene	ND		ug/l	0.50	0.17	1
trans-1,2-Dichloroethene	ND		ug/l	2.5	0.70	1
Trichloroethene	0.40	J	ug/l	0.50	0.18	1
1,2-Dichlorobenzene	ND		ug/l	2.5	0.70	1

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-02
Client ID: 2024-05-06_EFFLUENT
Sample Location: WEST NYACK, NY
Date Collected: 05/06/24 10:05
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
1,3-Dichlorobenzene	ND		ug/l	2.5	0.70	1
1,4-Dichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl tert butyl ether	0.40	J	ug/l	2.5	0.17	1
p/m-Xylene	ND		ug/l	2.5	0.70	1
o-Xylene	ND		ug/l	2.5	0.70	1
cis-1,2-Dichloroethene	ND		ug/l	2.5	0.70	1
Styrene	ND		ug/l	2.5	0.70	1
Dichlorodifluoromethane	ND		ug/l	5.0	1.0	1
Acetone	3.3	J	ug/l	5.0	1.5	1
Carbon disulfide	ND		ug/l	5.0	1.0	1
2-Butanone	ND		ug/l	5.0	1.9	1
4-Methyl-2-pentanone	ND		ug/l	5.0	1.0	1
2-Hexanone	ND		ug/l	5.0	1.0	1
Bromochloromethane	ND		ug/l	2.5	0.70	1
1,2-Dibromoethane	ND		ug/l	2.0	0.65	1
1,2-Dibromo-3-chloropropane	ND		ug/l	2.5	0.70	1
Isopropylbenzene	ND		ug/l	2.5	0.70	1
1,2,3-Trichlorobenzene	ND		ug/l	2.5	0.70	1
1,2,4-Trichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl Acetate	ND		ug/l	2.0	0.23	1
Cyclohexane	ND		ug/l	10	0.27	1
1,4-Dioxane	ND		ug/l	250	61.	1
Freon-113	ND		ug/l	2.5	0.70	1
Methyl cyclohexane	ND		ug/l	10	0.40	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	119		70-130
Toluene-d8	101		70-130
4-Bromofluorobenzene	112		70-130
Dibromofluoromethane	108		70-130

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-03
Client ID: 2024-05-06_MID-FLUENT
Sample Location: WEST NYACK, NY

Date Collected: 05/06/24 10:00
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:
Matrix: Water
Analytical Method: 1,8260D
Analytical Date: 05/10/24 12:51
Analyst: LAC

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
Methylene chloride	ND		ug/l	2.5	0.70	1
1,1-Dichloroethane	ND		ug/l	2.5	0.70	1
Chloroform	ND		ug/l	2.5	0.70	1
Carbon tetrachloride	ND		ug/l	0.50	0.13	1
1,2-Dichloropropane	ND		ug/l	1.0	0.14	1
Dibromochloromethane	ND		ug/l	0.50	0.15	1
1,1,2-Trichloroethane	ND		ug/l	1.5	0.50	1
Tetrachloroethene	ND		ug/l	0.50	0.18	1
Chlorobenzene	ND		ug/l	2.5	0.70	1
Trichlorofluoromethane	ND		ug/l	2.5	0.70	1
1,2-Dichloroethane	ND		ug/l	0.50	0.13	1
1,1,1-Trichloroethane	ND		ug/l	2.5	0.70	1
Bromodichloromethane	0.20	J	ug/l	0.50	0.19	1
trans-1,3-Dichloropropene	ND		ug/l	0.50	0.16	1
cis-1,3-Dichloropropene	ND		ug/l	0.50	0.14	1
Bromoform	ND		ug/l	2.0	0.65	1
1,1,2,2-Tetrachloroethane	ND		ug/l	0.50	0.17	1
Benzene	0.74		ug/l	0.50	0.16	1
Toluene	ND		ug/l	2.5	0.70	1
Ethylbenzene	ND		ug/l	2.5	0.70	1
Chloromethane	ND		ug/l	2.5	0.70	1
Bromomethane	ND		ug/l	2.5	0.70	1
Vinyl chloride	0.07	J	ug/l	1.0	0.07	1
Chloroethane	ND		ug/l	2.5	0.70	1
1,1-Dichloroethene	ND		ug/l	0.50	0.17	1
trans-1,2-Dichloroethene	ND		ug/l	2.5	0.70	1
Trichloroethene	29		ug/l	0.50	0.18	1
1,2-Dichlorobenzene	ND		ug/l	2.5	0.70	1

