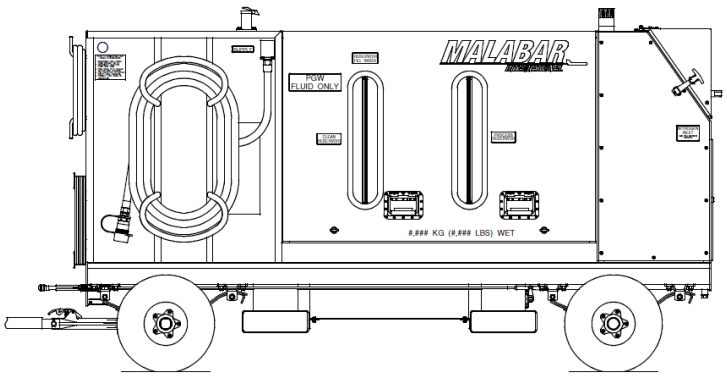
OPERATION & SERVICE MANUAL



Model: 1016
Coolant Service Cart (CSC)
Diesel-Electric
For Airbus A350 Aircraft

S/N 104 and Up

CE

06/2019 – Rev. 01

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TABLE OF CONTENTS

PAGE

1.0 PRODUCT INFORMATION 2
1.1 LIMITS OF USE 2
1.1.1 Other Limits 2
1.2 MODEL & SERIAL NUMBER 3
1.3 MANUFACTURER 3
2.0 SAFETY INFORMATION 3
2.1 USAGE AND SAFETY INFORMATION 3
2.2 GENERAL SAFETY INFORMATION 3
2.3 SHOCK HAZARD 3
2.4 HAZARDOUS MATERIALS INFORMATION – PGW (60% PROPYLENE GLYCOL, 40% WATER) 3
2.5 COMPRESSED GAS WARNING 3
2.6 STATIC GROUNDING 3
2.7 SAFETY GROUND 3
2.8 ROTATING EQUIPMENT HAZARD 3
2.9 PRESSURE HAZARD 4
2.10 SAFETY DEVICES AND GUARDING 4
2.10.1 General Information 4
2.10.2 Fan Guard 4
2.10.3 Battery Cover 4
2.10.4 Electrical Disconnect - Lockable 4
2.10.5 Control Panel Latch 4
2.10.6 Pressure Transducer 4
2.10.7 Emergency Stop Pushbutton 4
2.10.8 Relief Valves 4
2.10.9 Removable Access Panels & Covers 4
2.11 WARNING LABELS 5
2.12 WARNING LABELS - MODELS WITH GENERATOR SET 5
2.13 FIRE EXTINGUISHER 6
3.0 TERMS AND ABBREVIATIONS 6
4.0 INTRODUCTION 7
4.1 SCOPE 7
4.2 SYSTEM DESCRIPTION 7
4.2.1 System Functions 7
4.2.2 Major Components 7
4.3 THEORY OF OPERATION 10
4.4 SPECIFICATIONS 11
4.5 LEVEL OF NOISE EMISSION 11
5.0 TRAINING 12
5.1 TRAINING REQUIREMENTS 12
5.2 TRAINING PROGRAM 12
5.3 OPERATOR TRAINING 12
6.0 SYSTEM SETUP 13
6.1 POSITIONING THE COOLANT SERVICE CART 13
6.2 POWER CONNECTION 13
6.3 HOSE CONNECTIONS 13
6.4 ADAPTER KITS 13
6.5 VERIFYING HOSE AND ADAPTER CONNECTIONS 14
6.6 FILLING CLEAN RESERVOIR 14
6.7 DRAINING RESERVOIRS 14
7.0 OPERATION 15
7.1 GENERAL 15
7.2 PRIME MOVER 15
7.3 MODES OF OPERATION 15
7.4 CONTROLS AND INDICATORS 16
7.4.1 Control Panel 16
7.4.2 Main Power Disconnect Box 18
7.4.3 Drain And Sampling Valves 20
7.4.4 Miscellaneous Controls 22
7.5 TOUCHSCREEN INTERFACE 24
7.5.1 System Startup Screen 24
7.5.2 Main Navigation Screen 25
7.5.2.1 Prepare Empty Service Cart For Servicing Whole SCS 27
7.5.2.2 Filling Of Whole SCS 28

7.5.2.3 Drain Service Carts 30
7.5.2.4 Drainage Of Whole SCS 31
7.5.2.5 Prepare Empty Service Cart For Top Up Of Accumulator 33
7.5.2.6 Top Up Of Accumulator 34
7.5.2.7 Prepare Empty Service Cart And Top Up Consumer Unit 36
7.5.2.8 Drainage Of Consumer Unit 38
7.5.2.9 Alarm History Screen 40
7.5.2.10 Mode Recipe Edit Screen 41
7.5.2.11 Diagnostics Screen 42
7.6 PRE-OPERATION CHECKS 43
7.7 CONNECT CART FOR OPERATION 43
7.8 OPERATING PROCEDURES 43
7.8.1 Operating Sequence - Diesel Generator Operation (if so equipped) 43
7.8.1.1 Diesel Engine-Generator Start 43
7.8.1.2 Diesel Engine-Generator Shutdown 44
7.8.2 Operating Sequence - Electric Operation 44
7.8.2.1 Electric Operation Startup 44
7.8.3 CSC Operation 44
7.8.3.1 Operating Setup 44
7.8.3.2 Prepare Empty Service Cart For Servicing Whole SCS 45
7.8.3.3 Drain Service Cart Hoses 45
7.8.3.4 Drainage Of Whole SCS 45
7.8.3.5 Prepare Empty Service Cart For Top Up Of Accumulator 46
7.8.3.6 Prepare Empty Service Cart And Top Up Consumer Unit 46
7.8.3.7 Drainage Of Consumer Unit 46
7.8.3.8 Monitoring Operation 46
7.8.3.9 Stopping Operation 47
7.8.4 System Shutdown 47
7.9 SYSTEM FAULT LIST 48
7.10 MODE RECIPE EDIT 49
7.11 DIAGNOSTICS 49
7.12 CALIBRATION 49
7.12.1 Pressure Transducer Calibration Verification 49
7.12.2 Tank Level Transmitter Calibration Verification 51
7.12.3 Flow Meter Calibration Verification 52
7.12.4 Temperature Transmitter Calibration 52
8.0 REGULAR MAINTENANCE 53
8.1 MAINTAINING FLUID LEVELS 53
8.2 CHANGING FILTER ELEMENTS 53
8.3 SERVICING VACUUM TRAP 53
8.4 LUBRICATION 53
8.5 FUSES 54
8.5.1 Fuses In The Main Electrical Disconnect Enclosure 54
8.5.2 Fuses In The Control Enclosure 54
9.0 TROUBLESHOOTING 55
9.1 GENERAL 55
9.2 DIAGNOSTIC MODE 55
9.3 ELECTRICAL TROUBLESHOOTING 56
9.4 FLUID SYSTEM TROUBLESHOOTING 57
10.0 REPAIR 58
10.1 INTRODUCTION 58
10.2 MOTOR/PUMP ASSEMBLY REPLACEMENT 58
10.3 TOP UP PUMP/MOTOR ASSEMBLY REPLACEMENT 59
10.4 VACUUM PUMP ASSEMBLY REPLACEMENT 59
10.5 DIESEL GENERATOR SET REMOVAL 60
10.6 DIESEL GENERATOR SET REPAIR 61
10.7 CIRCULATION HEATER REPLACEMENT 61
10.8 ELECTRO-PNEUMATIC NITROGEN REGULATOR REPLACEMENT 62
10.9 DRAIN VALVE REPLACEMENT 62
10.10 SOLENOID REPLACEMENT (TYPICAL) 62
10.11 SOLENOID VALVE REPLACEMENT (TYPICAL) 63
10.12 TEMPERATURE TRANSMITTER REPLACEMENT (TYPICAL) 63
10.13 PRESSURE TRANSDUCER REPLACEMENT (TYPICAL) 63
10.14 FLOWMETER REPLACEMENT 64
10.15 TOWER HORN REPLACEMENT 64
10.16 GROUND CABLE REEL REPLACEMENT 65
10.17 MAIN POWER DISCONNECT ENCLOSURE REPAIRS 65

10.17.1 Variable Speed Drive (VFD) Replacement 65
10.17.2 Main Power Selector Switch (DISC A) Replacement 65
10.17.3 24 VDC Power Supply (PS1) Replacement 65
10.18 CONTROL PANEL REPAIR 66
10.18.1 HMI Touchscreen Replacement 66
10.18.2 Flow Sight Gauge Replacement 66
10.18.3 Emergency Stop Switch Replacement 66
10.18.4 Power On/Off Button Replacement 66
10.18.5 Hour Meter Replacement 66
10.18.6 PLC Module Replacement 67
10.19 RUNNING GEAR REPAIR 68
10.19.1 Wheel Bearing Service 68
10.19.2 Wheel Alignment 69
10.19.3 Brake Shoe Replacement 70
10.19.4 Spring Replacement 71
10.19.5 Rear Axle Replacement 72
10.19.6 Steering Knuckle And King Pin Replacement 73
10.19.7 Tie Rod End Replacement 74
10.19.8 Steering Lever And Pin Replacement 74
11.0 PREVENTATIVE MAINTENANCE SCHEDULE 75
11.1 GENERAL 75
11.2 PREVENTATIVE MAINTENANCE TABLES 75
11.3 MAINTENANCE SCHEDULE 76
12.0 PROVISION OF SPARES 77
12.1 SOURCE OF SPARE PARTS 77
12.2 RECOMMENDED SPARE PARTS LISTS 77
13.0 IN SERVICE SUPPORT 77
14.0 GUARANTEES/LIMITATION OF LIABILITY 77
15.0 APPENDICIES 78

This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., it suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

WARNING!

By contractual agreement:

ONLY persons who fully understand ENGLISH are permitted to operate, service or maintain this equipment.

CAUTION!

Aircraft manufacturer's specifications and instructions must be followed. In the event of contradiction between aircraft manufacturer's specifications and Malabar's, aircraft manufacturer's will prevail.

Note: Malabar model 1016000-1 & 1016000-2 are electric cord powered and have a diesel engine driven generator set to enable self-powered operation. Malabar model 1016000-3 & 1016000-4 are electric cord powered only. Functionally the units operate in an identical manner.

1.0 PRODUCT INFORMATION

1.1 LIMITS OF USE

The intended use of the model 1016 Coolant Service Cart is to service the coolant systems on a Airbus A350 aircraft and associated CU as specified in the Aircraft Maintenance Manual by aircraft and equipment maintenance personnel. Service means filling, bleeding, and draining the aircraft systems and CU using the approved coolant, PGW (see below for coolant information), or dry nitrogen. Aspects of use limits are listed below.

Modes of Operation:

- *Aircraft functions* (powered) circulate coolant and/or nitrogen through the equipment, external hoses and the aircraft or aircraft components;
- *Cart functions* (powered) circulate coolant and/or nitrogen within the machine or through the machine and external hoses;
- *Filling and draining* (powered or un-powered) include filling the clean reservoir manually or by using the machine's internal pump, or manually draining the waste reservoir;
- *Towing* (un-powered) requires a powered tow vehicle using the integral tow bar and lunette eye at a maximum speed of 5 mph (8 km/h) with power cord and hoses stowed;
- *Positioning* (powered or un-powered) involves minor re-positioning of the unit manually with the power cord and/or hoses either deployed or stowed.

Ergonomics: no accommodations are made for persons with handicaps. Operators and maintenance personnel are expected to possess average physical abilities (e.g. vision, hearing, size, strength).
Training: operators and maintenance personnel are required to have the requisite skills, to be trained on the proper use of the machine and to have read the owner's manual.
Safety of Unqualified Personnel in Vicinity: no special consideration is given to establishing a safe perimeter around the machine. The machine, stowed or operating under the control of a qualified operator presents no inherent danger to nearby disassociated personnel. The design of the machine protects against casual or inadvertent contact with hazards that may be associated with the machine.

1.1.1 Other Limits

Space Requirements: in order to use the cart as intended, it must be positioned in an open area, either in an aircraft hangar, equipment bay, or outdoors, usually adjacent to an aircraft being serviced. Sufficient clearance on all sides during operation of the machine is necessary for the operator or technician to gain free access to gauges, displays, hose and cord racks, service access panels and doors.
Calibration: periodic (generally annual) calibration verification of pressure safety and monitoring devices is required to maintain the inherent protection provided by these devices. Calibration is defined in this manual.
Preventative Maintenance & Repair: in order to use the cart as intended, repair and periodic preventative maintenance must be performed by qualified technicians as described in this manual and according to accepted standards and practices.
Language: the owner's manual, all documentation, machine placards and signage, instrument panel displays and labels are in English, to be consistent with the aircraft maintenance manual on the aircraft for which this machine was designed to service. Therefore, operators, service and maintenance personnel are required to have sufficient English language skills.
Environment: limits are defined in this manual. These include ambient temperature limits of -22oF to 122oF (-30oC to 50oC) and operation only in non-hazardous (no ignitable gasses, vapors or dust) areas, outdoors or indoors in well ventilated areas.
Surface conditions: the unit is expected to be towed and operated on even, relatively level, paved surfaces.
Service coolant: the unit is not approved for use with any coolants except the specified coolant, PGW (60% propylene glycol and 40% water).

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

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1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
E-mail: sales@malabar.com
Website: www.malabar.com

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions which are explained below. Please read carefully.

WARNING!
Warning is used to indicate the presence of a hazard that can cause ***severe personal injury, death, and/or substantial property damage*** if the Warning Notice is ignored.

CAUTION!
Caution is used to indicate the presence of a hazard, which will or can cause ***minor personal injury or property damage*** is the Caution Notice is ignored.

2.2 GENERAL SAFETY INFORMATION

This manual describes equipment that may cause injury to personnel, or damage to equipment if correct operation and maintenance procedures are not followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment.

Operators shall familiarize themselves with all operating procedures and safety precautions contained in this manual. If abnormal operating conditions are observed, the system should be shut down and the source of the problem investigated.

Do not use the CSC for purposes other than those described in this manual. See **Limits of Use**.

2.3 SHOCK HAZARD

The CSC cart has potentially fatal voltages applied during operation.

- Turn off the main Power Disconnect / Selector Switch before beginning any service procedure and ensure that the generator (if so equipped) is off.
- Before performing any work in the disconnect (lower) enclosure, verify that the Variable Frequency Drive (VFD) bus capacitors have discharged. Measure the DC bus voltage across the -DC and +DC terminals on the lower Power Terminal Block. The voltage must be zero. Darkened LED / LCD displays do not indicate that the capacitors have discharged to a safe voltage leve.

2.4 HAZARDOUS MATERIALS INFORMATION – PGW (60% PROPYLENE GLYCOL, 40% WATER)

The CSC and the aircraft systems being serviced are filled with a PGW (60/40) coolant mixture. Refer to the PGW SDS for details of toxicity of the fluid.

2.5 COMPRESSED GAS WARNING

The CSC uses compressed nitrogen gas to purge aircraft systems. Use caution when connecting nitrogen lines to cart. Sudden release of compressed nitrogen can create an environment of airborne particles that may enter eyes or penetrate skin. Always use nitrogen in a well ventilated area, never in a pit.

2.6 STATIC GROUNDING

The CSC ground clamp (ground reel) must be connected to the aircraft grounding point prior to operation to prevent a buildup of static electricity and static discharge.

2.7 SAFETY GROUND

Never operate the cart if the ground connection from the power cord or generator set has been disconnected or compromised in any way.

2.8 ROTATING EQUIPMENT HAZARD

Before accessing the main and top up pump-motor shaft couplings (pump adapters), turn off the main Power Disconnect / Selector Switch to avoid sudden or unexpected starts while touching the shaft coupling.

2.9 PRESSURE HAZARD

Before loosening any tube, hose, or reservoir fittings, ensure that the internal system pressure is zero by turning off the main Power Disconnect / Selector Switch. The internal vent valve (LV8) will bleed the return side pressure to the sub reservoir. If the supply pressure transducer shows trapped pressure, use the purge valve located by the supply hose rack to depressurize the supply and return hoses. Connect the supply to return hose in runaround configuration to relieve pressure.

2.10 SAFETY DEVICES AND GUARDING

2.10.1 General Information

Certain devices are installed on the coolant service cart for the purpose of safeguarding personnel and/or equipment. Their proper use is necessary for safe operation. Never operate the cart with any safety device removed or defeated.

2.10.2 Fan Guard

The radiator cooling fan on the generator set (if so equipped) is covered by a fan shroud to guard against hand/finger injury during operation. Do not remove this guard. Do not attempt to penetrate the openings in the guard with fingers or any tool.

2.10.3 Battery Cover

A 12V automotive type battery for starting the engine-generator (if so equipped) is located in the opening at the tow-bar end of the cart. The battery is contained inside a closed battery case with a removable cover. The cover protects against falling objects coming in contact with the live battery posts and from inadvertent touching. Keep the battery case cover in place at all times, even when the cart is not in operation.

2.10.4 Electrical Disconnect - Lockable

The main Power Disconnect Switch handle is interlocked with the electrical enclosure door to prevent enclosure access unless the power is off. The electrical enclosure door cannot be opened unless the Disconnect Switch is in the OFF position. The switch handle can be pad locked in the OFF position. DO NOT defeat this safety feature. Only qualified electrical technicians may enter the electrical enclosure: electrocution hazard. Lock-out / Tag-out procedures should be followed by anyone working on electrical or mechanical systems.

2.10.5 Control Panel Latch

The control panel is hinged and latched to the control enclosure behind it. The latch is a quarter-turn latch, requiring a tool (such as a screwdriver) to open it. To avoid electric shock and component damage, the control panel should remain closed and latched at all times except for service by a qualified technician.

2.10.6 Pressure Transducer

All nine pressure transducers that monitor the various points in the fluid and nitrogen circuits are centrally located on the manifold block. The manifold block includes calibration ports and isolation valves. The pressure settings are listed in 4.4 Specifications. Periodic calibration verification is required and is described in 7.12 Calibration.

2.10.7 Emergency Stop Pushbutton

The Red Mushroom pushbutton on the control panel is used to immediately stop the coolant service cart in the event of an emergency. Pressing this button at any time will bring the main pump motor, top up pump motor, vacuum pump, nitrogen regulator, and circulation heater to a stop.

2.10.8 Relief Valves

Several pressure relief valves are located throughout the piping system and serve to limit operating pressure at various points within the system. These relief valves can be adjusted externally, however, caution is advised: do not re-adjust any of these relief valves - system and/or aircraft damage could occur. Bench calibration under static conditions is the only reliable method to set the cracking pressure of these relief valves.

2.10.9 Removable Access Panels & Covers

It is not safe to operate the cart with any removable covers removed. These covers are attached to the cart body with screws and are for service access only.

2.11 WARNING LABELS

Observe the following warning labels where they appear on the cart:



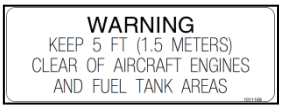
Electrical Hazard Warning: posted on any enclosure in which hazardous electrical potentials might exist. Exercise caution when opening or removing the cover.



High Voltage Warning: posted on electrical enclosures in which there is a risk of electrocution when energized. Access by qualified electricians only. Turn off or disconnect the electrical power source before accessing the enclosure.



Arc Flash And Shock Hazard Warning: posted on electrical enclosures in which there is a risk of arc flash and/or electrical shock when working on or near energized equipment in the enclosure. Qualified technicians only: use appropriate protective clothing, shields and apparatus. Access by qualified electricians only.



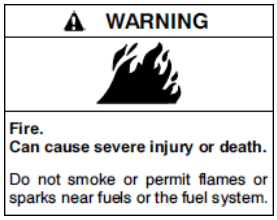
Explosion Hazard Warning: Do not operate this equipment under aircraft fuel tanks, engines, or where fuel vapors might exist within 5 ft. (1.5 meters) of the CSC.

2.12 WARNING LABELS - MODELS WITH GENERATOR SET

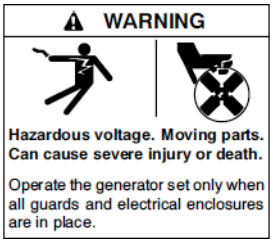


Two Sources Of Power Warning: posted on the main electrical enclosure of the CSC equipped with an on-board generator set. The equipment can be powered by either the line cord or the generator. Before servicing, be sure both sources of power are OFF and/or disconnected.

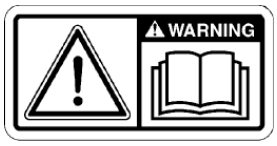
Warning labels found on the generator set are shown below. Refer to the generator set instruction manual for complete operation, maintenance, and safety information.