Project Name: FORMER CHROMALLOY **Lab Number:** L2424744

Project Number: 190273.2021.0000 **Report Date:** 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-03 Date Collected: 05/06/24 10:00

Client ID: 2024-05-06_MID-FLUENT Date Received: 05/06/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
Volatile Organics by GC/MS - Westborough Lab						
1,3-Dichlorobenzene	ND		ug/l	2.5	0.70	1
1,4-Dichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl tert butyl ether	0.55	J	ug/l	2.5	0.17	1
p/m-Xylene	ND		ug/l	2.5	0.70	1
o-Xylene	ND		ug/l	2.5	0.70	1
cis-1,2-Dichloroethene	3.2		ug/l	2.5	0.70	1
Styrene	ND		ug/l	2.5	0.70	1
Dichlorodifluoromethane	ND		ug/l	5.0	1.0	1
Acetone	ND		ug/l	5.0	1.5	1
Carbon disulfide	ND		ug/l	5.0	1.0	1
2-Butanone	ND		ug/l	5.0	1.9	1
4-Methyl-2-pentanone	ND		ug/l	5.0	1.0	1
2-Hexanone	ND		ug/l	5.0	1.0	1
Bromochloromethane	ND		ug/l	2.5	0.70	1
1,2-Dibromoethane	ND		ug/l	2.0	0.65	1
1,2-Dibromo-3-chloropropane	ND		ug/l	2.5	0.70	1
Isopropylbenzene	1.5	J	ug/l	2.5	0.70	1
1,2,3-Trichlorobenzene	ND		ug/l	2.5	0.70	1
1,2,4-Trichlorobenzene	ND		ug/l	2.5	0.70	1
Methyl Acetate	ND		ug/l	2.0	0.23	1
Cyclohexane	ND		ug/l	10	0.27	1
1,4-Dioxane	ND		ug/l	250	61.	1
Freon-113	ND		ug/l	2.5	0.70	1
Methyl cyclohexane	ND		ug/l	10	0.40	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	118		70-130
Toluene-d8	100		70-130
4-Bromofluorobenzene	111		70-130
Dibromofluoromethane	107		70-130

Project Name: FORMER CHROMALLOY **Lab Number:** L2424744

Project Number: 190273.2021.0000 **Report Date:** 05/13/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 05/10/24 08:07
Analyst: PID

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by GC/MS - Westborough Lab for sample(s): 01-03 Batch: WG1919628-5					
Methylene chloride	ND		ug/l	2.5	0.70
1,1-Dichloroethane	ND		ug/l	2.5	0.70
Chloroform	ND		ug/l	2.5	0.70
Carbon tetrachloride	ND		ug/l	0.50	0.13
1,2-Dichloropropane	ND		ug/l	1.0	0.14
Dibromochloromethane	ND		ug/l	0.50	0.15
1,1,2-Trichloroethane	ND		ug/l	1.5	0.50
Tetrachloroethene	ND		ug/l	0.50	0.18
Chlorobenzene	ND		ug/l	2.5	0.70
Trichlorofluoromethane	ND		ug/l	2.5	0.70
1,2-Dichloroethane	ND		ug/l	0.50	0.13
1,1,1-Trichloroethane	ND		ug/l	2.5	0.70
Bromodichloromethane	ND		ug/l	0.50	0.19
trans-1,3-Dichloropropene	ND		ug/l	0.50	0.16
cis-1,3-Dichloropropene	ND		ug/l	0.50	0.14
Bromoform	ND		ug/l	2.0	0.65
1,1,2,2-Tetrachloroethane	ND		ug/l	0.50	0.17
Benzene	ND		ug/l	0.50	0.16
Toluene	ND		ug/l	2.5	0.70
Ethylbenzene	ND		ug/l	2.5	0.70
Chloromethane	ND		ug/l	2.5	0.70
Bromomethane	ND		ug/l	2.5	0.70
Vinyl chloride	ND		ug/l	1.0	0.07
Chloroethane	ND		ug/l	2.5	0.70
1,1-Dichloroethene	ND		ug/l	0.50	0.17
trans-1,2-Dichloroethene	ND		ug/l	2.5	0.70
Trichloroethene	ND		ug/l	0.50	0.18
1,2-Dichlorobenzene	ND		ug/l	2.5	0.70
1,3-Dichlorobenzene	ND		ug/l	2.5	0.70

Project Name: FORMER CHROMALLOY **Lab Number:** L2424744

Project Number: 190273.2021.0000 **Report Date:** 05/13/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 05/10/24 08:07
Analyst: PID

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by GC/MS - Westborough Lab for sample(s): 01-03 Batch: WG1919628-5					
1,4-Dichlorobenzene	ND		ug/l	2.5	0.70
Methyl tert butyl ether	ND		ug/l	2.5	0.17
p/m-Xylene	ND		ug/l	2.5	0.70
o-Xylene	ND		ug/l	2.5	0.70
cis-1,2-Dichloroethene	ND		ug/l	2.5	0.70
Styrene	ND		ug/l	2.5	0.70
Dichlorodifluoromethane	ND		ug/l	5.0	1.0
Acetone	ND		ug/l	5.0	1.5
Carbon disulfide	ND		ug/l	5.0	1.0
2-Butanone	ND		ug/l	5.0	1.9
4-Methyl-2-pentanone	ND		ug/l	5.0	1.0
2-Hexanone	ND		ug/l	5.0	1.0
Bromochloromethane	ND		ug/l	2.5	0.70
1,2-Dibromoethane	ND		ug/l	2.0	0.65
1,2-Dibromo-3-chloropropane	ND		ug/l	2.5	0.70
Isopropylbenzene	ND		ug/l	2.5	0.70
1,2,3-Trichlorobenzene	ND		ug/l	2.5	0.70
1,2,4-Trichlorobenzene	ND		ug/l	2.5	0.70
Methyl Acetate	ND		ug/l	2.0	0.23
Cyclohexane	ND		ug/l	10	0.27
1,4-Dioxane	ND		ug/l	250	61.
Freon-113	ND		ug/l	2.5	0.70
Methyl cyclohexane	ND		ug/l	10	0.40

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

Method Blank Analysis
Batch Quality Control

Analytical Method: 1,8260D
Analytical Date: 05/10/24 08:07
Analyst: PID

Parameter	Result	Qualifier	Units	RL	MDL
Volatile Organics by GC/MS - Westborough Lab for sample(s): 01-03 Batch: WG1919628-5					

Surrogate	%Recovery	Qualifier	Acceptance Criteria
1,2-Dichloroethane-d4	115		70-130
Toluene-d8	100		70-130
4-Bromofluorobenzene	112		70-130
Dibromofluoromethane	105		70-130

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021.0000

Lab Number: L2424744

Report Date: 05/13/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by GC/MS - Westborough Lab Associated sample(s): 01-03 Batch: WG1919628-3 WG1919628-4								
Methylene chloride	98		110		70-130	12		20
1,1-Dichloroethane	110		120		70-130	9		20
Chloroform	100		110		70-130	10		20
Carbon tetrachloride	94		100		63-132	6		20
1,2-Dichloropropane	110		120		70-130	9		20
Dibromochloromethane	83		87		63-130	5		20
1,1,2-Trichloroethane	93		99		70-130	6		20
Tetrachloroethene	90		92		70-130	2		20
Chlorobenzene	100		110		75-130	10		20
Trichlorofluoromethane	96		100		62-150	4		20
1,2-Dichloroethane	100		110		70-130	10		20
1,1,1-Trichloroethane	98		100		67-130	2		20
Bromodichloromethane	97		110		67-130	13		20
trans-1,3-Dichloropropene	89		95		70-130	7		20
cis-1,3-Dichloropropene	91		99		70-130	8		20
Bromoform	75		81		54-136	8		20
1,1,2,2-Tetrachloroethane	96		110		67-130	14		20
Benzene	100		110		70-130	10		20
Toluene	100		110		70-130	10		20
Ethylbenzene	110		110		70-130	0		20
Chloromethane	110		120		64-130	9		20
Bromomethane	62		71		39-139	14		20
Vinyl chloride	100		120		55-140	18		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021.0000