Engine Backfire/Flash Fire Warning: A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the fuel injection system, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuels or fuel vapors. Catch fuels in an approved container when removing the fuel line or fuel system.



Moving Parts Warning: Never operate the engine-generator set without all guards and covers in place.



Universal Warning: Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death

2.13 FIRE EXTINGUISHER

Carts with Genset Only
Generator set engine fuels and fuel vapors are flammable and explosive. Handle these materials carefully to minimize the risk of fire or explosion. Equip the CSC with a fully charged fire extinguisher. Select a fire extinguisher rated ABC or BC for electrical fires or as recommended by the local fire code or an authorized agency. Train all personnel on fire extinguisher operation and fire prevention procedures.

Recommended Fire Extinguisher Location on the CSC:
A fire extinguisher should be located in an area where it is highly visible and easily accessed. Do not locate the fire extinguisher in or immediately adjacent to the generator-set compartment. This is the area most likely to be engulfed in flames, making devices at that location potentially inaccessible.

The recommended location for a fire extinguisher on the CSC is at the rear (control panel end) of the cart. Suitable location is:
1. On the (vertical) rear body panel to the left of the lower electrical enclosure.

NOTE: Throughout this manual, references to the "right" or "left" side of the cart are to be interpreted as the user standing at the control panel, at rear of cart.

3.0 TERMS AND ABBREVIATIONS

AC .....Alternating Current
ACMS .....Aircraft Condition Monitoring System
ACU .....Air Cooling Unit
AMM .....Aircraft Maintenance Manual
C .....Contactor
CB .....Circuit Breaker
CCW .....Counterclockwise
CDM.....Coolant Distribution Module
CE .....Conformité Européenne ("CE" is a marking to indicate conformity with European legislative obligations)
CIRC .....Circulation
CP .....Cracking Pressure
CR.....Control Relay
CU .....Consumer Unit
CV.....Check Valve
DC.....Direct Current
EMI .....Electromagnetic Interference
FIG.....Figure
FT.....Flow Meter
FU .....Fuse
GENSET.....Generator Set
GSP .....Ground Service Panel
HMI .....Human Machine Interface
HTR .....Heater
LSH.....High Level Switch
LSL .....Low Level Switch
LT.....Level Transmitter
LV.....Solenoid Valve
MCR.....Master Control Relay
N2 .....Nitrogen
NV.....Needle Valve
OEM.....Original Equipment Manufacturer
P.....Pump
PGW .....Propylene Glycol / Water Solution
PLC.....Programmable Logic Controller
P/N .....Part Number
PT .....Pressure Transducer
QD .....Quick Disconnect
RTD .....Resistance Temperature Detector
RV.....Relief Valve
SCS .....Supplemental Cooling System
SV .....Sampling Valve
TCPL.....Temperature Compensated Pressure Level
TEFC .....Totally Enclosed, Fan Cooled
VCRU .....Vapor Cycle Refrigeration Unit
VFD.....Variable Frequency Drive

4.0 INTRODUCTION

4.1 SCOPE

This manual provides operation, maintenance, and repair procedures for the Model 1016 CSC manufactured by Malabar International for the Airbus A350 aircraft. The manual is intended for trained personnel responsible for maintaining the Supplemental Cooling System (SCS) and the Consumer Units (CU) which include the Vapor Cycle Refrigeration Unit (VCRU), small Air Cooling Unit (ACU), and SCS chillers. In addition to the information supplied by Malabar International, supplemental documentation for operation and maintenance of some subassemblies are provided in appendicies.

NOTE: Throughout this manual, references to the "right" or "left" side of the cart are to be interpreted as the user standing at the control panel, at rear of cart.

4.2 SYSTEM DESCRIPTION

The following paragraphs provide a description of the CSC functions, major components, and specifications.

4.2.1 System Functions

The CSC is a mobile service cart designed to FILL, DRAIN, and TOP UP the Airbus A350 aircraft SCS loops, and TOP UP and DRAIN the VCRU and small ACU/SCS chillers. Internal BLEED, DRAIN, PREHEATING, and DEAERATION modes are provided to allow conditioning of cart fluid prior to aircraft and/or CU servicing. The cart is electrically powered and has a diesel engine driven generator set to allow user selectable self-powered operation. The cart features a PLC based control system with a Human Machine Interface (HMI) touchscreen. Normal operation of the cart is semi-automatic with pre-programmed modes established for each of the aircraft systems. It can also be operated in a manual (Diagnostic) mode, allowing engineers to selectively control individual components of the cart, such as valves and pumps.

4.2.2 Major Components

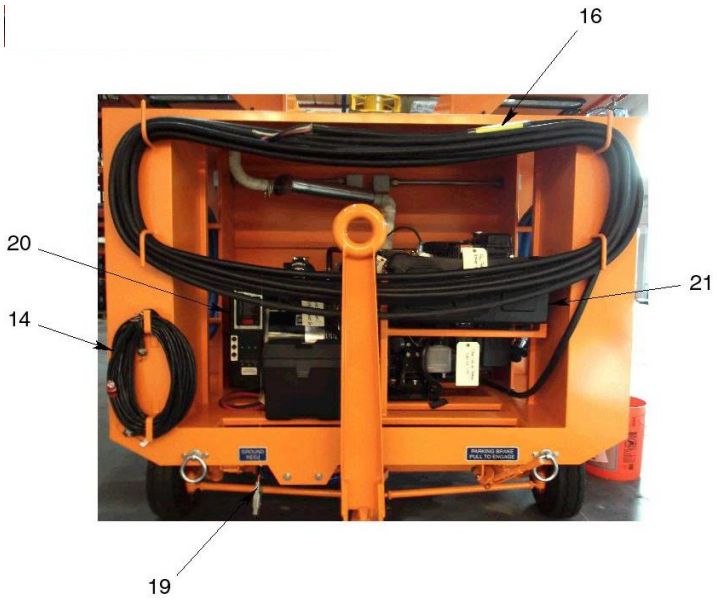
The following paragraphs describe the major components of the CSC. Refer to Figures.

1. **Control Panel:** The control panel provides the primary operator interface for the cart. Located at the rear of the cart, it has an HMI touchscreen monitor that is mounted on the hinged door of the main control enclosure that houses a PLC, control relays, interconnection terminal blocks, a heater thermostat, and an enclosure heater. Also located on the control enclosure are the Power On/Off Button, an hour meter, and an Emergency Stop. Located at either side of the control enclosure are the illuminated sight glasses for monitoring fluid aeration and drain status.
2. **Clean Reservoir:** A 45 gallon (170 l) useable capacity stainless steel cylindrical tank equipped with a level transmitter, low level switch, fluid sight gauge, vented fill cap with strainer, cleanout port, and drain valve is provided for storage of clean fluid.
3. **Sub Reservoir:** A 10 gallon (37.9 l) useable capacity insulated stainless steel cylindrical tank equipped with a level transmitter, high & low level switches, fluid sight gauge, vacuum and pressure relief valves, and drain valve is provided for fluid processing.
4. **Waste Reservoir:** A 45 gallon (170 l) useable capacity stainless steel cylindrical tank equipped with a high level switch, fluid sight gauge, vented fill cap with strainer, cleanout port, and drain valve is provided for collection of fluid purged from aircraft systems.
5. **Main Motor / Pump Assembly:** An internal gear pump close coupled to a 3 hp, 1750 rpm, 208-240 / 3 / 60VAC, ‘C’ face, TEFC electric motor that can output up to 20 gpm (75.7 l/min). This main pump is used for all modes of operation except for the Top Up of Accumulator mode.
6. **Top Up Motor / Pump Assembly:** An internal gear pump close coupled to a 1/3 hp, 1750 rpm, 208-240 / 3 / 60VAC, ‘C’ face, TEFC electric motor that can output up to 0.6 gpm (2.27 l/min). This top up pump is used for the Top Up of Accumulatorr.
7. **Supply Filter and Valve Assembly:** A manifolded system of filter and valves on the supply side of the fluid circuit designed to minimize fluid connections and piping. It contains a 12-micron absolute, non-bypass type filter. All directional valves have stainless steel bodies and are 24VDC solenoid operated.
8. **Return Filter Assembly:** A manifolded system of filter on the return side of the fluid circuit designed to minimize fluid connections and piping. It contains a 12-micron absolute, non-bypass type filter.
9. **Heater and Valve Assembly:** A 5.5 kW circulation heater and valves on the return side of the fluid circuit. All directional valves have stainless steel bodies and are 24VDC solenoid operated.
10. **Turbine Flow meter:** An exact dual rotor turbine flow meter with an integrated flow computer that provides flow rate information to the HMI touchscreen monitor. The flow meter is located in the supply line.
11. **Flow Sights:** Panel mounted, illuminated flow sights (3) are provided, one located upstream of the flow meter in the supply line, one in the return flow line to sub reservoir, and one in the drain flow line to waste reservoir.
12. **Vacuum Pump System:** A 24VDC motor driven vacuum pump, trap, muffler and vacuum regulator are provided to apply a vacuum to the reservoir for deaerating the fluid. The regulator is preset for 4 inches Hg (136 mbar) vacuum.

4.2.2 Major Components *(continued)*

13. **Supply and Return Hose Assemblies:** 50-ft (15.2 m) long PKR blue rubber covered, two steel wire braids reinforced, conductive PKR hoses with Parker flush face couplers/nipples installed at the ends. There is a supply and a return hose, and they are located at the front of the cart. The supply hose has the quick disconnect coupler at its end and the return hose has the quick disconnect nipple. This permits connection of a supply hose to a return hose to allow operation in a run-around mode to precondition the cart fluid or drain the cart system.
14. **Interconnection Cable Assembly:** A 60-ft (18.3 m) long 300V power limited tray cable used for interconnection between the service cart and the aircraft. It features a shell size 12 plug that plugs into the cart and a shell size 14 plug that plugs into the aircraft. The port is located at the rear of the cart while the cable assembly is stored at the front of the cart.
15. **Accessory Storage Box:** Located above the fork lift pockets on the right side of the unit, the storage box provides storage for a pocket pH meter, drain tube, and adapters for interfacing the cart to the aircraft.
16. **Cable and Cable Storage Rack:** There are two located at the front of the unit. One is designed to store the 100-ft (30.5 m) power cable that mates with the facility power receptacle and the other is designed to store the 60-ft (18.3 m) interconnection cablee.
17. **Main Power Disconnect / Selector:** An electrical enclosure, located below the control panel at the rear of the cart, houses the main Power Disconnect / Selector Switch (carts with genset), two variable speed pump drives for the main pump and top up pump, an EMI filter, a 24VDC power supply for the control system, a heater thermostat, and an enclosure heater.
18. **Nitrogen Drain System:** The cart incorporates a pressure regulator that can supply nitrogen at pressures up to 116 psia (8 bar abs) to assist in draining the aircraft SCS, CU, or service cart hoses into the waste reservoir. Nitrogen inlet connection is located at the rear of the cart above the interconnection cable port.
19. **Static Grounding Reel:** Used to connect to the aircraft grounding system during servicing operations. The grounding reel is located at the front lower section of the cart.
20. **Diesel Generator Set:** Models 1016000-1 and 1016000-2 have a 15 kVA diesel driven generator set for self-contained operation.
21. **Diesel Fuel Tank and Gauge:** The generator set (if so equipped) has an 8 gallon (30.3 l) fuel tank located above the engine. A fuel gauge is located in the top of the tank.
22. **Audible Alarm:** A surface mount tower horn is located above the control panel that will sound when a horn alarm occurs (silenced from the control panel).
23. **Enclosure and Running Gear:** The cart operating components are enclosed in a painted steel, weather resistant, sheet metal housing mounted on a four wheel, Ackerman steering trailer equipped with a towbar and lunette eye. Manually operated mechanical parking brakes on the rear wheels hold the cart while in operation or on a grade. The cart has a spring suspension and is equipped with foam filled or non-marking rubber tires. Fork lift pockets are provided on the frame for lifting along with tie-down rings for securing during transportation. Gull wing doors on each side permit access to internal components for maintenance and a hinged lift up cover at the rear, allows operator access to the controls.
24. **Pressure Transducer Manifold:** All nine pressure transducers (PT) that monitor the various points in the fluid and nitrogen circuits are centrally located on the manifold block. The manifold block includes calibration ports and isolation valves.





4.2.2 Major Components *(continued)*



4.3 THEORY OF OPERATION

The CSC is designed to service the supplemental cooling system on the Airbus A350 aircraft. The system circulates PGW coolant through the aircraft systems, filters it, deaerates it, and drains it. The cart can also be used to service consumer units including VCRU, small ACU, and SCS chillers. These will be referred to as CU hereinafter.

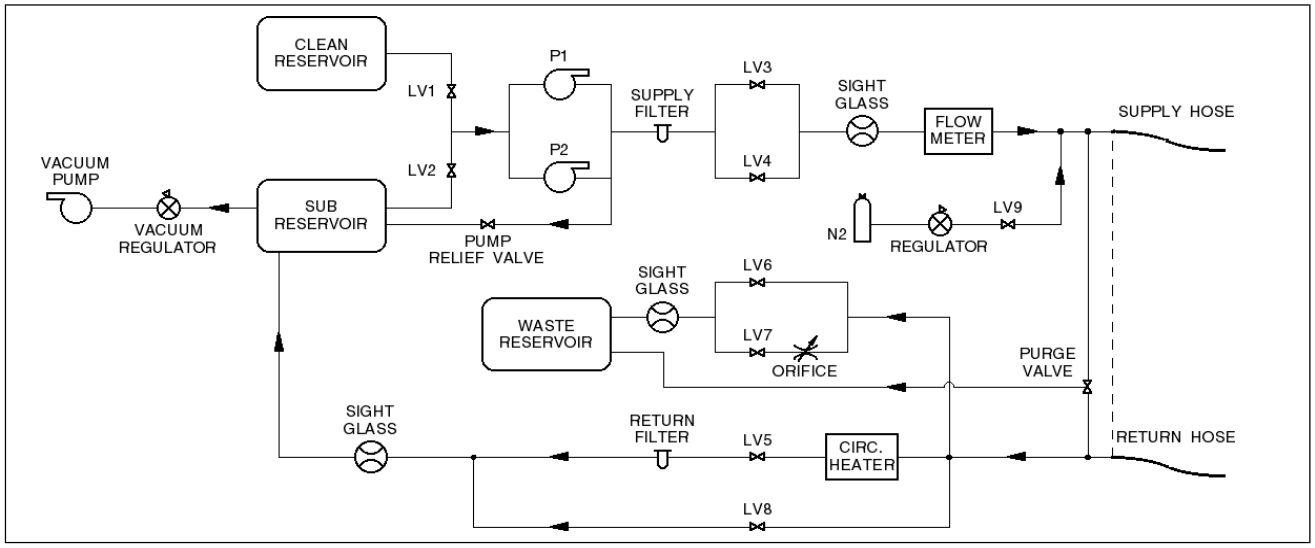
The cart uses two gear pumps: a 3 HP electric motor driven main pump (P1) that circulates coolant through the cart and the aircraft SCS, as well as a 1/3 HP top up pump (P2) that tops up the aircraft accumulator with low flow rate. The cart is powered by either a line cord or a water-cooled diesel generator set (if so equipped).

The coolant flow is directed by a selection of solenoid valves based on the selected service mode for the aircraft SCS and/or the service cart. Initially, the solenoid valve (LV1) opens and P1 draws coolant from the 45 gallon clean reservoir and sends it through the connected supply and return loop to fill up the sub reservoir. LV1 then closes and LV2 opens. From the sub reservoir, depending on the selected mode of operation, the coolant can pass through: (1) the supply filter, a sight glass, a flow meter, and supply hose to the aircraft (or return hose in runaround mode), (2) the solenoid valve (LV3) that opens in Top Up of CU mode which is protected by a relief valve, or (3) the pump relief valve, bypassing the supply filter.

Coolant returning from the aircraft system re-enters the cart through the return hose. Solenoid valves direct the fluid to either the sub or waste reservoir. Sight glasses monitor fluid condition in each circuit. The flow path to the sub reservoir also includes a 12 micron return filter. A complete set of adapter fittings is provided for connecting the hoses to the appropriate points on the aircraft. The entire coolant loop is protected from overpressure by factory preset relief valves and pressure transducers.
The sub reservoir on the cart is connected to a 24VDC vacuum pump and vacuum regulator that will maintain a vacuum on the sub reservoir to deaerate the coolant. This regulator is factory set at 4 inches Hg (136 mbar) vacuum. The vacuum pump is controlled by the regulator located above the sub reservoir.

CSC operation is controlled by an Allen-Bradley programmable logic controller (PLC) in conjunction with two variable frequency drives (VFD), relays, contactors, transducers, and other devices. By controlling the VFD (pump motor speed) and numerous solenoid valves the PLC controls the flow of coolant through the service cart and the aircraft.

For each service mode, the PLC system is pre-programmed with the required flow rate (motor speed), nitrogen regulator controller output, and valve configuration. The PLC system also monitors fluid levels in the clean and sub reservoirs, fluid temperature and filter differential pressures. The purge valve located by the supply hose rack is used to depressurize the supply and return hoses prior to connecting them in runaround when needed. The user of the coolant service cart uses an HMI touchscreen to select and perform various modes of operation. Certain user levels can access additional diagnostics and mode recipe edit functions, all of which are also accomplished by using the HMI touchscreen.



CSC Simplified Schematic

4.4 SPECIFICATIONS

Model Number	1016, Diesel/Electric
Unit Weight (dry)	3019 lbs (1369 kg)
Unit Weight (dry) with Genset	3779 lbs (1714 kg)
Shipping Weight (mobile-dry)	3510 lbs (1592 kg)
Shipping Weight (mobile-dry) with Genset	4270 lbs (1937 kg)
Fluid Weight, Operating (90 gal. onboard, typical)	780 lbs (354 kg)
Fluid	PGW (60% Propylene Glycol/Water, clear)
Rated Flow	0.25 to 13.2 gpm (0.95 to 50 l/min), variable
Pump Relief Valve setting (cp)	150 psia (10.3 bar abs)
Supply (outlet) Relief Valve setting (cp)	140 psia (9.7 bar abs)
Supply (outlet) Relief Valve setting for CU (cp)	43.5 psia (3 bar abs)
Supply (outlet) Pressure Transducer setting	145 psia (10 bar abs)
Supply (outlet) Pressure Transducer setting for CU	50 psia (3 bar abs)
Return (inlet) Relief Valve setting, Top Up of Accumulator (cp)	105 psia (7.2 bar abs)
Clean Reservoir, Usable Capacity	45 gal (170.3 l)
Waste Reservoir, Usable Capacity	45 gal (170.3 l)
Sub Reservoir, Usable Capacity	10 gal (37.9 l)
Supply Fluid Filter	12 micron absolute
Return Fluid Filter	12 micron absolute
Turbine Flow meter	0.25 to 15 gpm (0.95 to 56.8 l/min)
Aircraft Supply and Return Hoses	1 in ID, 50 ft. long (25.4 mm ID, 15.24 m long) conductive PKR
Vacuum Pump Capacity	0.39 cfm (0.011 m3/min) 25 in Hg vacuum (847 mbar)
Vacuum Regulator Setting	4.0 in Hg vacuum (136 mbar)
Nitrogen Inlet	7/16-20 (-4), 37° flared male port
Electro Pneumatic Nitrogen Pressure Regulator	3500 psia (241 bar abs) inlet max 0-116 psia (0-8 bar abs) outlet
Nitrogen Assisted Drain System Capacity	10 scfm @ 50 psia (16.99 m3/h @ 3.4 bar abs)
Ground Clearance	6.5 in (16.5 cm)
Maximum Towing Speed	5 mph (8 km/h)
Brakes	Parking brakes on rear wheels
Tires	Foam filled 16.00x9
Standard Finish	Yellow orange (RAL2000) Skydrol resistant paint
Power Cord	100 ft (30.5 m), 4-conductor hard-service cord (8 awg / 8.37 mm2, plug by customer)
Interconnection Cable	720 in (18.3 m)
Electrical Power Requirement	380/480V, 3Ph, 50/60Hz, 16A or 200/240V, 3Ph, 50/60Hz, 32A
Diesel Fuel Tank Capacity (carts with genset)	8 gal (30.3 l)
Diesel Fuel (carts with genset)	DF-2, DF-1, Jet A, Jet A-1
Operating Ambient	-30ºC to 50ºC (-22°F to 122°F)

4.5 LEVEL OF NOISE EMISSION

Equipment Description: Malabar model 1016, Coolant Service Cart
Operating Voltage: 480/3/60
Operating Conditions: The equipment was placed in the middle of a paved delivery yard and operated at nominal production rate. It was powered by genset with main motor/pump running at 13 gpm, vacuum pump running, and access doors removed.