Lab Number: L2424744

Report Date: 05/13/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by GC/MS - Westborough Lab Associated sample(s): 01-03 Batch: WG1919628-3 WG1919628-4								
Chloroethane	100		120		55-138	18		20
1,1-Dichloroethene	89		97		61-145	9		20
trans-1,2-Dichloroethene	93		100		70-130	7		20
Trichloroethene	95		98		70-130	3		20
1,2-Dichlorobenzene	94		100		70-130	6		20
1,3-Dichlorobenzene	98		100		70-130	2		20
1,4-Dichlorobenzene	98		100		70-130	2		20
Methyl tert butyl ether	81		92		63-130	13		20
p/m-Xylene	100		110		70-130	10		20
o-Xylene	100		110		70-130	10		20
cis-1,2-Dichloroethene	97		110		70-130	13		20
Styrene	100		110		70-130	10		20
Dichlorodifluoromethane	86		96		36-147	11		20
Acetone	94		110		58-148	16		20
Carbon disulfide	86		88		51-130	2		20
2-Butanone	84		100		63-138	17		20
4-Methyl-2-pentanone	76		97		59-130	**24**	Q	20
2-Hexanone	84		110		57-130	**27**	Q	20
Bromochloromethane	88		100		70-130	13		20
1,2-Dibromoethane	87		93		70-130	7		20
1,2-Dibromo-3-chloropropane	72		85		41-144	17		20
Isopropylbenzene	100		110		70-130	10		20
1,2,3-Trichlorobenzene	88		94		70-130	7		20

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021.0000

Lab Number: L2424744

Report Date: 05/13/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Volatile Organics by GC/MS - Westborough Lab Associated sample(s): 01-03 Batch: WG1919628-3 WG1919628-4								
1,2,4-Trichlorobenzene	88		93		70-130	6		20
Methyl Acetate	98		120		70-130	20		20
Cyclohexane	100		110		70-130	10		20
1,4-Dioxane	84		94		56-162	11		20
Freon-113	95		100		70-130	5		20
Methyl cyclohexane	94		98		70-130	4		20

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
1,2-Dichloroethane-d4	111		114		70-130
Toluene-d8	103		101		70-130
4-Bromofluorobenzene	105		104		70-130
Dibromofluoromethane	98		102		70-130

METALS

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-01
Client ID: 2024-05-06_INFLUENT
Sample Location: WEST NYACK, NY
Date Collected: 05/06/24 09:55
Date Received: 05/06/24
Field Prep: Not Specified

Sample Depth:
Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Arsenic, Total	0.0027	J	mg/l	0.0050	0.0019	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Cadmium, Total	ND		mg/l	0.0050	0.0010	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Chromium, Total	0.0052	J	mg/l	0.0100	0.0021	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Copper, Total	0.115		mg/l	0.0100	0.0022	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Lead, Total	0.0510		mg/l	0.0100	0.0027	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Nickel, Total	0.0040	J	mg/l	0.0250	0.0024	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM
Zinc, Total	0.143		mg/l	0.0050	0.0021	1	05/08/24 23:00	05/10/24 19:43	EPA 3005A	19,200.7	MAM

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-02
Client ID: 2024-05-06_EFFLUENT
Sample Location: WEST NYACK, NY
Sample Depth:
Matrix: Water

Date Collected: 05/06/24 10:05
Date Received: 05/06/24
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Arsenic, Total	0.0029	J	mg/l	0.0050	0.0019	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Cadmium, Total	ND		mg/l	0.0050	0.0010	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Chromium, Total	0.0043	J	mg/l	0.0100	0.0021	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Copper, Total	0.0244		mg/l	0.0100	0.0022	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Lead, Total	0.0189		mg/l	0.0100	0.0027	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Nickel, Total	0.0047	J	mg/l	0.0250	0.0024	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM
Zinc, Total	0.0550		mg/l	0.0050	0.0021	1	05/08/24 23:00	05/10/24 19:49	EPA 3005A	19,200.7	MAM

Project Name: FORMER CHROMALLOY **Lab Number:** L2424744

Project Number: 190273.2021.0000 **Report Date:** 05/13/24

SAMPLE RESULTS

Lab ID: L2424744-03 Date Collected: 05/06/24 10:00

Client ID: 2024-05-06_MID-FLUENT Date Received: 05/06/24

Sample Location: WEST NYACK, NY Field Prep: Not Specified

Sample Depth:

Matrix: Water

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Mansfield Lab											
Arsenic, Total	ND		mg/l	0.0050	0.0019	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Cadmium, Total	ND		mg/l	0.0050	0.0010	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Chromium, Total	0.0039	J	mg/l	0.0100	0.0021	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Copper, Total	0.0156		mg/l	0.0100	0.0022	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Lead, Total	0.0119		mg/l	0.0100	0.0027	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Nickel, Total	0.0041	J	mg/l	0.0250	0.0024	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM
Zinc, Total	0.0318		mg/l	0.0050	0.0021	1	05/08/24 23:00	05/10/24 19:54	EPA 3005A	19,200.7	MAM

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000
Lab Number: L2424744
Report Date: 05/13/24

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Mansfield Lab for sample(s): 01-03 Batch: WG1919483-1										
Arsenic, Total	ND		mg/l	0.0050	0.0019	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Cadmium, Total	ND		mg/l	0.0050	0.0010	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Chromium, Total	ND		mg/l	0.0100	0.0021	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Copper, Total	ND		mg/l	0.0100	0.0022	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Lead, Total	ND		mg/l	0.0100	0.0027	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Nickel, Total	ND		mg/l	0.0250	0.0024	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM
Zinc, Total	ND		mg/l	0.0050	0.0021	1	05/08/24 23:00	05/10/24 18:36	19,200.7	MAM

Prep Information

Digestion Method: EPA 3005A

Lab Control Sample Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021.0000

Lab Number: L2424744

Report Date: 05/13/24

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01-03 Batch: WG1919483-2								
Arsenic, Total	95		-		85-115	-		
Cadmium, Total	92		-		85-115	-		
Chromium, Total	94		-		85-115	-		
Copper, Total	98		-		85-115	-		
Lead, Total	99		-		85-115	-		
Nickel, Total	96		-		85-115	-		
Zinc, Total	93		-		85-115	-		

Matrix Spike Analysis
Batch Quality Control

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000

Lab Number: L2424744
Report Date: 05/13/24

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01-03 QC Batch ID: WG1919483-3 QC Sample: L2409778-71 Client ID: MS Sample												
Arsenic, Total	0.009	0.12	0.116	89		-	-		75-125	-		20
Cadmium, Total	0.002J	0.053	0.0366	**69**	Q	-	-		75-125	-		20
Chromium, Total	0.171	0.2	0.342	86		-	-		75-125	-		20
Copper, Total	0.216	0.25	0.469	101		-	-		75-125	-		20
Lead, Total	0.0304	0.53	0.536	95		-	-		75-125	-		20
Nickel, Total	0.505	0.5	0.998	99		-	-		75-125	-		20
Zinc, Total	0.418	0.5	0.907	98		-	-		75-125	-		20

Lab Duplicate Analysis

Batch Quality Control

Project Name: FORMER CHROMALLOY

Project Number: 190273.2021.0000

Lab Number: L2424744

Report Date: 05/13/24

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Total Metals - Mansfield Lab Associated sample(s): 01-03 QC Batch ID: WG1919483-4 QC Sample: L2409778-71 Client ID: DUP Sample						
Lead, Total	0.0304	0.0307	mg/l	1		20

Project Name: FORMER CHROMALLOY
Project Number: 190273.2021.0000

Lab Number: L2424744
Report Date: 05/13/24

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2424744-01A	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-01B	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-01C	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-01D	Plastic 250ml HNO3 preserved	A	<2	<2	3.4	Y	Absent		NI-UI(180),ZN-UI(180),CD-UI(180),CR-UI(180),AS-UI(180),CU-UI(180),PB-UI(180)
L2424744-02A	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-02B	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-02C	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-02D	Plastic 250ml HNO3 preserved	A	<2	<2	3.4	Y	Absent		NI-UI(180),ZN-UI(180),CD-UI(180),CR-UI(180),PB-UI(180),AS-UI(180),CU-UI(180)
L2424744-03A	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-03B	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-03C	Vial HCl preserved	A	NA		3.4	Y	Absent		NYTCL-8260-R2(14)
L2424744-03D	Plastic 250ml HNO3 preserved	A	<2	<2	3.4	Y	Absent		NI-UI(180),ZN-UI(180),CD-UI(180),CR-UI(180),PB-UI(180),CU-UI(180),AS-UI(180)

*Values in parentheses indicate holding time in days

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

GLOSSARY

Acronyms

DL	- Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LOD	- Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
LOQ	- Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.) Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
NR	- No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Chlordane: The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Gasoline Range Organics (GRO): Gasoline Range Organics (GRO) results include all chromatographic peaks eluting from Methyl tert butyl ether through Naphthalene, with the exception of GRO analysis in support of State of Ohio programs, which includes all chromatographic peaks eluting from Hexane through Dodecane.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively

Report Format: DU Report with 'J' Qualifiers

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

Data Qualifiers

Identified Compounds (TICs). For calculated parameters, this represents that one or more values used in the calculation were estimated.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

V - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Z - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Project Name:	FORMER CHROMALLOY	**Lab Number:**	L2424744
Project Number:	190273.2021.0000	**Report Date:**	05/13/24

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - VI, 2018.