Level of noise emission in conformance with ISO 4871

Sound pressure level LpA (reference 20 µPa) measured at the operator's station (dB) Electric power provided by embedded diesel generator	77
Uncertainty KpA (dB)	1
Sound pressure level LpA (reference 20 µPa) measured at the operator's station (dB) Electric power provided by connection to external power drop - Embedded diesel engine stopped	70
Uncertainty KpA (dB)	1

Levels measured with reference to standards ISO 11201: 1995, ISO 3744:1994

NOTE: The sum of a level measured with the associated uncertainty is the upper limit of the range in which the level measured may be located.

5.0 TRAINING

5.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the unit.

5.2 TRAINING PROGRAM

The employer provided operator training program should cover safety procedures concerning use of the unit in and around the intended aircraft at the intended aircraft servicing location.

5.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the unit.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

6.0 SYSTEM SETUP

6.1 POSITIONING THE COOLANT SERVICE CART

The CSC must be properly located before operation. The cart should be located so that the power cable can be readily connected to the facility power outlet ("Electric" Mode), and the supply and return hoses can be readily connected to the appropriate points on the aircraft.

Note: With the optional cart lifter, which is a heavy duty pallet lifter frame with fixed forks, it is possible to lift up the service cart using a crane instead of a forklift. The cart lifter (P/N 999-056) may be ordered separately from Malabar.

CAUTION!

The CSC cart must never be located within 5 feet of the aircraft envelope.

6.2 POWER CONNECTION

The cart is powered by standard 3-Phase facility power or by a water cooled diesel generator set (if so equipped). Connect the 100-foot power cord to a suitable power outlet in an appropriate location when operating in "Electric" mode.

6.3 HOSE CONNECTIONS

Before operating the service cart, the supply and return hoses must be removed from the cart, uncoiled, and connected to the appropriate connection points on the aircraft SCS or CU. The hoses are 50-foot long PKR blue rubber covered, two steel wire braids reinforced, conductive PKR hoses with Parker flush face couplers/nipples installed at the ends. The supply hose has a male quick-disconnect coupler on its end. The return hose has a female quick-disconnect nipple on its end.

To facilitate connections to the various aircraft systems, an A350 SCS Adapter Kit (p/n 1016309) and an A350 CU Adapter Kit (p/n 1016310) can be obtained from Malabar. There are seven adapters included in the kits. Refer to Airbus AMM for additional information on proper connections for different applications. These adapters can be stored in the tool box located on the right side of the unit above the fork lift channels. The following tables list the adapter part numbers and descriptions that are included in the 1016309 and 1016310 Adapter Kits.

6.4 ADAPTER KITS

Aircraft..... Airbus A350
Mates With ..... CSC - Model 1016, Includes storage compartments
Shipping Size ..... 16 in x 16 in x 20 in
1016309 Adapter Weight ..... 15 lbs
1016310 Adapter Weight ..... 30 lbs

Malabar International is an Airbus-licensed 1016309 tooling manufacturer. All parts are built to Airbus specifications.

1016309 ADAPTER KIT – SUPPLEMENTAL COOLING SYSTEM

Part Number	Description	Qty
1016305	GSP FILL ADAPTER	1
1016306	GSP DRAIN ADAPTER	1

1016310 ADAPTER KIT – CONSUMER UNITS

Part Number	Description	Qty
1016300	VCRU LOOP 1 FILL ADAPTER	1
1016301	VCRU LOOP 1 AND 2 BRIDGE ADAPTER	1
1016302	VCRU LOOP 2 DRAIN ADAPTER	1
1016303	SMALL ACU/SCS CHILLER FILL ADAPTER	1
1016304	SMALL ACU/SCS CHILLER DRAIN ADAPTER	1

6.5 VERIFYING HOSE AND ADAPTER CONNECTIONS

Before operating the service cart it is mandatory that the user physically check all the connections of the supply and return hoses and adapters. For additional information on the appropriate connections of hoses, refer to Airbus AMM.

6.6 FILLING CLEAN RESERVOIR

NOTE: The CSC clean reservoir should ONLY be filled with PGW (Propylene Glycol/Water) coolant. Use of any other coolant could result in damage to the system or the aircraft.

To fill the CSC clean reservoir:

1. Ensure the service cart power on/off button is off.
2. Ensure drain valve at bottom of reservoir is closed.
3. Remove fill cap on top of reservoir.
4. Fill reservoir with approved clean PGW fluid to 170 l / 45 gal indication.
5. Install fill cap and tighten.

Note: Optional smooth-flow drum pump (P/N 441-220) may be ordered separately from Malabar to assist with fluid transfer.



6.7 DRAINING RESERVOIRS

To drain the service cart reservoirs:

1. Ensure the service cart power on/off button is off.
2. Attach drain hose to hose barb connection at bottom of reservoir.
3. Observe reservoir level and place drain hose in container large enough to hold fluid.
4. Open reservoir drain valve located at bottom of reservoir to drain fluid.
5. Close drain valve and disconnect drain hose.

7.0 OPERATION

7.1 GENERAL

This section provides operation instructions for the CSC.

7.2 PRIME MOVER

The service cart can be set to operate on the following prime movers.
ELECTRIC: 10 hp 3-phase induction motor operated from facility AC power.
DIESEL: A water-cooled diesel engine-generator, self-powered (if so equipped).

7.3 MODES OF OPERATION

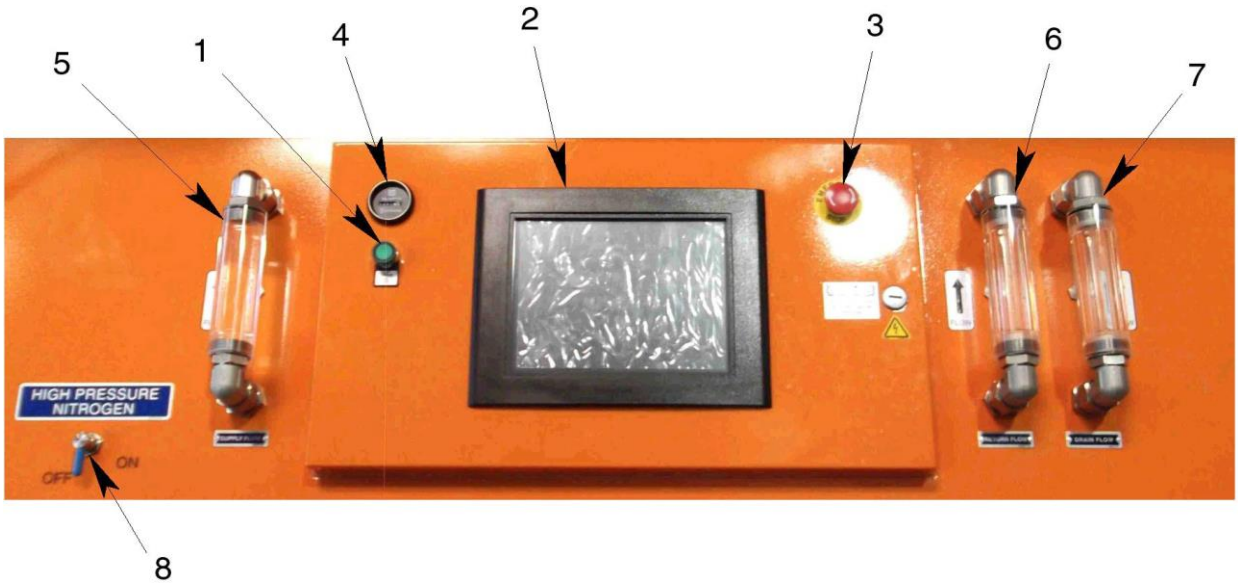
The CSC operates in nine different modes. The following paragraphs describe each of the operating modes.

PREPARE EMPTY SERVICE CART FOR SERVICING WHOLE SCS (90-100% EMPTY): This mode conditions the service cart coolant through filling sub reservoir to 10 gallons / 37.9 l, bleeding and preheat using the main hydraulic pump, vacuum pump and circulation heater prior to Filling of Whole SCS.
PREPARE EMPTY SERVICE CART FOR SERVICING WHOLE SCS (FULL): This mode conditions the service cart coolant through filling sub reservoir to 6 gallons / 22.7 l, bleeding and preheat using the main hydraulic pump, vacuum pump and circulation heater prior to Filling of Whole SCS.
FILLING OF WHOLE SCS: This mode uses the main pump to circulate coolant between the service cart and the aircraft SCS.
PREPARE EMPTY SERVICE CART FOR TOP UP OF ACCUMULATOR: This mode conditions the service cart coolant through filling sub reservoir and bleeding using the main hydraulic pump and vacuum pump prior to top up of accumulator.
TOP UP OF ACCUMULATOR: This mode uses the top up pump or the drain orifice to adjust the accumulator pressure with a specified amount of coolant.
PREPARE EMPTY SERVICE CART AND TOP UP CONSUMER UNIT: This mode conditions the service cart coolant through filling sub reservoir and bleeding using the main hydraulic pump and vacuum pump prior to top up of the CU (VCRU, small ACU, and SCS chillers).
DRAINAGE OF WHOLE SCS: This mode uses compressed N2 gas to purge coolant from the aircraft SCS into the waste reservoir.
DRAINAGE OF CONSUMER UNIT: This mode uses compressed N2 gas to purge coolant from the CU into the waste reservoir.
DRAINAGE OF SERVICE CART HOSES: In this mode, the supply and return hoses are connected for runaround and coolant is purged into the waste reservoir by compressed N2 gas.

7.4 CONTROLS AND INDICATORS

The following list all the controls, indicators, and manually operable components on the CSC.

7.4.1 Control Panel



Item	Name	Description
1	Power On/Off Button	Pushbutton that controls power to the coolant service cart. Light indicates ON
2	Touchscreen	Primary operator interface. See “Touchscreen Interface” for more information on use of the system software
3	E-Stop Switch	Pushbutton switch used to immediately stop all motion of the coolant service cart in the event of an emergency. To reset the switch, push the Power On/Off Button OFF, then twist/pull the E-Stop button out
4	Hour Meter	Digital meter that displays the cumulative operating time on the service cart
5	Supply Flow Sight Glass	A clear, backlit sight glass used to monitor supply fluid flow
6	Return Flow Sight Glass	A clear, backlit sight glass used to monitor return fluid flow
7	Drain Flow Sight Glass	A clear, backlit sight glass used to monitor drain fluid flow
8	Nitrogen Valve	Shutoff valve used to control regulated flow of nitrogen gas into the electro-pneumatic nitrogen regulator and controller during drainage

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7.4.2 Main Power Disconnect Box



7.4.2 Main Power Disconnect Box *(continued)*

Item	Name	Description
1	Power Selector Switch (carts with genset) Power Disconnect Switch (carts without genset)	Transfer Switch, 3-Position, disconnects power from the cart (POWER OFF), selects ELECTRIC (power cord), or DIESEL (generator set power) Disconnect Switch, ON-OFF, disconnects line cord power from the cart
2	Variable Frequency Drive VFD1 & VFD2	AC induction motor drive, controls motor/pump speed based on commands from the control system. VFD1 controls the main pump while VFD2 controls the top up pump
3	Input EMI Filter	Protects both VFDs from electromagnetic interference
4	DC Power Supply	Supplies 24VDC for the control circuit from incoming AC power
5	Circuit Breaker CB1	Main Circuit Breaker
6	Circuit Breaker CB2 (380-480V units only)	Transformer Primary Circuit Breaker
7	Circuit Breaker CB4	Circulation Heater Controller Circuit Breaker
8	Circuit Breaker CB5	VFD2 Circuit Breaker
9	Circuit Breaker CB6	VFD1 Circuit Breaker
10	Fuses FU1 & FU2	Enclosure Heater & DC Power Supply Fuses, AC line voltage (see 8.0 Maintenance for type)
11	Fuse FU3	Vacuum Pump Fuse, 24VDC (see 8.0 Maintenance for type)
12	Enclosure Heater HTR1	Raises the internal enclosure temperature to 14°F (-10°C) for the internal devices in cold ambient conditions
13	Enclosure Heater Thermostat	Controls the enclosure heater to regulate the temperature inside the enclosure
14	Circulation Heater Controller	Controls the circulation heater
15	Contactor C1	Vacuum Pump Contactor
16	Contactor C2	Power Supply Contactor
17	Contactor C3	Circulation Heater Controller Contactor
18	Contactor C4	VFD Contactor
19	Control Relay CR3	Enclosure Heater HTR1 Control Relay
20	Control Relay CR4	Enclosure Heater HTR2 Control Relay
21	Equipment Ground Bus	Common grounding point for all electrical grounds
22	Heating Light (on enclosure door)	Green light, ON while enclosure heating is on, thermostat controlled. Nothing else will turn on while enclosure heating is on

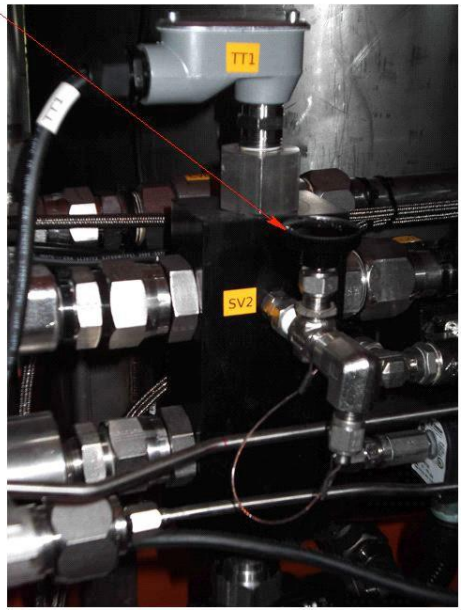
7.4.3 Drain And Sampling Valves



1

2

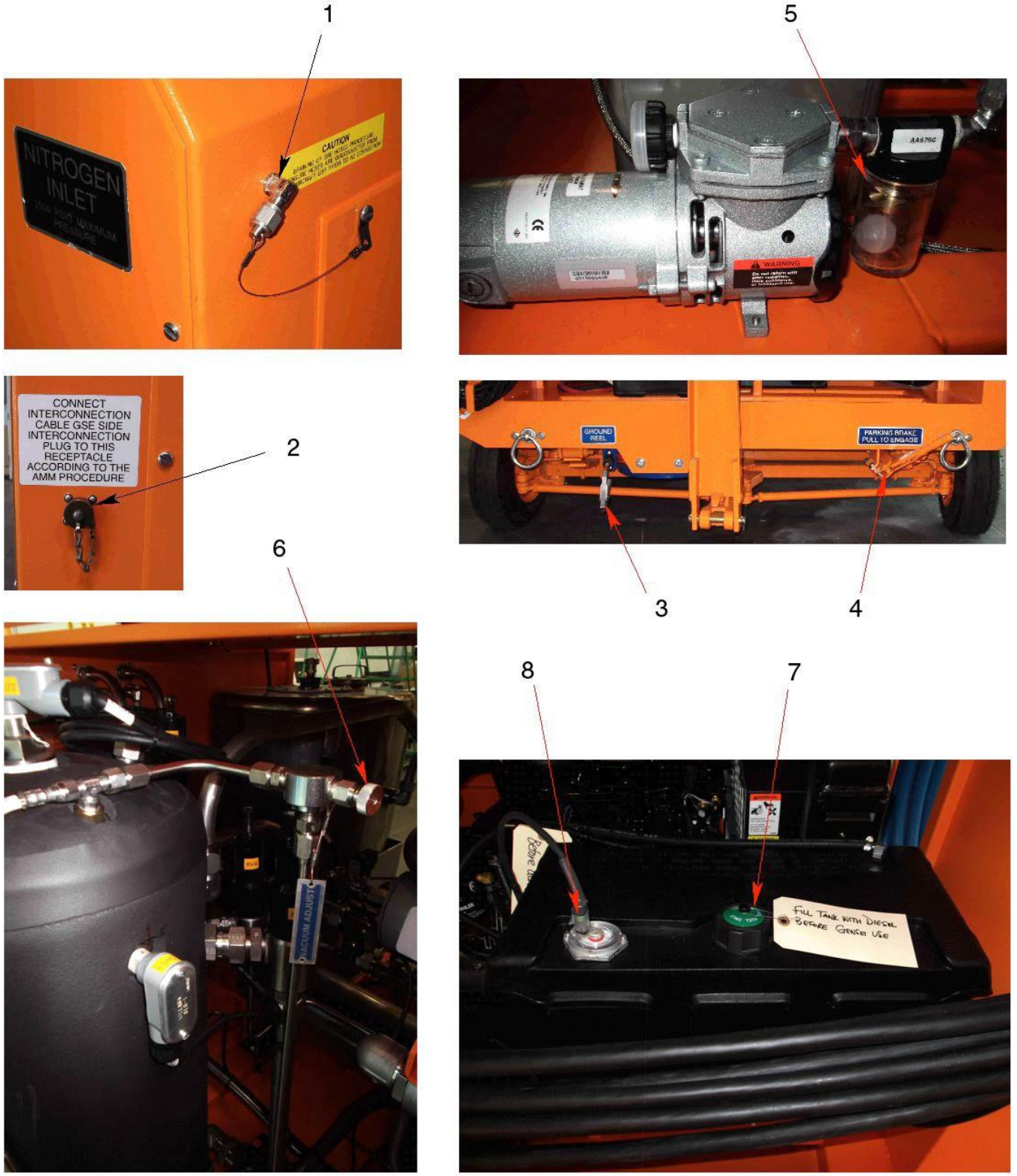




Item	Name	Description
1	Reservoir Drain Valves	Manually operated ball valve located beneath all three reservoirs at the reservoir low point; used to drain coolant from the reservoirs
2	Sampling Valves (SV1 & SV2)	Manually operated valves located on the exit manifolds of both the supply and return filters. These valves can be used to draw samples of the aircraft coolant for testing purposes

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7.4.4 Miscellaneous Controls



7.4.4 Miscellaneous Controls *(continued)*

Item	Name	Description
1	N2 Inlet	Standard nitrogen inlet port connected to the facility dry nitrogen supply
2	Interconnection Receptacle	To be plugged into with an interconnection cable that interlinks the coolant service cart with the GSP
3	Ground Reel	Static grounding reel located at the front of the service cart. The grounding cable must be connected to the aircraft grounding system prior to any operation to prevent static discharge
4	Parking Brake	Hand operated parking brake that activates drum brakes on the rear axles to prevent the cart from rolling
5	Vacuum Pump Trap	A glass trap that collects any fluid carryover from the vacuum pump and requires periodic servicing. Refer to Servicing Vacuum Trap on page 64 for more information
6	Vacuum Regulator	Adjusts reservoir vacuum
7	Diesel fuel fill cap (carts with genset)	Vented cap to fill diesel fuel using funnel or nozzle
8	Fuel Level Gage (carts with genset)	Displays diesel fuel level in fuel tank

7.5 TOUCHSCREEN INTERFACE

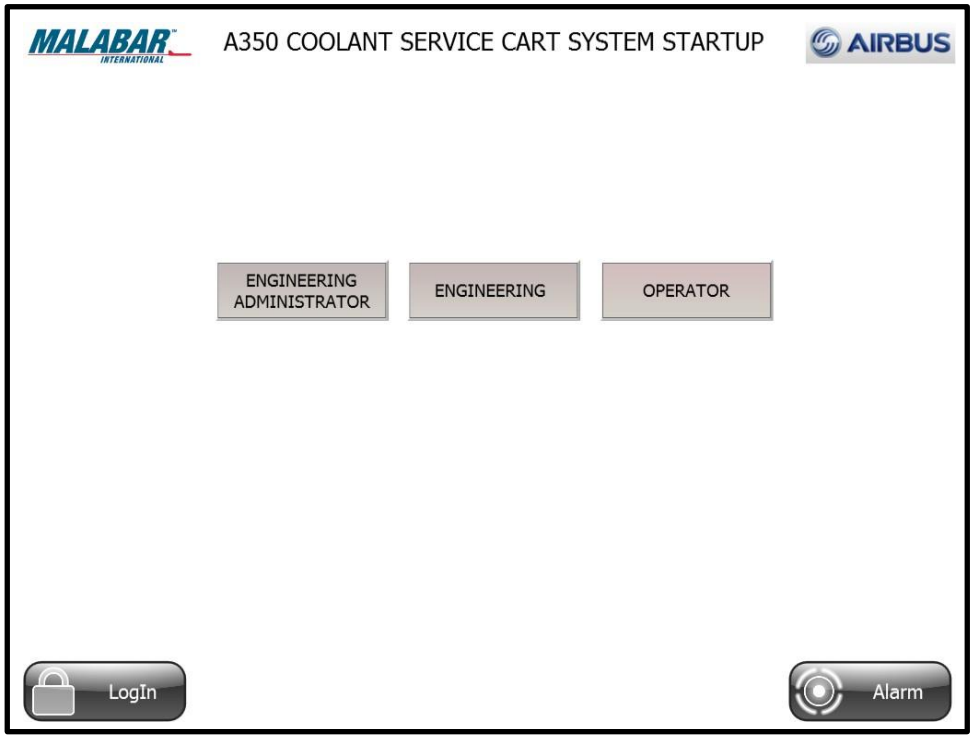
The touchscreen is the primary operator interface for the CSC. The following provides an introduction to the features of the touchscreen and detailed instructions on how to use it.