19 Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes. Appendix C, Part 136, 40 CFR (Code of Federal Regulations). July 1, 1999 edition.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625.1: alpha-Terpineol
EPA 8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol, Azobenzene; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Nonpotable Water: EPA RSK-175 Dissolved Gases
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 524.2: THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables).
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

NEW YORK CHAIN OF CUSTODY

ALPHA ANALYTICAL

Westborough, MA 01581
8 Walkup Dr.
TEL: 508-898-9220
FAX: 508-898-9193

Mansfield, MA 02048
320 Forbes Blvd
TEL: 508-822-9300
FAX: 508-822-3288

Service Centers
Mahwah, NJ 07430: 35 Whitney Rd, Suite 5
Albany, NY 12205: 14 Walker Way
Tonawanda, NY 14150: 275 Cooper Ave, Suite 105

Page 1 of 1

Date Rec'd in Lab: 5/7/24

ALPHA Job #: L2424744
~~L2424607TF~~

Client Information

Client: TRC
Address: 3 Corporate Dr. St 202
Clifton Park, NY 12065
Phone: 518-348-1192
Fax: 518-348-1194
Email: JKing@TRCCompanies.com

Project Information

Project Name: Former Chromalloy
Project Location: West Nyack, NY
Project #: 190273.2021.0000
(Use Project name as Project #): ☐
Project Manager: Justin King
ALPHAQuote #:

Turn-Around Time

Standard ☑ Due Date:
Rush (only if pre approved) ☐ # of Days:

Deliverables

☑ ASP-A ☐ ASP-B
☑ EQuIS (1 File) ☐ EQuIS (4 File)
☐ Other

Billing Information

☑ Same as Client Info
PO #

Regulatory Requirement

☐ NY TOGS ☐ NY Part 375
☐ AWQ Standards ☐ NY CP-51
☐ NY Restricted Use ☐ Other
☐ NY Unrestricted Use
☐ NYC Sewer Discharge

Disposal Site Information

Please identify below location of applicable disposal facilities.
Disposal Facility:
☐ NJ ☐ NY
☐ Other:

These samples have been previously analyzed by Alpha ☐

Other project specific requirements/comments:

Please specify Metals or TAL.

Metals: Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Zinc

ANALYSIS

Sample Filtration
☐ Done
☐ Lab to do
Preservation
☐ Lab to do
(Please Specify below)

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	TCL Volatiles	PPL Metals	Total Bottle	Sample Specific Comments
24744-01	2024-05-06_Influent	5/6/24	9:55	A	BA	X	X		
-02	2024-05-06_Effluent	5/6/24	10:05	A	BA	X	X		
-03	2024-05-06_Mid-fluent	5/6/24	10:00	A	BA	X	X		

Preservative Code:
A = None
B = HCl
C = HNO_3
D = H_2SO_4
E = NaOH
F = MeOH
G = $NaHSO_4$
H = $Na_2S_2O_3$
K/E = Zn Ac/NaOH
O = Other

Container Code
P = Plastic
A = Amber Glass
V = Vial
G = Glass
B = Bacteria Cup
C = Cube
O = Other
E = Encore
D = BOD Bottle

Westboro: Certification No: MA935
Mansfield: Certification No: MA015

Container Type	V	P
Preservative	B	C

Relinquished By:	Date/Time	Received By:	Date/Time
	5/6/24 1210	ALPHA	5/6/24 1210
ALPHA Paul Mazzella	5/6/24 1215	Paul Mazzella	5/6/24 1615
Paul Mazzella	5/6/24		5/6/24 2200
	5/7/24 0010		5/7/24 0:10

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. BY EXECUTING THIS COC, THE CLIENT HAS ~~READ~~ AND AGREES TO ~~BE~~ BOUND BY ALPHA'S TERMS & CONDITIONS. (See reverse side.)