NOTE: If the ambient temperature is less than -10°C / 14°F, the cart will not run and the enclosure heaters will automatically activate and the heater light will illuminate on the lower disconnect enclosure. Heater light will turn off when run temperature is reached.

7.5.1 System Startup Screen

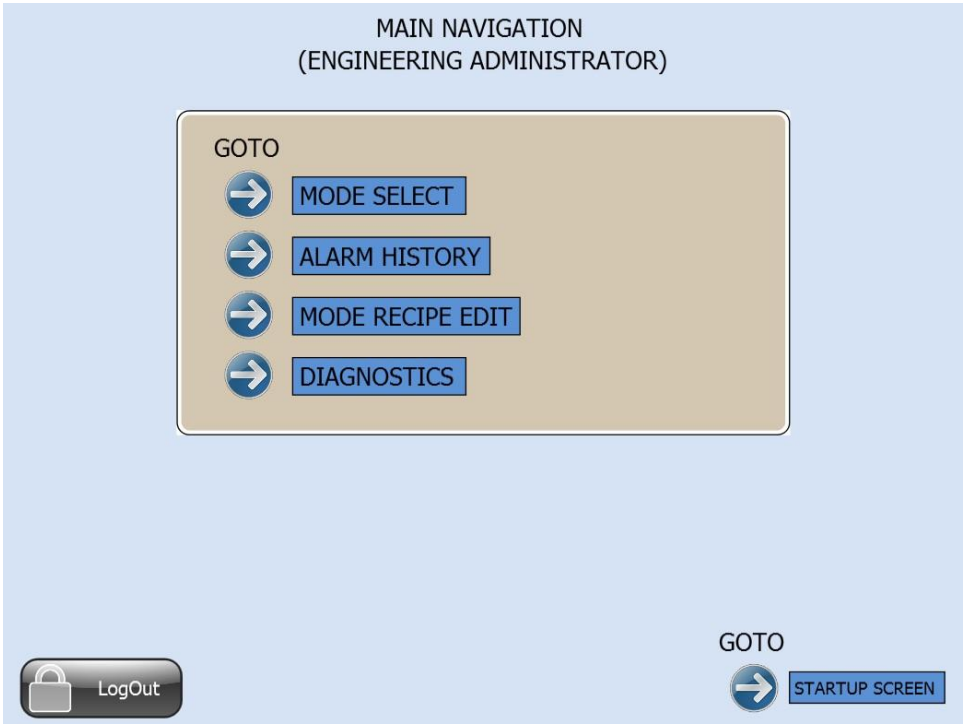
The SYSTEM STARTUP screen prompts the user to select one of three identities: **ENGINEERING ADMINISTRATOR** (Airbus & Malabar access only; password protected), **ENGINEERING** (password protected), and **OPERATOR**. Engineering administrators have access to all screens. Engineering users have access to the following screens: MODE SELECT, ALARM HISTORY, and DIAGNOSTICS. Operators have access to the following screens: MODE SELECT and ALARM HISTORY. The SYSTEM STARTUP screen also provides a button to access any alarms generated by the system. Once the user logs in, the MAIN NAVIGATION screen will come up.

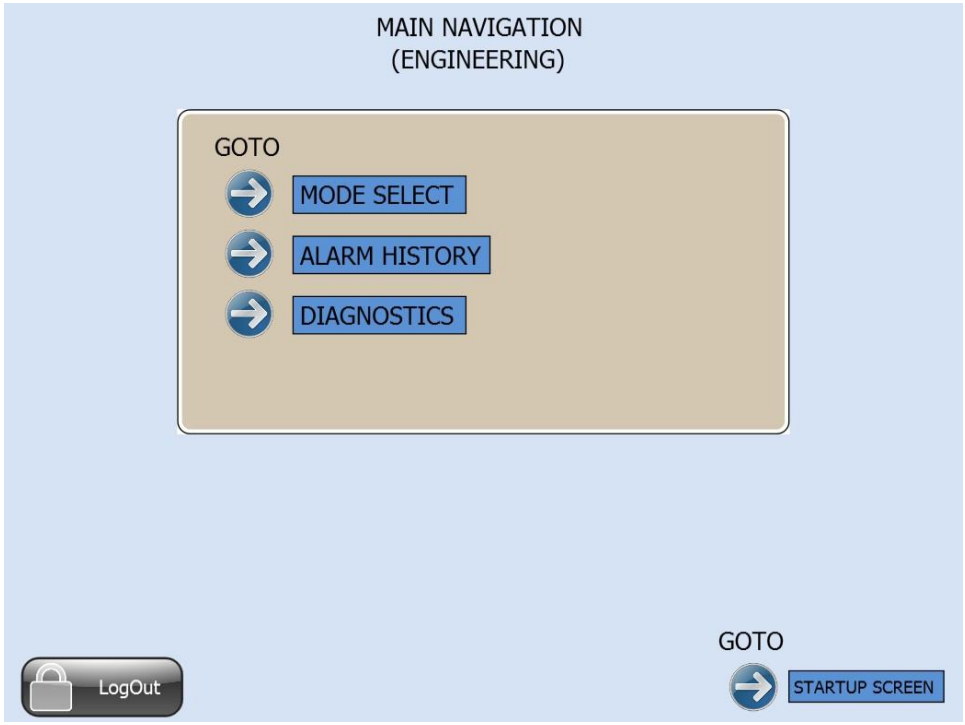
USER LEVEL	RUN DEFAULT CONFIGURATION	RUN DIAGNOSTICS	RUN MODE RECIPE EDIT
1 - Operator	✓		
2 - Engineering	✓	✓	
3 - Engineering administrator (Airbus & Malabar only)	✓	✓	✓



7.5.2 Main Navigation Screen

The MAIN NAVIGATION screen will be different depending on the user level.

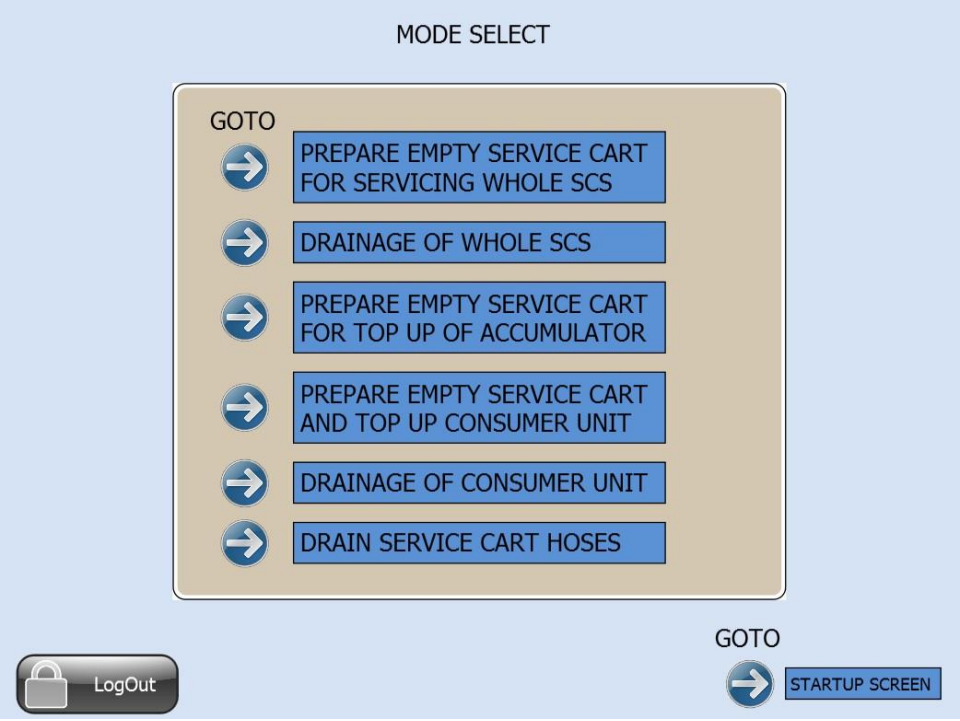




7.5.2 Main Navigation Screen *(continued)*

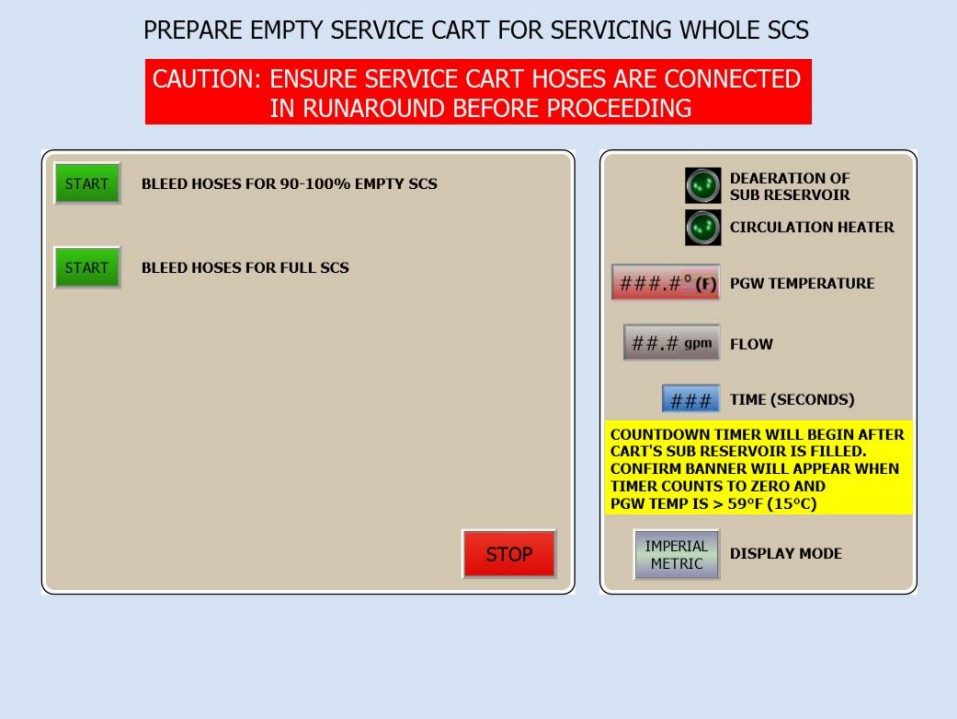


MODE SELECT SCREEN
The MODE SELECT screen shows a list of aircraft, CU and cart service modes for users to choose from.



NOTE: During any mode, pressing the red STOP button on the screen will shut down the pumps and/or the nitrogen regulator and summon a banner displaying "PROCEED WITH PROCEDURE?" Select YES to restart the interrupted procedure unless otherwise specified. Select NO to return to Mode Select.

7.5.2.1 Prepare Empty Service Cart For Servicing Whole SCS



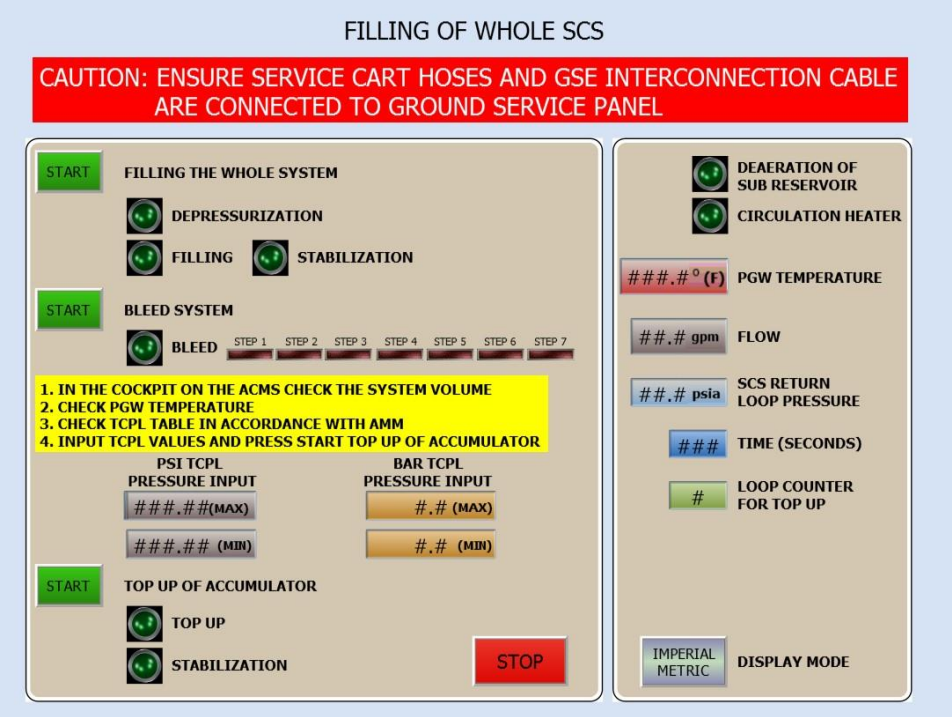
The PGW return temperature and the supply flow rate are displayed on the right side of the screen. The circulation heater will automatically preheat whenever the PGW temperature falls below 59°F (15°C) and heat until it is above 85°F (29.4°C). The circulation heater light on screen will illuminate while preheating is on. DEAERATION OF SUB RESERVOIR is an automatic sequence; the vacuum pump will deaerate the sub reservoir during PREPARE EMPTY SERVICE CART modes and FILLING OF WHOLE SCS.

The user shall connect the service cart supply and return hoses for runaround and then select either BLEED HOSES FOR 90-100% EMPTY SCS or BLEED HOSES FOR FULL SCS. If BLEED HOSES FOR 90-100% EMPTY SCS is selected, the main pump will run and fill the sub reservoir with 10 gal (37.9 l) of PGW. If BLEED HOSES FOR FULL SCS is selected, the main pump will run and fill the sub reservoir with 6 gal (22.7 l) of PGW. A banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will appear after two minutes and the user shall **CONFIRM** the banner to stop the bleeding process once full fluid stream is shown in the return flow sight.



The cart will automatically advance to the next mode, FILLING OF WHOLE SCS.

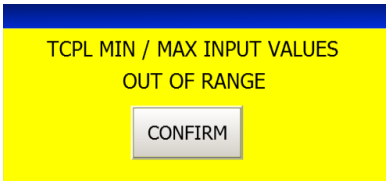
7.5.2.2 Filling Of Whole SCS



The user shall connect the service cart supply and return hoses to GSP with the appropriate QDs and then press the **START** FILLING THE WHOLE SYSTEM button. DEPRESSURIZATION will occur If the SCS return loop pressure is above 36.3 psia (2.5 bar abs), LV7 will open for up to five minutes to slowly depressurize the SCS return loop down to 36.3 psia (2.5 bar abs). When the green FILLING light illuminates on the screen, the main pump will pump PGW from sub reservoir to the aircraft SCS. If the sub reservoir low level trips, the clean reservoir will deliver additional PGW to fill the whole SCS. DEAERATION OF SUB RESERVOIR happens automatically in this mode. In addition, the circulation heater will auto heat the PGW from below 59°F to 65°F (15°C to 18.3°C) at the start of this mode, then it will auto heat from 65°F to 85°F (18.3°C to 29.4°C) at any time thereafter but prior to TOP UP OF ACCUMULATOR.

The FILLING cycle takes approximately six minutes to complete, at which point the user will be reminded to perform a visual check on the return flow sight for full fluid stream. FILLING is followed by STABILIZATION where the main pump will continue to run for additional 30 seconds. After this, the green BLEED light will illuminate to indicate that it is ready to bleed the system. During the seven bleed steps, the main pump will automatically speed up timed flow for each step and the whole bleeding process will take about 17 minutes to complete. If the user stops the bleeding process during steps 4~7, the process can be resumed only from step 4 to avoid initial high flow rate spike. Once BLEED is complete, the green TOP UP light will illuminate.

To begin the TOP UP OF ACCUMULATOR procedure, the user shall refer to the Temperature Compensated Pressure Level (TCPL) table in the AMM and, given the on-screen PGW temperature and the pressure tolerance from the TCPL table, manually input the corresponding maximum and minimum pressure values in either psia or bar abs on the touchscreen. Verify that the pressure inputs are not <59.5 psia (4.1 bar abs) or >94.3 psia (6.5 bar abs) and the pressure range is not >4.35 psia (0.3 bar abs), or a "**TCPL MIN/MAX INPUT VALUES OUT OF RANGE**" banner will appear and the user shall **CONFIRM** it and reenter new values.



7.5.2.2 Filling Of Whole SCS *(continued)*

When valid input values are entered, press the **START** TOP UP OF ACCUMULATOR button to start the procedure. The top up pump or LV7 will perform the task of pressurizing/depressurizing the SCS during TOP UP. Once within specified range, a STABILIZATION period of 60 seconds will begin. If the SCS loop pressure fails to be maintained within range during this process, the user shall confirm the pop-up banner to restart the procedure from TOP UP while increasing the loop counter by one.

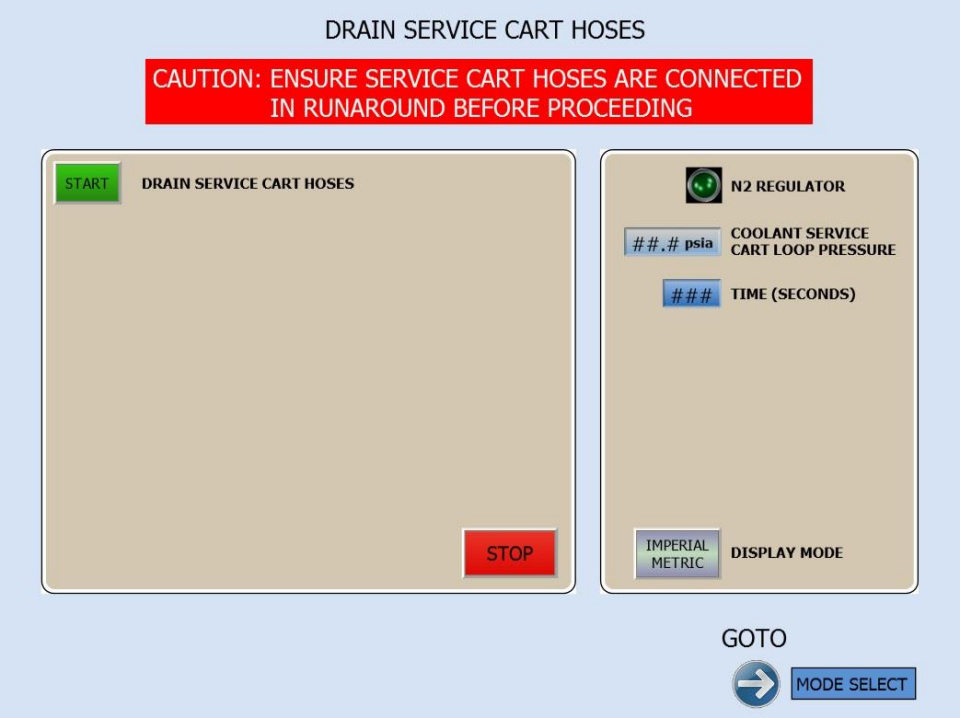


It may take multiple loops in order to achieve the input pressure range. If the SCS pressure is still out of range after five loops, the cart will automatically increase the tolerance of max pressure input by 1.45 psia (0.1 bar abs) and then try again. If the pressure is successfully kept within range through STABILIZATION, the service cart will notify the user that the procedure is finished.