Form No: 01-25 HC (rev. 30-Sept-2013)

APPENDIX J

1166/Corr

91-20-2a (1/89)

Site No.:3-44-039
Part 1, Page 1 of 2

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning June 2001
and lasting until June 2006

the discharges from the treatment facility to Hackensack River , water index number NJ-1-9 , Class A , RECEIVING WATER shall be limited and monitored by the operator as specified below:

Outfall Number and Parameter	Discharge Limitations		Units	Minimum Monitoring Requirements	
	Daily Avg.	Daily Max		Measurement Frequency	Sample Type
Outfall 001 - Treated Groundwater Remediation Discharge:					
Flow	Monitor	435,000	GPD	Continuous	Meter
pH (range)	6.0 to 9.0		SU	Daily	Grab
Cadmium, Total	Monitor	42	µg/l	Weekly	Grab
Chromium, Total	Monitor	500	µg/l	Weekly	Grab
Copper, Total	Monitor	144	µg/l	Weekly	Grab
Lead, Total	Monitor	150	µg/l	Weekly	Grab
Nickel, Total	Monitor	1000	µg/l	Weekly	Grab
Zinc, Total	Monitor	1000	µg/l	Weekly	Grab
Arsenic	Monitor	100	µg/l	Weekly	Grab
1,1,1,2-Tetrachloroethane	Monitor	50	µg/l	Weekly	Grab
1,1,1 Trichloroethane	Monitor	10	µg/l	Weekly	Grab
1,1,2 Trichloroethane	Monitor	10	µg/l	Weekly	Grab
1,1 Dichloroethane	Monitor	10	µg/l	Weekly	Grab
1,1 Dichloroethene	Monitor	7	µg/l	Weekly	Grab
Benzene	Monitor	5	µg/l	Weekly	Grab
Carbon Tetrachloride	Monitor	4	µg/l	Weekly	Grab
Chloroform	Monitor	70	µg/l	Weekly	Grab
cis-1,2 Dichloroethene	Monitor	10	µg/l	Weekly	Grab
trans-1,2 Dichloroethene	Monitor	10	µg/l	Weekly	Grab
Methylene Chloride	Monitor	10	µg/l	Weekly	Grab
sec- Butylbenzene	Monitor	50	µg/l	Weekly	Grab
Tetrachloroethene	Monitor	7	µg/l	Weekly	Grab
Trichloroethene	Monitor	10	µg/l	Weekly	Grab
Vinyl Chloride	Monitor	3	µg/l	Weekly	Grab

Note: The treatment facility consists of the dual phase extraction system and the pump-and- treat system installed in compliance with the NYSDEC Record of Decision for the cleanup of the groundwater contamination.

Additional Conditions:

(1) Discharge is not authorized until such time as an engineering submission showing the method of treatment is approved by the Department. The discharge rate may not exceed the effective or design treatment system capacity. All monitoring data, engineering submissions and modification requests must be submitted to:

Chief - Operation Maintenance and Support Section
Bureau of Hazardous Site Control
Division of Environmental Remediation
NYSDEC
50 Wolf Road
Albany, N.Y. 12233-7010

With a copy sent to:
Joe Marcogliese, RWE - 3
NYS Dept. of Env. Con.
200 White Plains Rd., 5th Fl
Tarrytown, NY 10591-5805

(2) Only site generated wastewater is authorized for treatment and discharge.

(3) Authorization to discharge is valid only for the period noted above but may be renewed if appropriate. A request for renewal must be received 6 months prior to the expiration date to allow for a review of monitoring data and reassessment of monitoring requirements.

(4) Both concentration (mg/l or µg/l) and mass loadings (lbs/day) must be reported to the Department for all parameters except flow and pH.

(5) Any use of corrosion/scale inhibitors or biocidal-type compounds used in the treatment process must be approved by the department prior to use.

(6) This discharge and adminstration of this discharge must comply with the attached General Conditions.

(7) ***This condition is applicable only when the max. flow rate of outfall 001 is 7200 GPD and outfall 001 consists of discharge only from the Dual Phase extraction system.***
The measurement frequency for all parameters of outfall 001except flow and pH shall be **Monthly** following a period of **eight** consecutive weekly sampling events that show no exceedance of discharge limits. If the discharge limit for any parameter is exceeded, the measurement frequency for **all** parameters shall again be **weekly**, until a period of eight consecutive sampling events that show no exceedance at which point Monthly monitoring may resume.