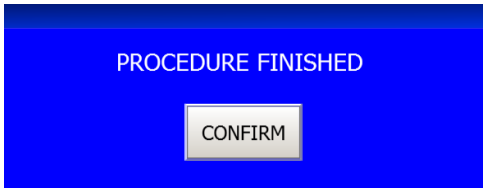
The cart will automatically advance to DRAIN SERVICE CART HOSES mode

7.5.2.3 Drain Service Carts

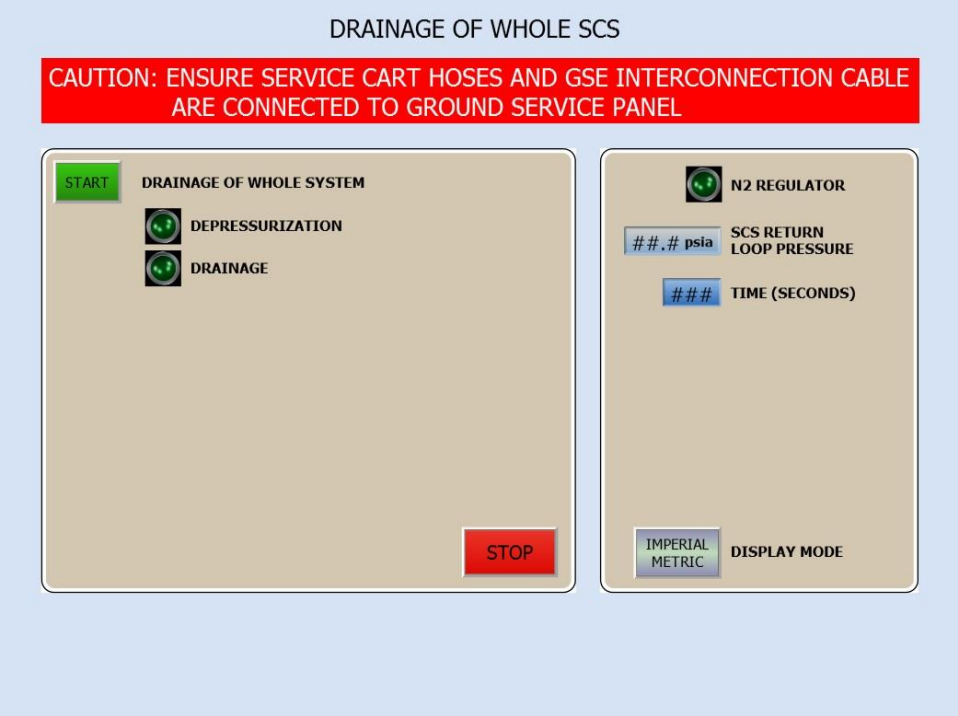


NOTE: To depressurize the service cart hoses prior to connecting them in runaround, the user shall push in and then pull out the purge valve located by the supply hose rack for five seconds to release the PGW from the return and supply lines respectively to the waste tank.

To drain the PGW to the waste reservoir, the service cart uses compressed nitrogen gas (customer furnished) controlled by an electro-pneumatic nitrogen regulator. The user shall ensure that an N2 bottle is connected to the cart N2 inlet and that the high pressure N2 panel valve is open. Once the DRAIN SERVICE CART HOSES procedure starts, the main pump will pump PGW out of the sub reservoir and into the waste reservoir until low level alarm trips (this alarm is not visual or audible), then the N2 regulator will quickly purge PGW from hoses into the waste reservoir. The service cart will notify the user that the procedure is finished and take advance to MODE SELECT.

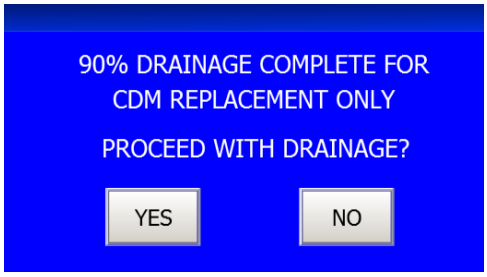


7.5.2.4 Drainage Of Whole SCS



The user shall connect the service cart supply and return hoses to GSP with the appropriate QDs. Once this mode starts, DEPRESSURIZATION will occur If the SCS return loop pressure is above 2.5 bar abs (36.3 psia), LV7 will open for up to five minutes to slowly depressurize the SCS return loop down to 2.5 bar abs (36.3 psia). To drain the PGW completely out of the system, the service cart uses compressed nitrogen gas (customer furnished) controlled by an electro-pneumatic nitrogen regulator.

Initially, the N2 regulator will increase the supply pressure gradually to 72.5 psia (5 bar abs) and hold for 10 minutes, then it is going to increase the pressure to 116 psia (8 bar abs) and hold for 12 minutes. At no time shall the return pressure be >36.3 psia (2.5 bar abs) and the N2 regulator will automatically back off pressure if necessary. When the countdown timer reads 570 seconds, in other words, after 150 seconds of high pressure drainage, a notification banner displaying "**90% DRAINAGE COMPLETE FOR CDM REPLACEMENT ONLY. PROCEED WITH DRAINAGE?**" will appear.

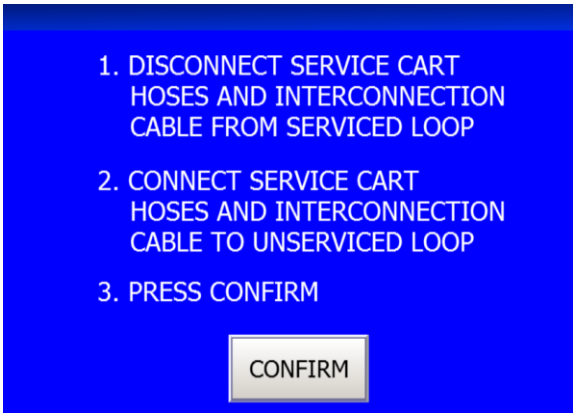


The user can visually see the drainage by checking the drain flow sight to determine whether to continue or stop the procedure. If YES, the drainage will continue until the timer counts down to zero. If NO, the N2 regulator will gradually decrease pressure to zero and shut off. The service cart will notify the user that the procedure is finished and ask to service next SCS.

7.5.2.4 Drainage Of Whole SCS (*continued)*

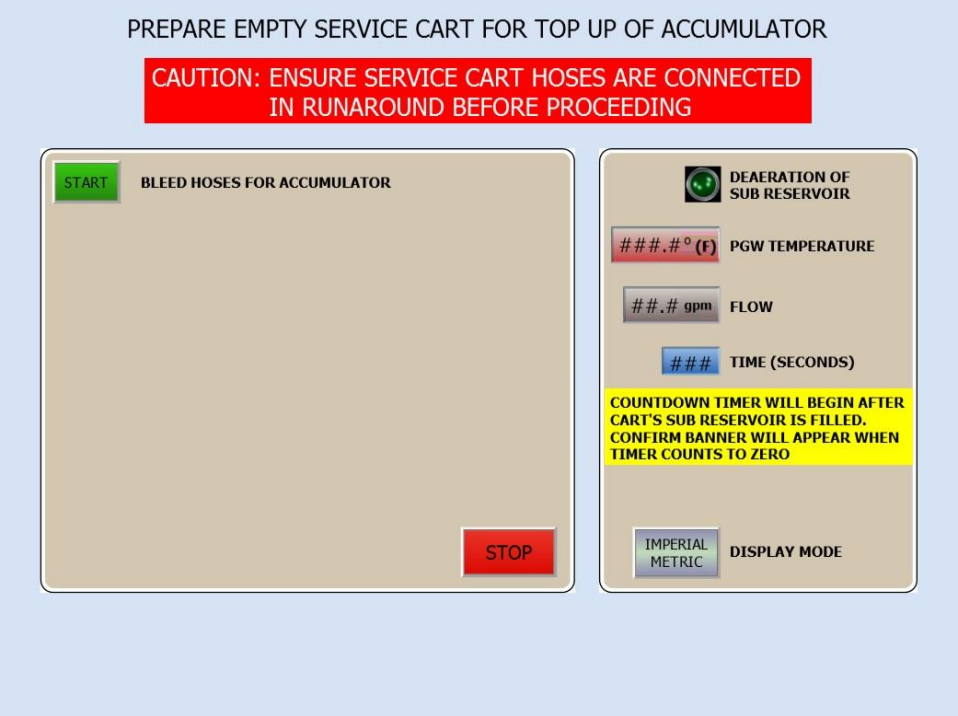


If answered YES, the user will be taken back to the beginning of DRAINAGE OF WHOLE SCS mode and will be reminded to connect a new SCS to the service cart.



If answered NO, the cart automatically goes back to MODE SELECT.

7.5.2.5 Prepare Empty Service Cart For Top Up Of Accumulator

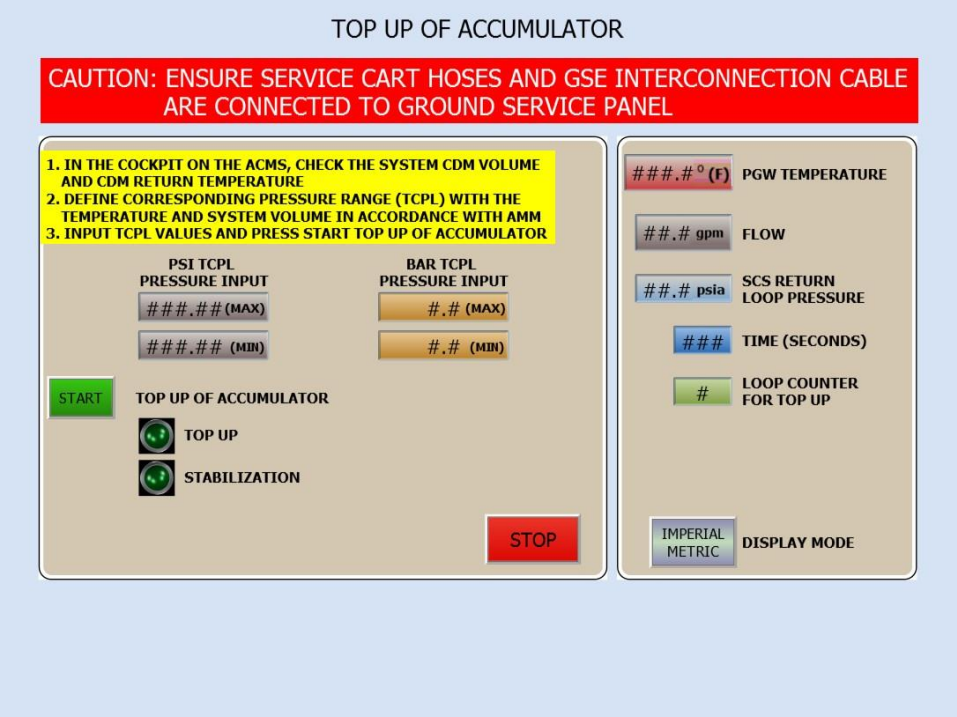


The user shall connect the service cart supply and return hoses for runaround and then press the **START** BLEED HOSES FOR ACCUMULATOR button. The main pump will fill the sub reservoir with 6 gal (22.7 l) of PGW while DEAERATION OF SUB RESERVOIR is running automatically in the background. A banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will appear after two minutes and the user shall **CONFIRM** the banner to stop the bleeding process once full fluid stream is shown in the return flow sight.

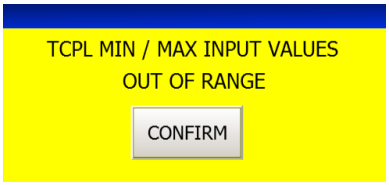


The cart will automatically advance to the next mode, TOP UP OF ACCUMULATOR.

7.5.2.6 Top Up Of Accumulator



The user will need to refer to the Temperature Compensated Pressure Level (TCPL) table in the AMM and, given the CDM return temperature on the ACMS in the cockpit and the pressure tolerance from the TCPL table, manually input the corresponding maximum and minimum pressure values in either psia or bar abs on the touchscreen. Verify that the pressure inputs are not <59.5 psia (4.1 bar abs) or >94.3 psia (6.5 bar abs) and the pressure range is not >4.35 psia (0.3 bar abs), or a "**TCPL MIN/MAX INPUT VALUES OUT OF RANGE**" banner will appear and the user shall **CONFIRM** it and reenter new values.

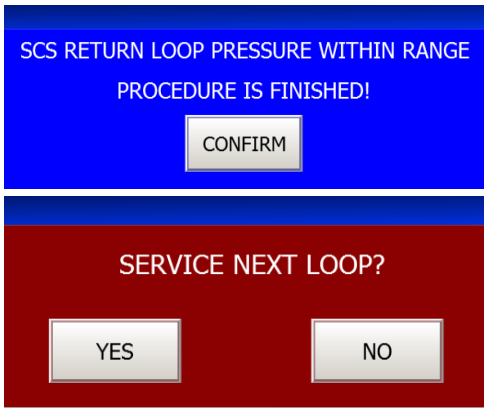


When valid input values are entered, press the **START** TOP UP OF ACCUMULATOR button to start the procedure. The top up pump or LV7 will perform the task of pressurizing/depressurizing the SCS during TOP UP. Once within specified range, a STABILIZATION period of 60 seconds will begin. If the SCS loop pressure fails to be maintained within range during this process, the user shall confirm the pop-up banner to restart the procedure from TOP UP while increasing the loop counter by one.

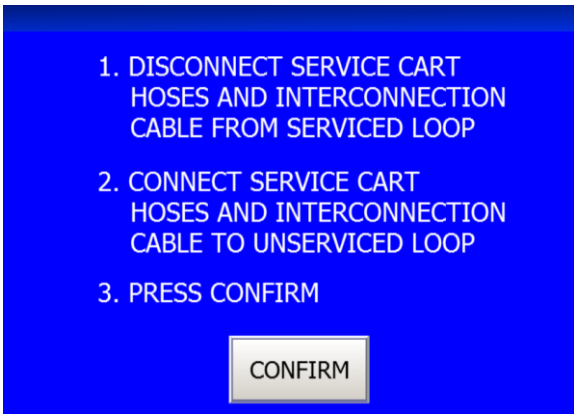


It may take multiple loops in order to achieve the input pressure range. If the SCS pressure is still out of range after five loops, the cart will automatically increase the tolerance of max pressure input by 1.45 psia (0.1 bar abs) and then try again. If the pressure is successfully kept within range through STABILIZATION, the service cart will notify the user that the procedure is finished and ask to service next SCS.

7.5.2.6 TOP UP OF ACCUMULATOR *(continued)*



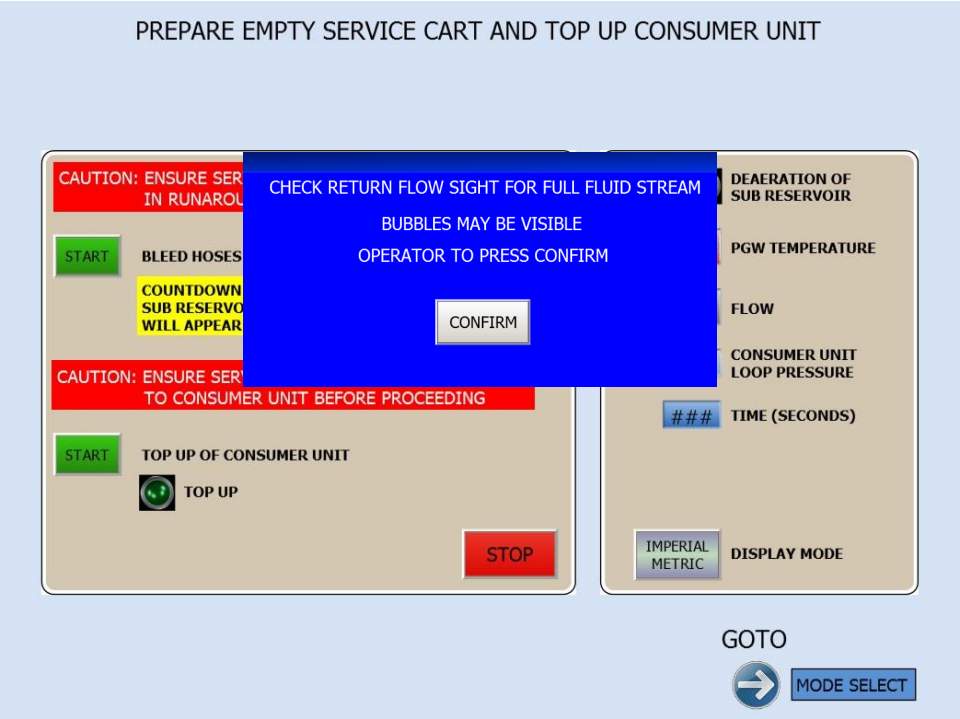
If answered YES, the user will be taken back to the beginning of TOP UP OF ACCUMULATOR mode and will be reminded to connect a new SCS to the service cart.



If answered NO, the cart automatically advance to DRAIN SERVICE CART HOSES mode.

7.5.2.7 Prepare Empty Service Cart And Top Up Consumer Unit

NOTE: This mode is for servicing VCRU and small ACU/SCS chillers.



The user shall connect the service cart supply and return hoses for runaround and then press the **START** BLEED HOSES FOR CONSUMER UNIT button. The main pump will fill the sub reservoir with 6 gal (22.7 l) of PGW while DEAERATION OF SUB RESERVOIR is running automatically in the background. A banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will appear after two minutes and the user shall **CONFIRM** the banner to stop the bleeding process once full fluid stream is shown in the return flow sight.

At this point the green TOP UP light will illuminate, indicating that it is ready to proceed to TOP UP OF CONSUMER UNIT. The user shall connect the service cart supply and return hoses with appropriate adapters to CU. For VCRU service, the user shall use the bridge adapter to connect loops 1 & 2.

Once the user presses the **START** TOP UP OF CONSUMER UNIT button, the main pump will run at 2.64 gpm (10 l/min) at 43.5 psia (3 bar abs) while not exceeding 72.5 psia (5 bar abs) for 90 seconds. The user shall **CONFIRM** the pop-up banner to stop the TOP UP process once full fluid stream is shown in the return flow sight.

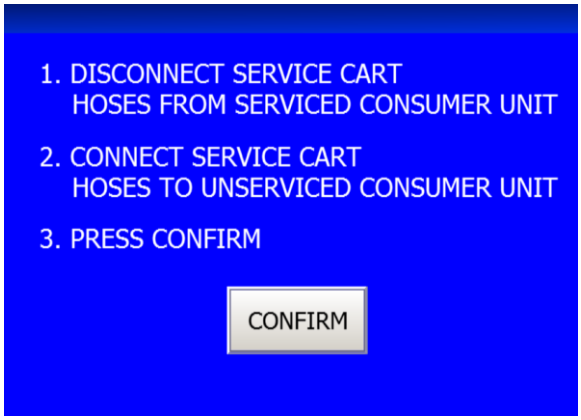


7.5.2.7 Prepare Empty Service Cart And Top Up Consumer Unit *(continued)*

The service cart will notify the user that the procedure is finished and ask to service next CU.

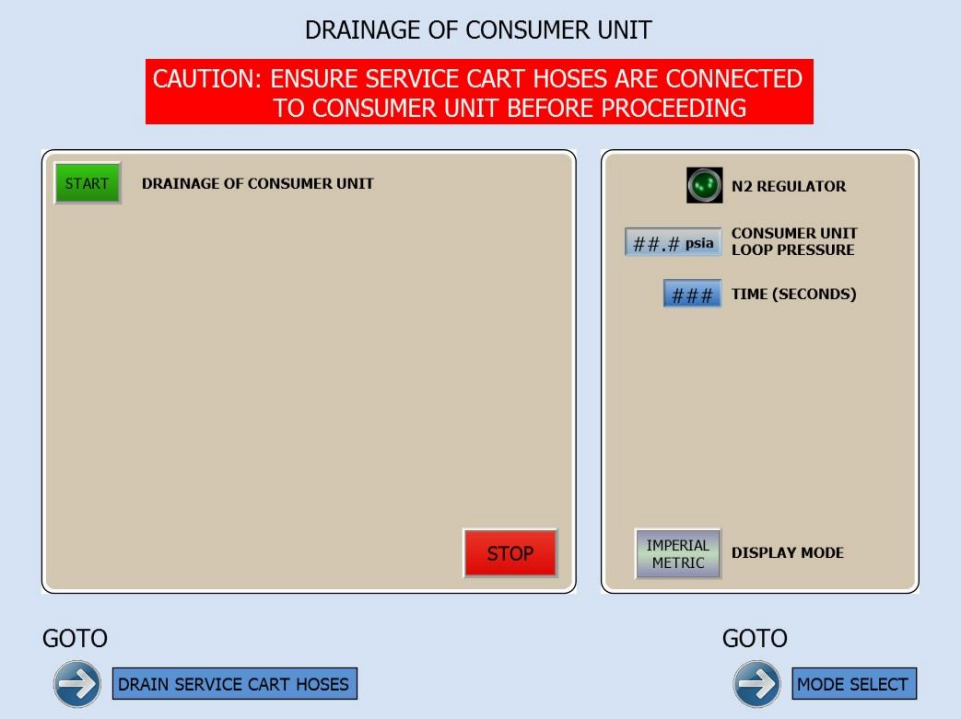


If answered YES, the user will be taken back to the beginning of TOP UP OF CU procedure and will be reminded to connect a new CU to the service cart.

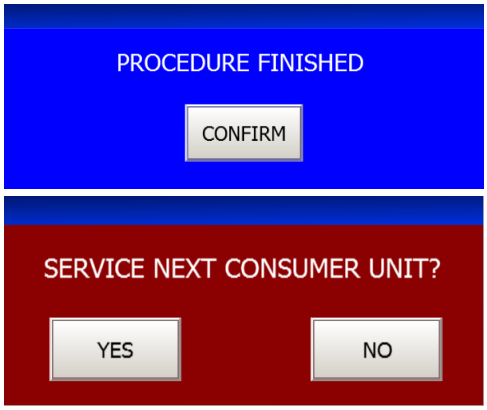


If answered NO, the cart will automatically advance to DRAIN SERVICE CART HOSES mode. The user shall disconnect service cart hoses from CU and bridge adapter from VCRU.

7.5.2.8 Drainage Of Consumer Unit

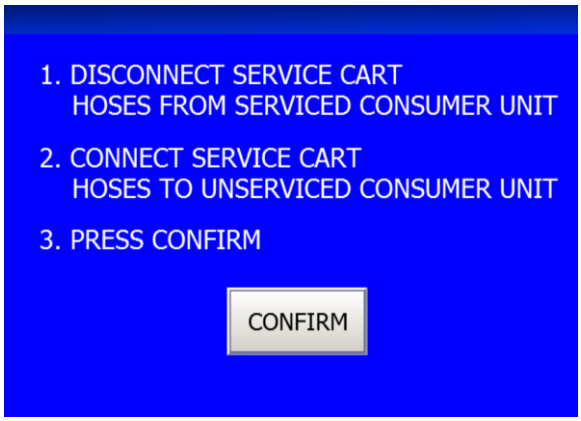


The user shall connect the service cart supply and return hoses with appropriate adapters to CU. For VCRU service, the user shall use the bridge adapter to connect loops 1 & 2. To drain the PGW from the CU to the waste reservoir, the service cart uses compressed nitrogen gas (customer furnished) controlled by an electro-pneumatic nitrogen regulator. The user shall ensure that an N2 bottle is connected to the cart N2 inlet and that the high pressure N2 panel valve is open. After starting DRAINAGE OF CONSUMER UNIT, the N2 regulator will gradually increase pressure to 43.5 psia (3 bar abs) and hold for 90 seconds to purge any PGW from CU into the waste reservoir. It will then decrease pressure back to zero and shut off. The service cart will notify the user that the procedure is finished and ask to service next CU.



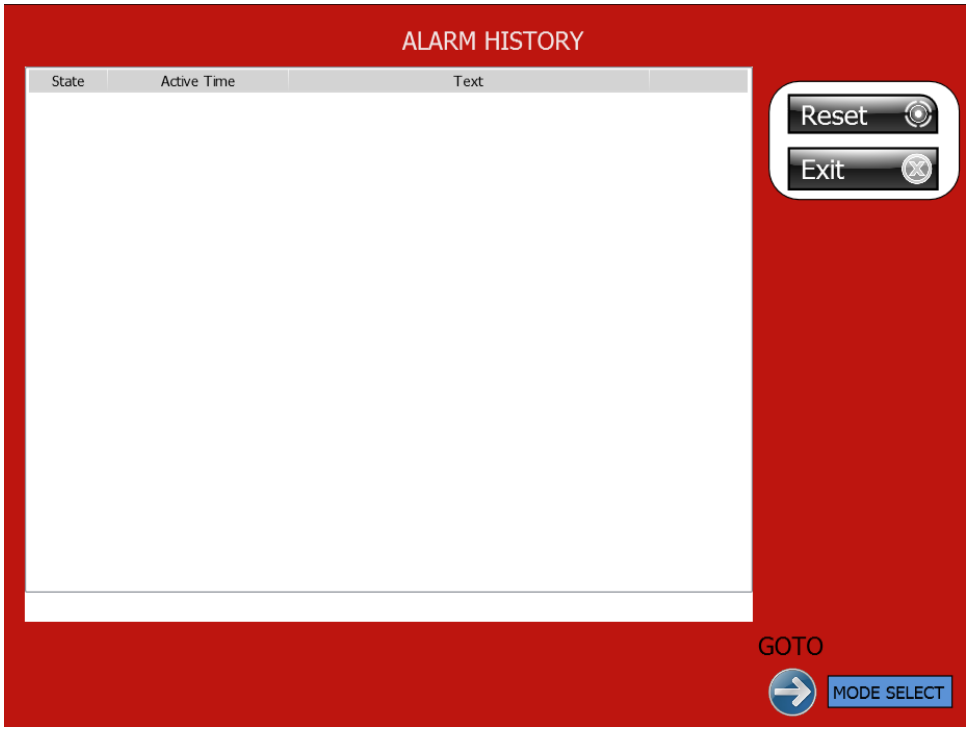
If answered YES, the user will be taken back to the beginning of DRAINAGE OF CONSUMER UNIT mode and will be reminded to connect a new CU to the service cart.

7.5.2.8 Drainage Of Consumer Unit *(continued)*



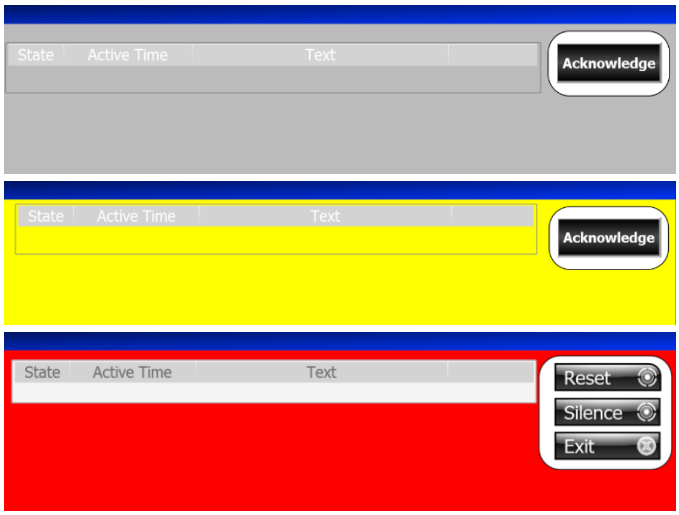
If answered NO, the cart automatically goes back to MODE SELECT. The user shall disconnect service cart hoses from CU and bridge adapter from VCRU.

7.5.2.9 Alarm History Screen



The Alarm History can be accessed from STARTUP and MAIN NAVIGATION screens. Alarms that have not been reset will be shown active. To deactivate an alarm after the problem is remedied, select it and press "**Reset**". To exit to previous screen, press "**Exit**".

If an abnormal condition is detected by the system, a gray banner (display notification), a yellow banner (warning alarm), or a red banner (shutdown alarm) with horn will be generated and displayed on screen.



The user may "**acknowledge**" the gray and yellow alarm banners to close them and continue the procedure, **"reset"** the red alarm banners after remedying the cause of alarm to return to normal operation, "**silence**" the red alarm banners to turn the horn off, or "**exit**" to close the alarm banner and silence the horn regardless if the alarm is reset. Alarms that are not reset will be shown active in Alarm History. All active shutdown alarms must be reset before the service cart can continue to operate.

7.5.2.10 Mode Recipe Edit Screen

NOTE: Can be accessed by user level 3 (Engineering administrator).

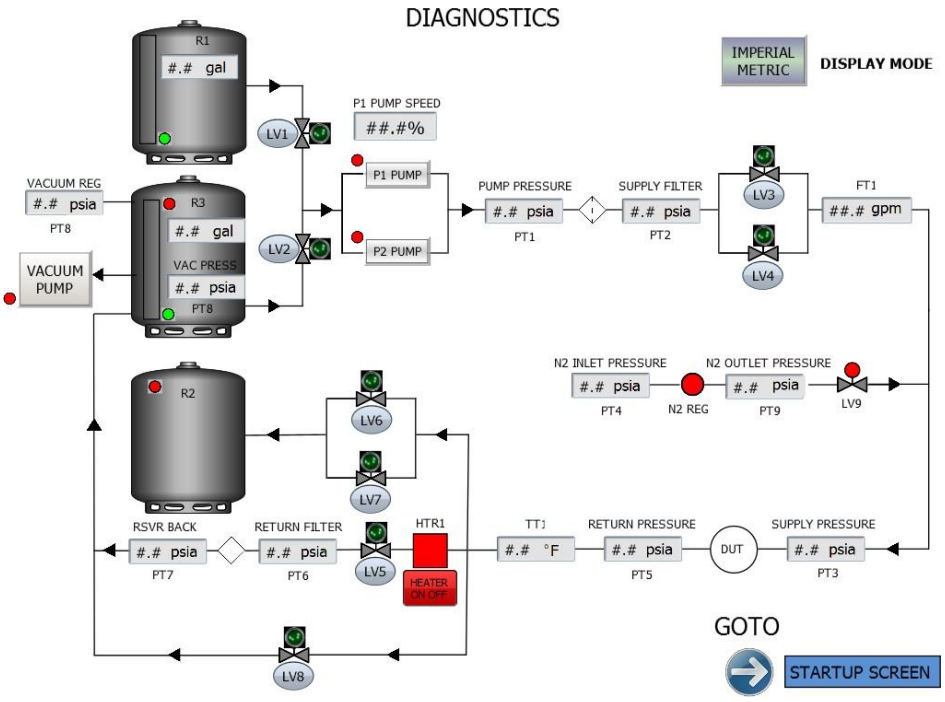
The MODE RECIPE EDIT screen allows the engineering administrator to set the coolant service cart's default operating parameters for the aircraft SCS and CU service modes. Within each mode the default values of TIMER and/or PUMP SPEED % for various sequences can be adjusted and then saved to the HMI touchscreen's internal storage in order to service different kinds of aircraft SCS and CU. This adjustment shall only be performed by MALABAR or AIRBUS and is protected with a special password.



7.5.2.11 Diagnostics Screen

NOTE: Can be accessed by user level 2 (Engineering) or higher.

The DIAGNOSTICS screen shows a simplified schematic of the coolant service cart. It can be used to manually operate system components, including the pumps, valves, and circulation heater. The screen also displays system parameters including main pump speed, pump pressure, filter pressure differentials, N2 regulator inlet/outlet pressures, fluid temperature and flow rate, reservoir levels, and reservoir vacuum pressure. The user can change the main pump speed % (from 10% to 55%) and toggle system components on (green) and off (red) to troubleshoot individual components or sections of the overall cart. All of the changes made are in effect only within the Diagnostic mode and will be discarded once the user exits the mode.



7.6 PRE-OPERATION CHECKS

Perform the following checks prior to operating the CSC.

1. Check the frame structure for rigidity. Make sure all bolts are tightened.
2. Check system for any fluid or gas leaks. Fix or tighten as required.
3. Check parking brakes for proper operation by pulling on brake handle.
4. Check power cable for damage such as cut insulation or frayed wires.
5. Check supply and return hoses for cover damage, kinks or separation at end fitting.
6. Check fluid levels in clean, sub, and waste reservoirs. Fill clean reservoir or drain sub and waste reservoirs as necessary.
7. Check fuel level in diesel tank (carts with genset). Top off as necessary.
8. Fully open the fuel valve under the diesel tank (carts with genset).
9. Be sure the Power Disconnect / Selector Switch on the rear of the unit is OFF prior to connecting the power cord or starting the diesel generator (if so equipped).

7.7 CONNECT CART FOR OPERATION

Perform the following procedures to connect the CSC system for operation.

1. Connect the static ground cable to the aircraft ground system.
2. Verify that the service cart power cord is connected to facility power when operating on electric power.
3. Verify that the interconnection cable is connected between the service cart and the GSP during aircraft SCS functions (Service Whole SCS and Top Up Accumulator). Check the direction stickers on cable to ensure cable connectors mate properly with their respective receptacles.
4. Ensure nitrogen bottle is connected to cart nitrogen inlet if Drainage operations are to be performed.
5. Connect supply and return hoses for runaround during service cart functions (Prepare Empty Service Cart and Drain Service Cart Hoses) or up to the GSP/CU using appropriate adapters during aircraft SCS/CU functions (Service Whole SCS, Top Up Accumulator, and Top Up/Drain CU).

7.8 OPERATING PROCEDURES

NOTE: The following procedures are provided only as a guide. Airbus Maintenance and/or Servicing Documentation shall take precedence over these procedures.

7.8.1 Operating Sequence - Diesel Generator Operation (if so equipped)



CAUTION!

Make sure the electrical power selector switch on the rear of the equipment is <u>off</u> before starting the diesel engine/generator. Always start the generator unloaded.

7.8.1.1 Diesel Engine-Generator Start

(REFER TO DYNAGEN POWER CONTROLS OPERATION INSTRUCTIONS)

1. With the Genset and Power Selector Switch off, set the coolant service cart control panel pushbuttons as follows:
   - Power On/Off Button: No light on
   - Emergency Stop Pushbutton: Out
2. Open fuel shut-off valve on bottom of diesel fuel tank.
3. Press the generator set controller AUTO button and then press the RUN button. The engine should start and run at normal speed. NOTE: The controller must be in the auto mode to activate the run button.
4. Allow the engine to reach normal operating temperature (2-3 minutes).
5. Turn the Power Selector Switch on the rear of the unit to the DIESEL position. The green heating light located on the power disconnect box will come on if the temperature is below -10°C / 14°F. The heaters will heat the enclosures to operating temperature, the green light will go out and the unit will be ready to operate.
6. Press the Power On/Off Button, which will light up. The touchscreen monitor and panel backlights should come on. Alarms, if any, will also activate. The system is now ready to start.
7. Refer to 7.8.3 CSC Operation for detailed information on running the cart.

7.8.1.2 Diesel Engine-Generator Shutdown

It is recommended that the engine be unloaded before it is stopped. Do this by performing the following steps in the order listed:

1. Turn off all loads before shutting off the diesel engine:
   - Log out on the touchscreen.
   - Press the Power On/Off Button to turn off the cart.
   - Turn the Power Selector Switch to the POWER OFF position.
2. Run the generator set at no load for at least two minutes to ensure adequate engine cooldown.
3. Press the generator set controller OFF button. The engine stops.

NOTE: The Emergency Stop button has no effect on generator set operation.

7.8.2 Operating Sequence - Electric Operation

7.8.2.1 Electric Operation Startup

1. Before turning on the Power Disconnect / Selector Switch on the front of the equipment, set the control panel pushbuttons as follows:
   - Power On/Off Button: No light on
   - Emergency Stop Pushbutton: OUT
2. Turn the Power Disconnect / Selector Switch to the ON / ELECTRIC position. The green heating light located on the power disconnect box will come on if the temperature is below -10°C / 14°F. The heaters will heat the enclosures to operating temperature, the green light will go out and the unit will be ready to operate.
3. Press the Power On/Off Button, which will light up. The touchscreen monitor and panel backlights should come on. Alarms, if any, will also activate. The system is now ready to start.
4. Refer to 7.8.3 CSC Operation for detailed information on running the cart.

7.8.3 CSC Operation

7.8.3.1 Operating Setup

1. On the touchscreen, select user identity and log in as required.
2. On the Main Navigation screen, press **MODE SELECT**.
3. Refer to 7.5 Touchscreen Interface for detailed explanations on each mode of operation.

NOTE: During any mode, pressing the red STOP button on the screen will shut down the pumps and/or the nitrogen regulator and summon a banner displaying "PROCEED WITH PROCESS?" Select YES to restart the interrupted procedure unless otherwise specified. Select NO to return to Mode Select.

NOTE: Ensure nitrogen bottle is connected to service cart nitrogen inlet.

7.8.3.2 Prepare Empty Service Cart For Servicing Whole SCS

1. Connect service cart supply and return hoses for runaround. Ensure hoses are uncoiled and relaxed to assist in hose bleeding.
2. On the MODE SELECT screen, select **PREPARE EMPTY SERVICE CART FOR SERVICING WHOLE SCS**.
3. If SCS is 90-100% empty, press the green **START** button next to BLEED HOSES FOR 90-100% EMPTY SCS. If SCS is full, press the **START** BLEED HOSES FOR FULL SCS button.
4. The sub reservoir will be filled to different levels depending on the selected procedure. Once filling is complete, a 120 second bleed timer will start counting down.
5. When timer reaches zero, a banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will pop up. Once full fluid stream is observed, **CONFIRM** the banner.
6. The service cart automatically advances to the next mode, Filling of Whole SCS.
7. Filling of Whole SCS:
   a. Connect service cart supply and return hoses to GSP with the appropriate QDs.
   b. **START** FILLING THE WHOLE SYSTEM. Depressurization will occur if SCS return pressure is > 36.3 psia (2.5 bar abs). The filling cycle takes about six minutes to complete.
   c. **CONFIRM** banner on touchscreen once full fluid stream is observed in return flow sight. STABILIZATION will start and run for additional 30 seconds.
   d. When the green BLEED light illuminates after STABILIZATION is complete, **START** BLEED SYSTEM to begin the seven steps of system bleed. STEP 1 runs for 60 seconds, STEPS 2 thru 6 each runs for 30 seconds while STEP 7 takes 810 seconds to complete
   e. Refer to the TCPL table in the AMM, check the on-screen PGW temperature and the pressure tolerance from the TCPL table, and input the maximum and minimum pressure values in either psia or bar abs on the touchscreen. *The inputs must be between 59.5 psia (4.1 bar abs) and 94.3 psia (6.5 bar abs) and the pressure range is not larger than 4.35 psia (0.3 bar abs).*
   f. **START** TOP UP OF ACCUMULATOR. If the input values are out of range, a banner will pop up and the user shall **CONFIRM** it and reenter new values. The top up pump or LV7 will perform the task of pressurizing/depressurizing the SCS during TOP UP. Once within specified range, a STABILIZATION period of 60 seconds will begin.
   g. If the SCS loop pressure fails to be maintained within range during STABILIZATION, the user shall confirm the pop-up banner to restart the procedure from TOP UP while increasing the loop counter by one. It may take multiple loops in order to achieve the input pressure range.
   h. If the pressure is successfully kept within range through STABILIZATION, the service cart will notify the user that the procedure is finished. The cart automatically advances to DRAIN SERVICE CART HOSES mode.

7.8.3.3 Drain Service Cart Hoses

1. Connect service cart supply and return hoses for runaround.
2. Open high pressure nitrogen panel valve.
3. **START** DRAIN SERVICE CART HOSES. The nitrogen regulator will gradually increase pressure to 43.5 psia (3 bar abs) and hold for 90 seconds before dropping to zero and shutting off. The procedure is finished.

7.8.3.4 Drainage Of Whole SCS

1. Connect service cart supply and return hoses to GSP with the appropriate QDs.
2. Open high pressure nitrogen panel valve.
3. On the MODE SELECT screen, select **DRAINAGE OF WHOLE SCS**.
4. **START** DRAINAGE OF WHOLE SYSTEM. Depressurization will occur if SCS return pressure is > 36.3 psia (2.5 bar abs). LV7 will open for up to 300 seconds to slowly depressurize the SCS return loop down to 36.3 psia (2.5 bar abs). The nitrogen regulator will gradually increase pressure to 72.5 psia (5 bar abs) and hold for 600 seconds. Then it will increase pressure to 116 psia (8 bar abs) and hold for 720 seconds.
5. Perform a visual check on drain flow sight for drained fluid.
6. A notification banner displaying **DRAINAGE COMPLETE FOR CDM REPLACEMENT ONLY. PROCEED WITH DRAINAGE?**" will appear when the countdown timer is at about 570 seconds. The user can visually see drain by checking the drain flow sight to determine whether to continue or stop the procedure. Select **"YES"** to continue draining until the timer counts down to zero or "**NO**" to stop draining. The nitrogen regulator will gradually decrease pressure to zero and shut off.
7. The service cart will notify the user that the procedure is finished and ask to "**SERVICE NEXT LOOP?**" If answered yes, the user will be taken back to the beginning of DRAINAGE OF WHOLE SCS mode and will be reminded to connect a new SCS to the service cart. If answered no, the cart automatically goes back to MODE SELECT..

7.8.3.5 Prepare Empty Service Cart For Top Up Of Accumulator

1. Connect service cart supply and return hoses for runaround. Ensure hoses are uncoiled and relaxed to assist in hose bleeding.
2. On the MODE SELECT screen, select **PREPARE EMPTY SERVICE CART FOR TOP UP OF ACCUMULATOR**.
3. **START** BLEED HOSES FOR ACCUMULATOR.
4. The sub reservoir will be filled to 6 gal (22.7 l). Once filling is complete, a 120 second bleed timer will start counting down.
5. When timer reaches zero, a banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will pop up. Once full fluid stream is observed, **CONFIRM** the banner.
6. The service cart automatically advances to the next mode, Top Up of Accumulator.
7. Top Up of Accumulator:
   a. Connect service cart supply and return hoses to GSP with the appropriate QDs.
   b. Check the CDM return temperature on the ACMS in the cockpit.
   c. Refer to the TCPL table in the AMM and, given the CDM return temperature and the pressure tolerance from the TCPL table, input the maximum and minimum pressure values in either psia or bar abs on the touchscreen.

      The inputs must be between 59.5 psia (4.1 bar abs) and 94.3 psia (6.5 bar abs) and the pressure range is not larger than 4.35 psia (0.3 bar abs).

   d. **START** TOP UP OF ACCUMULATOR. If the input values are out of range, a banner will pop up and the user shall **CONFIRM** it and reenter new values. The top up pump or LV7 will perform the task of pressurizing/depressurizing the SCS during TOP UP. Once within specified range, a STABILIZATION period of 60 seconds will begin.
   e. If the SCS loop pressure fails to be maintained within range during STABILIZATION, the user shall confirm the pop-up banner to restart the procedure from TOP UP while increasing the loop counter by one. It may take multiple loops in order to achieve the input pressure range.
   f. If the pressure is successfully kept within range through STABILIZATION, the service cart will notify the user that the procedure is finished and ask to "**SERVICE NEXT LOOP?**" If answered yes, the user will be taken back to the beginning TOP UP OF ACCUMULATOR mode and will be reminded to connect a new SCS to the service cart. If answered no, the cart automatically advances to DRAIN SERVICE CART HOSES mode.

7.8.3.6 Prepare Empty Service Cart And Top Up Consumer Unit

NOTE: This mode is for servicing VCRU and small ACU/SCS chillers.

1. Connect service cart supply and return hoses for runaround. Ensure hoses are uncoiled and relaxed to assist in hose bleeding.
2. On the MODE SELECT screen, select **PREPARE EMPTY SERVICE CART AND TOP UP CONSUMER UNIT**.
3. **START** BLEED HOSES FOR CONSUMER UNIT.
4. The sub reservoir will be filled to 6 gal (22.7 l). Once filling is complete, a 120 second bleed timer will start counting down.
5. When timer reaches zero, a banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will pop up. Once full fluid stream is observed, **CONFIRM** the banner.
6. Connect service cart supply and return hoses with appropriate adapters to CU. For VCRU service, use bridge adapter to connect loops 1 & 2.
7. **START** TOP UP OF CONSUMER UNIT. The main pump will run at 2.64 gpm (10 l/min) at 43.5 psia (3 bar abs) while not exceeding 72.5 psia (5 bar abs) for 90 seconds.
8. When timer reaches zero, a banner displaying "**CHECK RETURN FLOW SIGHT FOR FULL FLUID STREAM. BUBBLES MAY BE VISIBLE**" will pop up. Once full fluid stream is observed, **CONFIRM** the banner
9. Select **YES** or **NO** when prompted by a "**SERVICE NEXT CONSUMER UNIT?**" banner. If yes, procedure is performed again. If no, disconnect service cart supply and return hoses from CU. For VCRU service, disconnect bridge adapter.

7.8.3.7 Drainage Of Consumer Unit

1. Connect service cart supply and return hoses with appropriate adapters to CU. For VCRU service, use bridge adapter to connect loops 1 & 2.
2. Open high pressure nitrogen panel valve.
3. On the MODE SELECT screen, select **DRAINAGE OF CONSUMER UNIT**.
4. Press the **START** DRAINAGE OF CONSUMER UNIT button. The nitrogen regulator will gradually increase pressure to 43.5 psia (3 bar abs) and hold for 90 seconds before dropping to zero and shutting off. The procedure is finished.
5. Select **YES** or **NO** when prompted by a "**SERVICE NEXT CONSUMER UNIT?**" banner. If yes, procedure is performed again. If no, disconnect service cart supply and return hoses from CU. For VCRU service, disconnect bridge adapter

7.8.3.8 Monitoring Operation

If an abnormal condition is detected by the system, either a gray banner (display notification), a yellow banner (warning alarm) or a red banner (shutdown alarm) with audible alarm will be generated and displayed on screen. The user may "**acknowledge**" the gray and yellow alarm banners to close them and continue the procedure, **"reset"** the red alarm banners after remedying the cause of alarm to return to normal operation, "**silence**" the red alarm banners to turn the horn off, or "**exit**" to close the alarm banner and silence the horn regardless if the alarm is reset. Alarms that are not reset will be shown active in Alarm History. All active shutdown alarms must be reset before the service cart can continue to operate. Refer to System Fault List below for more information.

7.8.3.9 Stopping Operation

To end an operation before the pre-programmed time limit is reached, press the red **STOP** button on the screen. The pumps and/or the N2 regulator will be shut down and the appropriate valves in the system will close.

Automatic Timed Stop - When the timer reaches zero, the valves will de-energize and the pump motor will decelerate to a stop.

Manual Stop - The red STOP button may be pressed at any time to stop the pump motor, vacuum pump, and/or N2 regulator. Procedures can be restarted unless otherwise specified.

Emergency Stop **-** Press the EMERGENCY STOP button at any time to stop the pump motor, vacuum pump, and/or N2 regulator. This will de-energize the Master Control Relay (MCR) and disable the Variable Frequency Drive. It will NOT stop the diesel engine (if so equipped).

NOTE: To reset after an Emergency Stop, push the Power On/Off Button OFF and twist- pull the Emergency Stop Button out. The system will not reset unless the Power On/Off Button is off.

7.8.4 System Shutdown

When an operation reaches the end of its pre-programmed duration, the pumps will shut down. If all operations are completed at this point, perform the following procedures.

1. On the touch screen, press the **MODE SELECT** button to return to the mode select screen. Alternatively, press the red **STOP** button and then select **NO** to return to the mode select screen.
2. Push the power on/off button out to turn the control panel off.
3. Turn the Power Disconnect / Selector Switch to the OFF / POWER OFF position.
4. Disconnect and stow supply and return hoses on the rack at the front of the cart and the adapter fittings in the accessory storage box.
5. Disconnect the ground reel cable and allow it to retract into the cart.
6. Disconnect the power cable from the facility power outlet and stow on cart.

7.9 SYSTEM FAULT LIST

When the coolant service cart system detects abnormal conditions, display notifications and/or alarms are generated. The horn on top of the cart will sound and warning banners will be displayed on touchscreen. The following table summarizes the system fault list. There are three levels to these system faults ranging from light to severe:

1. Display Notification (Grey Banner)
2. Warning Alarm (Yellow Banner)
3. Shutdown Alarm (Red Banner, Horn Alarm, and Pump Stops)

The user may "**acknowledge**" the gray and yellow alarm banners to close them and continue the procedure, **"reset"** the red alarm banners after remedying the cause of alarm to return to normal operation, "**silence**" the red alarm banners to turn the horn off, or "**exit**" to close the alarm banner and silence the horn regardless if the alarm is reset. Alarms that are not reset will be shown active in Alarm History. All active shutdown alarms must be reset before the service cart can continue to operate. All diesel engine related alarms / shutdowns (except Low Fuel) are displayed on the generator set (if so equipped).

The remedial actions suggested in the following table are meant to serve as general guidance, see 9.0 Troubleshooting for more detailed information. If problem persists, call MALABAR for technical support.

Description	Transducer	Alarm Level	System Response	Remedial Action
Main Pump Motor VFD not Enabled/Ready			Display Notification	Call MALABAR
Main Pump Motor VFD Fault			Display Notification	Call MALABAR
Main Pump Motor Fault			Display Notification	Call MALABAR
Top Up Pump Motor VFD not Enabled/Ready			Display Notification	Call MALABAR
Top Up Pump Motor VFD Fault			Display Notification	Call MALABAR
Top Up Pump Motor Fault			Display Notification	Call MALABAR
Master Power Off/Emergency Stop			Display Notification	Reset E-Stop
Circulation Heater Temp Out of Range	TT1	> 70°C 158°F	Shutdown Alarm	Cool down PGW
Control Enclosure/Electrical Enclosure Inside Temp Out of Range		< -10°C 14°F	Enclosure Lamp On	Ensure the Thermostat is set at -10°C
Hydraulic Flow Out of Range			Display Notification	Call MALABAR
Low Level Clean Reservoir	LSL1	< 5 gal, 19 l	Warning Alarm	Add PGW
Low Level Clean Reservoir	LSL1	< 1 gal, 3.8 l	Shutdown Alarm	Add PGW
Low Level Sub Reservoir	LSL2	< 1 gal, 3.8 l	Shutdown Alarm	Add PGW to Clean Reservoir
High Level Sub Reservoir	LSH1	> 10 gal, 37.9 l	Warning Alarm	Drain PGW
High Level Sub Reservoir	LSH1	> 11 gal, 41.6 l	Shutdown Alarm	Drain PGW
High Level Waste Reservoir	LSH2	> 45 gal, 170 l	Shutdown Alarm	Drain PGW
Pump Pressure Out of Range	PT1	> 150 psia, 10.3 bar abs	Display Notification	Check for blockage in SCS
Supply Filter Pressure Out of Range	PT2	< -10 psid, -0.7 bar abs	Warning Alarm	Replace filter element
Supply Pressure Out of Range	PT3	> 145 psia 10 bar abs	Shutdown Alarm	Check for blockage in SCS
N2 Regulator Input Pressure Out of Range	PT4		Display Notification	Replace N2 bottle
Return Pressure Out of Range	PT5	> 95 psia, 6.6 bar abs	Shutdown Alarm	Call MALABAR
Return Filter Inlet Pressure Out of Range	PT6		Display Notification	Replace filter element
Sub Reservoir Vacuum Pressure Out of Range	PT8		Display Notification	Call MALABAR
N2 Regulator Output Pressure Out of Range	PT9		Warning Alarm	Call MALABAR
Low Level Genset Fuel	LSL3	<1 gal (1/8 tk)	Warning Alarm	Add fuel

7.10 MODE RECIPE EDIT

NOTE: Can be accessed by user level 3 (Engineering administrator, Airbus & Malabar only).

The mode recipe edit allows the user to configure the coolant service cart's default operating parameters for the aircraft SCS and CU service modes. To set the default values of the timer and pump speed % for each sequence, perform the following procedures.

1. Perform Pre-Operation Checks and System Startup procedures.
2. On the service cart Main Navigation screen, press the **MODE RECIPE EDIT** button.
3. Select any parameter field and enter a new value.
4. Once all the appropriate parameters have been entered, press the **Save** button to save the new configuration.
5. Press the GOTO **PREVIOUS** button to return to the Main Navigation screen.

7.11 DIAGNOSTICS

NOTE: Can be accessed by user level 2 (Engineering) and higher.

NOTE: Any modifications you make to the operating parameters via Diagnostics will be used ONLY for the current operation and will not replace the default values. To modify the default values, refer to Mode Recipe Edit.

The coolant service cart has a diagnostic mode that allows the user to manually operate the system pumps, vacuum pump, solenoid valves, and circulation heater. The Diagnostics screen also displays various system parameters to help with troubleshooting the cart. Perform the following procedures to use the Diagnostics.

1. Perform Pre-Operation Checks and Operation Startup procedures.
2. On the service cart Main Navigation screen, press the **DIAGNOSTICS** button.
3. To operate one of the pumps, tap its **PUMP** button on the screen to toggle it on (green) or off (red). Main pump P1 speed can be adjusted by selecting the parameter field and entering a new value (Pump speed can be adjusted from 10% to 55%). Top up pump P2 speed cannot be adjusted.
4. To operate an individual solenoid valve, tap its oval **LV** button to toggle it between red (closed) and green (open).
5. To operate the vacuum pump, tap the **VACUUM PUMP** button to toggle it on (green) or off (red).
6. To operate the circulation heater, tap the **HEATER** button to toggle it on (green) or off (red).
7. Press the GOTO **STARTUP SCREEN** button to exit the diagnostics mode.

7.12 CALIBRATION

NOTE: Only user level 2 (Engineering) or higher has access to calibration mode.

There are four calibration procedures for the coolant service cart: pressure transducers, the tank level transmitters, the flow meter, and the temperature transmitter.

7.12.1 Pressure Transducer Calibration Verification

The following procedure should be performed on the pressure transducers (PTs) every year, or whenever a transducer is replaced, or if erroneous readings are suspected. Proper calibration verification of the transducers requires a hand pump with a calibrated pressure gauge. A hand pump kit (p/n 1016205) for transducer calibration can be purchased from Malabar. Perform the following steps to verify the accuracy of a transducer.

NOTE: Ensure that the service cart is powered on and the right side access panel is raised to perform calibration verification.

1. Refer to 7.8 Operation Procedures and perform startup procedures.
2. On the service cart Main Navigation screen, click the **DIAGNOSTICS** button.
3. On the appropriate pressure transducer, Close the needle valve by turning it clockwise. (These valves are delicate precision devices and should not be over tightened. Finger tightness is adequate). For PT4, the high pressure needle valve is located along the hydraulic line under the manifold. It can be closed by turning the knob clockwise.
4. Remove the cap from the appropriate calibration port on the manifold.

NOTE: Unlike the other eight low pressure transducers, PT4, which is used for monitoring N2 inlet pressure, is rated at 5014.7 psia (345.75 bar abs) and configured with a high pressure in-line needle valve. To calibrate PT4, a hand pump with high pressure rating is required.

5. Attach the hose of the calibration hand pump to the calibration port. If calibrating any PTs other than PT4, skip step 7. If calibrating PT4, skip step 6.

7.12.1 Pressure Transducer Calibration Verification *(continued)*

If calibrating any PTs other than PT4:

6. Using the hand pump, pressurize the transducer until the calibration hand pump gauge reads 100 PSI, then compare with the pressure reading on the Diagnostics screen to verify PT is within range. If not, the pressure transducer will need to be replaced.

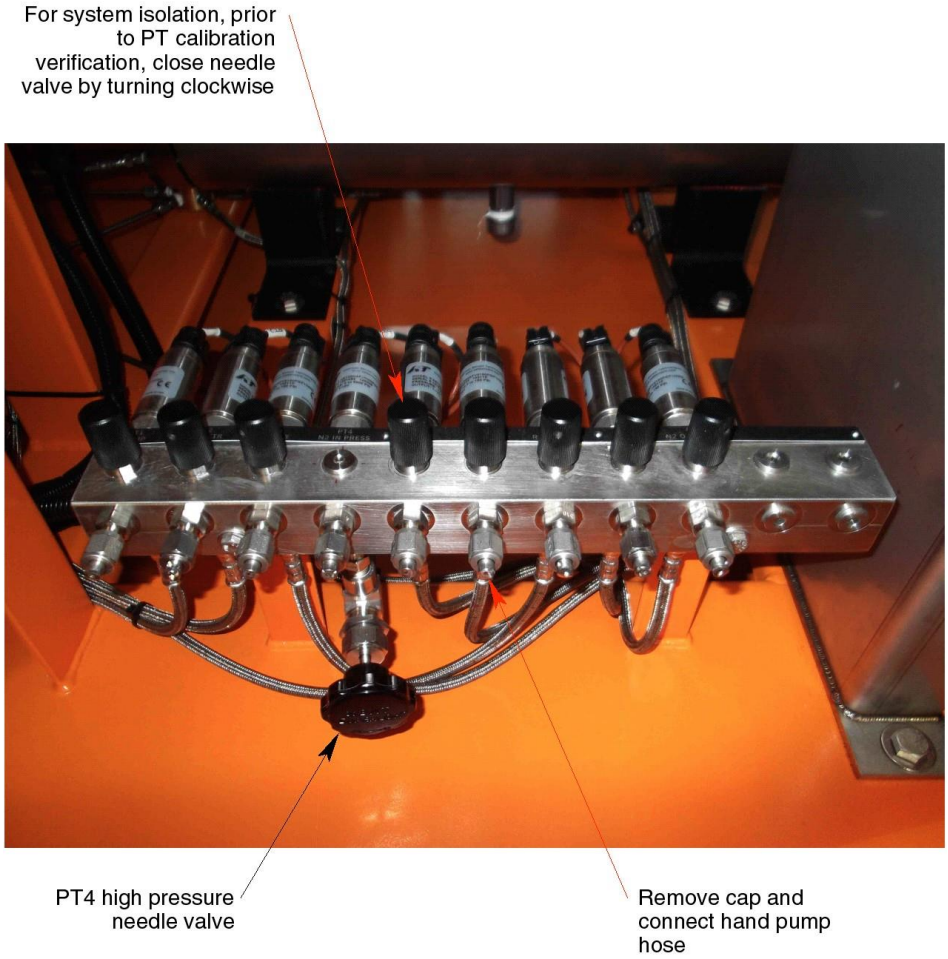
NOTE: Any pressure in the range 100 ± 20% may be chosen, so long as the gauge reading closely matches the pressure displayed on the Diagnostics screen

If calibrating PT4:

7. Using the high pressure hand pump, pressurize the transducer until the calibration hand pump gauge reads 2000 PSI, then compare with the pressure reading on the Diagnostics screen to verify PT is within range. If not, the pressure transducer will need to be replaced.

NOTE: Any pressure in the range 2000 ± 20% may be chosen, so long as the gauge reading closely matches the pressure displayed on the Diagnostics screen.

8. Disconnect the calibration hand pump hose from the calibration port and reinstall the cap.
9. Open the needle valve by turning the stem counterclockwise.
10. Click the **STARTUP SCREEN** button to return to the Startup Screen.

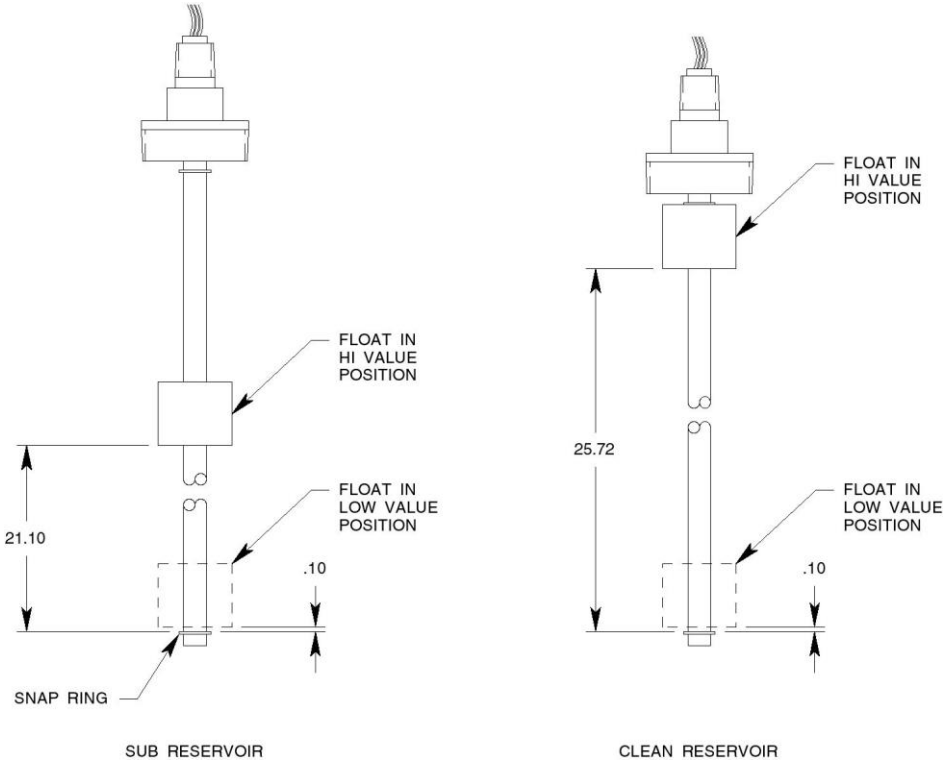


7.12.2 Tank Level Transmitter Calibration Verification

The following procedure should be performed on the clean and sub reservoir level transmitters whenever inaccurate readings are noticed, or whenever the transmitters are replaced.

NOTE: Ensure that the service cart is powered on and the left side access panel is raised to perform calibration verification.

1. Refer to 7.8 Operation Procedures and perform startup procedures.
2. On the service cart Main Navigation screen, press the **DIAGNOSTICS** button.
3. Compare the fluid level sight gauge on the clean tank with the reservoir level reading on the Diagnostics screen.
4. Unscrew the clean reservoir level transmitter from the top of the tank and lift it out.
5. Lift the clean reservoir level transmitter float 0.10 inches from the bottom snap ring and check the reservoir level reading on Diagnostics, which should display near 0 gal in R1.
6. Lift the clean reservoir level transmitter float 25.72 inches from the bottom snap ring and check the reservoir level reading on Diagnostics, which should display near 45 gal in R1.
7. Replace level transmitter if it does not read accurately.
8. Reinstall the tank level transmitter by screwing it into the clean tank.
9. Unscrew the sub reservoir level transmitter from the top of the tank and lift it out.
10. Lift the sub reservoir level transmitter float 0.10 inches from the bottom snap ring and check the reservoir level reading on Diagnostics, which should display near 0 gal in R3.
11. Lift the sub reservoir level transmitter float 21.10 inches from the bottom snap ring and check the reservoir level reading on Diagnostics, which should display near 10 gal in R3.
12. Replace level transmitter if it does not read accurately.
13. Reinstall the tank level transmitter by screwing it into the sub tank.
14. Press the **STARTUP SCREEN** button to return to the Startup Screen.



7.12.3 Flow Meter Calibration Verification

The turbine flow meter in the supply line was initially calibrated by the manufacturer. It does not normally require recalibration. However, the flow meter should be checked periodically for accuracy by installing a master flow metering device in runaround mode. A flowmeter test tool (p/n 1016201) for flowmeter calibration can be purchased from Malabar. The cart meter is a 2% accuracy device and checking intervals should be based on frequency and severity of use. Refer to the Diagnostics screen for cart flow meter reading.

In the event of discrepancy between the master meter and the cart meter, remove the flow meter from the cart and flush out the bearings with PGW (60% Propylene Glycol/Water, clear) or alcohol. Dirt in the bearings or wear are the usual cause for meter error. Recheck after flushing. If a discrepancy is still observed, recalibration is required by performing the following procedure:

1. Disconnect the cable connector.
2. Place a bucket underneath the flow meter to catch spilled PGW.
3. Loosen 'B' nuts on either side of flow meter and remove it from the piping. Note flow arrow and direction.
4. Send the flow meter assembly to a qualified metrology lab for calibration.
5. Re-assemble to the piping, re-connect the cable and tighten the cable connector.
6. Run the system and check for leaks. Verify that the flow displays are reading valid values.

7.12.4 Temperature Transmitter Calibration

Recalibration should be performed approximately annually (based on severity and frequency of operation), or whenever a gauge is replaced, or if erroneous readings are suspected. Proper calibration requires a temperature bath with a reference thermometer. A digital reference thermometer (p/n 486-054) can be purchased from Malabar.

To verify the calibration of your temperature transmitter:

1. Remove the temperature transmitter from the manifold located on top of the circulation heater.
2. Immerse the bulb totally in an agitated compatible liquid for at least 3 minutes with a master reference thermometer until they reach equilibrium.
3. Replace the temperature transmitter if it does not read accurately.

8.0 REGULAR MAINTENANCE

8.1 MAINTAINING FLUID LEVELS

The level of coolant in all three reservoirs should be checked prior to use. Add or drain coolant as needed (clean reservoir should be topped up while sub and waste reservoirs should be emptied).

8.2 CHANGING FILTER ELEMENTS

There are two filters in each system: one for the supply side and one for the return side. The pressure differential across the filters is continuously monitored and will generate an alarm to notify the user when the differential exceeds the preset maximum.

NOTE: It is not necessary to immediately stop operation when a filter alarm is generated. Complete the operation in process and change the filter after the system is shut down.

When the system is shut down, close pump suction valve. Perform the following procedures to change a filter element.

1. Obtain a suitable container and position it below the filter bowl.
2. Open the drain plug and drain fluid into the container.
3. Dispose of fluid in accordance with PGW material safety data sheet.

NOTE: It may be necessary to use a suitable wrench on the hexagon at the base of the filter to initially loosen the bowl.

4. Unscrew and remove filter bowl from head assembly.
5. Remove the filter element and the o-ring and discard in accordance with operator's environmental requirements.
6. Inspect the filter assembly for signs of damage. Replace if necessary.
7. Check the o-ring on the filter bowl for damage or signs of wear. Replace if necessary.

CAUTION!

Do not attemptto clean or reuse filter element.

8. Lubricate the replacement filter element o-ring with clean system fluid and push open end of the filter element straight onto the nipple in the filter head assembly.
9. Ensure threads on filter bowl and head assembly are clean and carefully screw filter bowl onto the filter head assembly.

CAUTION!

Do not use pipe wrench, hammer or any similar tool to tighten filter bowl.

1. Tighten filter bowl to 30 ft-lbs. (40 Nm).

Filter	Malabar Part No.	Manufacturers Part No.	Manufacturer
Supply	Filter: 481-113 O-ring Kit*: 481-134	Element: UE219AS13Z (12 Micron) O-ring: UR219SKZ	Pall
Return	Filter: 481-113 O-ring Kit*: 481-134	Element: UE219AS13Z (12 Micron) O-ring: UR219SKZ	Pall

***O-ring Kit p/n 481-134 includes the upper and lower filter housing seals.**

8.3 SERVICING VACUUM TRAP

The vacuum trap should be inspected prior to each use. If the trap is more than about 3/4 full of fluid, it should be emptied. To empty the trap, unscrew the glass trap from the head assembly. Discard fluid in accordance with PGW material safety data sheet, and re-install glass trap.

8.4 LUBRICATION

STEERING MECHANISM: There are six lubrication points on the steering mechanism of the running gear that should be lubricated periodically. Use standard automotive grease to lubricate the grease fittings on the steering knuckles and tie rod ends.
PARKING BRAKE MECHANISM: There are two lubrication points on the parking brake mechanism that should be lubricated periodically. Use standard automotive grease to lubricate the grease fittings on the supports for the rear cross shaft.
WHEEL BEARINGS: The wheel bearings should be repacked annually. Refer to 10.0 Repair for procedures for servicing the wheel bearings.

8.5 FUSES



WARNING!

Shock hazard - always turn off power before attempting to change fuses. See additional cautions under electrical troubleshooting.

CAUTION!

A blown fuse is a symptom of a problem in an electrical circuit. Do not bypass a fuse or use a fuse other than the one specified. Using any other type fuse can damage components.

8.5.1 Fuses In The Main Electrical Disconnect Enclosure

Three (3) fuses are located in the main electrical disconnect enclosure. Access by turning the Power Disconnect / Selector Switch to the OFF / POWER OFF position, turning the quarter-turn latch overlapping the two doors and opening it. The fuses are mounted in blown fuse indicator type fuseholders. The following table lists the fuses located in the main electrical disconnect enclosure.

Reference Designator	Manufacturers Part Number	Manufacturer	Ampere Rating	Voltage Rating	Fuse Class	Load
FU1, 2*	CCMR008	Littelfuse	8	600 VAC	CC	DC Pwr sply/ Enclosure Heaters
FU3	218005	Littelfuse	5	250 VAC	5 x 20 mm SLO-BLO	Vac. Pump

***NOTE: replace power fuses in sets of two; do not replace only one.**

8.5.2 Fuses In The Control Enclosure

Twelve (12) fuses are located in the control enclosure. Access by turning the quarter-turn latch on the right side of the control panel and opening it. The fuses are mounted in blown fuse indicator type fuseholders. A blown fuse is indicated by a red LED light in the terminal block. To replace a fuse, swing the fuse retainer latch up by pulling the handle. The fuses are removed and installed from the side of the retainer. The following table lists the fuses used in the control enclosure.

Reference Designator	Manufacturers Part Number	Manufacturer	Ampere Rating	Voltage Rating	Fuse Class	Load
FU4	218008	Littelfuse	8	250 VAC	5 x 20 mm SLO-BLO	MCR / Power On / Off Button / E-Stop Button
FU5	218008XP	Littelfuse	0.8 (8/10)	250 VAC	5 x 20 mm SLO-BLO	Panel Lights
FU6-11	218.800XP	Littelfuse	0.8 (8/10)	250 VAC	5 x 20 mm SLO-BLO	LV3-8
FU12, 13	2183.15XP	Littelfuse	3	250 VAC	5 x 20 mm SLO-BLO	LV1, LV2
FU14	2183.15XP	Littelfuse	3	250 VAC	5 x 20 mm SLO-BLO	PLC
FU15	218.800XP	Littelfuse	0.8 (8/10)	250 VAC	5 x 20 mm SLO-BLO	LV9

9.0 TROUBLESHOOTING

9.1 GENERAL

The following tables provide general guidance for diagnosing and correcting faults in the coolant service cart. These procedures are not intended to be a comprehensive guide to addressing every possible problem encountered. Additional information on troubleshooting individual components may be found in the documentation for those components in the appendicies. If additional assistance is required, contact Malabar.

9.2 DIAGNOSTIC MODE

The user can use the coolant service cart's diagnostic mode to individually operate specific components of the cart. Individual valves, pumps, and the vacuum pump can be manually manipulated to determine their operational status. If a component does not respond to manual commands, further troubleshooting procedures can be focused on that component.

In addition, the readings from individual pressure, flow, and temperature sensors can be monitored on the Diagnostics screen. If the Diagnostics screen shows no reading or obviously erroneous readings from an individual sensor, you should focus your further troubleshooting procedures on that sensor.

Instructions for accessing and using the Diagnostics screen can be found in 7.0 Operation.

9.3 ELECTRICAL TROUBLESHOOTING

Use the following table as a guide to troubleshoot the CSC electrical system in conjunction with Appendix II Electrical Schematic.



CAUTION!

SHOCK HAZARD. Before performing any work in the main electrical disconnect enclosure, verify that the Variable Frequency Drive (VFD) bus capacitors have discharged. Measure the DC bus voltage across the -DC and +DC terminals on the lower Power Terminal Block. The voltage must be zero. Darkened LED / LCD displays do not indicate that the capacitors have discharged to a safe voltage level.

Symptom	Probable Cause	Remedial Action
CSC will not power up	No power	ELECTRIC operation: Verify that power cable is plugged in and that facility power is turned on DIESEL operation (carts with genset): Verify that power cable to the generator is connected and circuit breaker at the generator is on
	Main Power Disconnect OFF	Set Power Disconnect / Selector Switch to ON / ELECTRIC or DIESEL
	Main Fuses Blown	Check and/or replace fuses FU1 & FU2 in Main Electrical Disconnect enclosure NOTE: replace in sets of two; do not replace only one
	No 24VDC	Check for 24VDC at DC Power Supply PS1 terminals. Refer to Appendix C. Replace power supply if necessary Check / Replace contactor C2 See “Main Fuses Blown” above
	No 24VDC to touchscreen	Check and/or replace fuses FU1 & FU2 in Main Electrical Disconnect enclosure
CSC powers up but nothing operates	E-Stop switch activated	Reset E-Stop switch (with Power On/Off Button OFF).
	Shutdown alarms remain active	Remedy and reset all active shutdown alarms in Alarm History
	No 24VDC to power on/off button	Check / Replace 24VDC fuse FU4
	PLC power off	Check / Replace 24VDC fuse FU14
	VFD circuit breaker CB5 or CB6 turned off	Set VFD circuit breaker CB5 or CB6 in Main Electrical Disconnect enclosure to ON
CSC powers up but pump(s) will not run	VFD fault	Check drive display for fault codes. Refer to VFD manual in Appendix C. Supplemental Documentation
	HEATING GREEN light is on	Wait for temperature in enclosure to rise above 14° F / -10°C (verify that internal heater is warm)
	Bad contactor(s)	Check / Replace contactor C4
Vacuum pump will not operate	Blown fuse	Check fuse FU3 in Main Electrical Disconnect enclosure, replace if necessary
	Bad switch	Check, replace
	Failed vacuum pump	Check on bench, replace
	Faulty wiring - open DC- connection	Check common DC- wiring for opens (wht/blu wire)
System powers up but no valves will operate	Open / blown fuse	Refer to electrical schematic and check corresponding fuse. Replace if necessary
System powers up but individual valve(s) will not operate	Solenoid valve fault	Replace solenoid coil for corresponding valve
No reading on flowmeter	Wiring fault or blown fuse to a solenoid valve	Refer to electrical schematic and verify the wiring to the valve
	Flow meter fault	Refer to electrical schematic and verify wiring from flow meter to display unit Refer to supplemental documentation in Appendix C for details

9.3 ELECTRICAL TROUBLESHOOTING *(continued)*

Refer to supplemental documentation in Appendix C for details on the diesel generator set.

Symptom	Probable Cause	Remedial Action
Diesel engine (if so equipped) will not crank	12V Battery discharged	Charge or Replace
	Defective starter solenoid or wiring	Check connections and tighten or replace wiring or solenoid
Diesel engine (if so equipped) will not start	No fuel or fuel valve shut	Fill tank and / or open valve under tank
	Fuel filter/ hoses clogged	Clean out lines or replace filter element
	Low oil pressure	Fill oil to dipstick mark

9.4 FLUID SYSTEM TROUBLESHOOTING

Use the following table as a guide to troubleshoot the CSC fluid system in conjunction with the Hydraulic System Schematic and Control System Operation in Appendix II.

Symptom	Probable Cause	Remedial Action
Supply Pressure too high	Obstruction in SCS loop	Check to ensure SCS loop is not contaminated with debris
	Aircraft valves not configured correctly	Check AMM, re-configure aircraft system as required
No Reading on Pressure Transducers (with pumps running)	Gage calibration valve shut	Open gage calibration / isolation valves 1-9 CAUTION: Never operate the cart with these valves closed, overpressure hazard
	Solenoid valve LV1 or LV2 did not open	Check/replace fuses FU12 and FU13, Check for failed LV1 or LV2
	Loss of fluid in Clean or Sub Reservoirs	Shut down immediately, check for stuck low level switches (LSL1 and LSL2) and look for leaks
Return Pressure too high	Solenoid valve LV5, LV6, or LV7 did not open	Check/replace fuse(s) FU8, FU9, FU10 Check for failed solenoid valves
Pump runs but Flow rate is too low	Relief Valve RV2 thru RV5 may be bypassing flow	Call MALABAR for instructions
	Recirc. Solenoid Valve LV8 may be stuck open	Tap valve body to un-stick Remove valve and bench check/test. Repair or replace
Drainage Doesn't work	Loss of N2 Supply	Verify N2 supply is connected and NV10 is open. Valves LV9 failed: check, repair or replace Valves LV9 didn't turn on: check fuse FU15
No readings for individual pressure transducer	Pressure transducer fault	Refer to electrical schematic in Appendix B and check corresponding wiring and connector. Call MALABAR for further instructions If all wiring is verified, replace pressure transducer
No readings for individual flow meter	Flow meter fault	Refer to electrical schematic in Appendix II and verify wiring to flow meter, and from flow meter to analog input module. Call MALABAR for further instructions Refer to supplemental documentation in Appendix C for detailed procedures
No reading for tank level	Level transmitter fault	Refer to electrical schematic in Appendix II and verify wiring to level transmitter, and from level transmitter to analog input module. Call MALABAR for further instructions Refer to supplemental documentation in Appendix C for detailed procedures

10.0 REPAIR

10.1 INTRODUCTION

Repair of the CSC consists of replacement of defective components.

WARNING!

This equipment has potentially fatal voltages applied during operation. Before beginning any repair procedure, ensure that the main power cable is disconnected, the CSC main power disconnect/selector switch is off, and the generator set (if so equipped) is off.

10.2 MOTOR/PUMP ASSEMBLY REPLACEMENT

REMOVAL

1. Open the access panel left of the main electrical disconnect enclosure to gain access to the main motor/pump assembly.
2. Remove two screws and remove cover to electric motor connection box.
3. Tag and disconnect electrical leads from electric motor connection box.
4. Unscrew conduit nut securing electrical cable to electric motor connection box.
5. Unscrew tube end swivel from inlet elbow on pump suction.
6. Unscrew tee swivel end from outlet check valve (CV6) on pump discharge.
7. Remove four capscrews, eight flat washers, four lockwashers, four nuts, and four spacers securing pump and motor assembly to cart frame.
8. Using a forklift or other suitable lifting device, carefully lift pump and motor assembly out of cart frame.

INSTALLATION

1. Using a forklift or other suitable lifting device, carefully install pump and motor assembly in cart frame and position over mounting holes.
2. Secure pump and motor assembly to cart frame using four capscrews, eight flat washers, four lockwashers, four nuts, and four spacers.
3. Install inlet tube on pump suction elbow.
4. Connect tee swivel end to pump discharge check valve (CV6).
5. Feed electrical leads into electrical connection box.
6. Secure electrical cable to connection box by tightening conduit nut.
7. Connect electrical leads to electric motor connection box.
8. Remove and discard tags.
9. Install cover on electric motor connection box and secure with two screws.
10. Check for leaks and tighten fittings if necessary. Install access panel back in place



10.3 TOP UP PUMP/MOTOR ASSEMBLY REPLACEMENT

REMOVAL

1. Unscrew tube end swivel from inlet elbow on pump suction.
2. Unscrew tube end swivel from outlet check valve (CV7) on pump discharge.
3. Remove four capscrews, eight flat washers, four lockwashers, and four nuts securing pump and motor assembly to cart frame.
4. Remove two screws and remove cover to electric motor connection box.
5. Tag and disconnect electrical leads from electric motor connection box.
6. Unscrew conduit nut securing electrical cable to electric motor connection box.
7. Carefully lift pump and motor assembly out of cart frame.

INSTALLATION

1. Carefully install pump and motor assembly in cart frame and position over mounting holes.
2. Feed electrical leads into electrical connection box.
3. Secure electrical cable to connection box by tightening conduit nut.
4. Connect electrical leads to electric motor connection box.
5. Remove and discard tags.
6. Install cover on electric motor connection box and secure with two screws.
7. Secure pump and motor assembly to cart frame using four capscrews, eight flat washers, four lockwashers, and four nuts.
8. Install inlet tube on pump suction elbow.
9. Install outlet tube on pump discharge check valve (CV7).
10. Check for leaks and tighten fittings if necessary.

10.4 VACUUM PUMP ASSEMBLY REPLACEMENT

REMOVAL

1. Disconnect electrical leads from vacuum pump.
2. Disconnect inlet tube from vacuum pump glass trap.
3. From underneath vacuum pump mount bracket, remove three screws, three lockwashers, and three flat washers securing vacuum pump, and remove vacuum pump from cart.

INSTALLATION

1. Install vacuum pump on cart floor and secure with three flat washers, three lockwashers and three screws.
2. Connect inlet tube to vacuum pump glass trap.
3. Connect electrical leads to vacuum pump.

10.5 DIESEL GENERATOR SET REMOVAL

The following procedure describes the removal and reassembly of the diesel generator set (if so equipped). Use caution when handling; the unit weighs approximately 758 lbs (344 kg).

REMOVAL FROM SERVICE CART

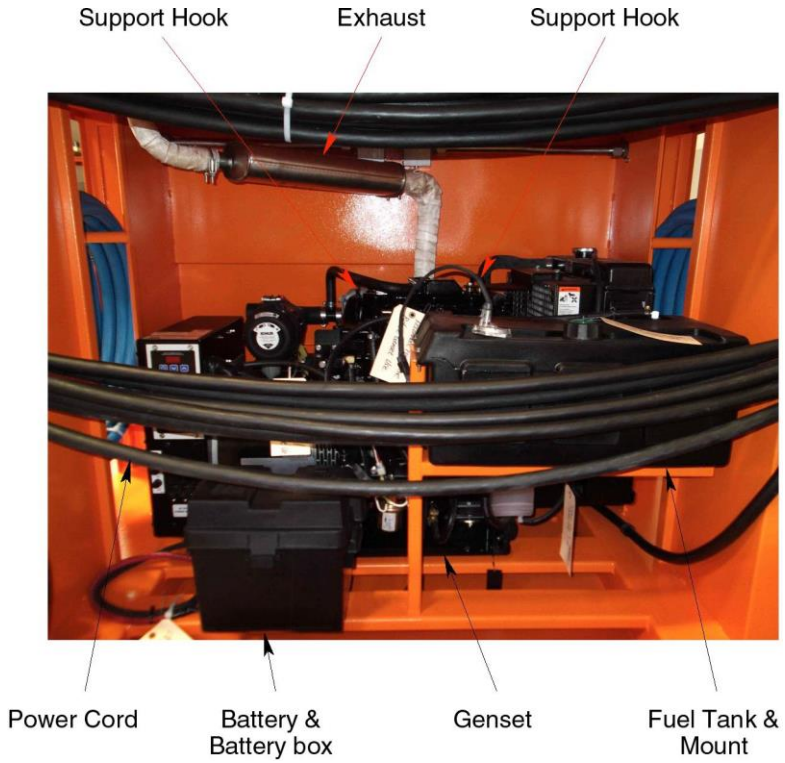
1. Remove the towbar from the coolant service cart.
2. Remove the service cart power cord from the cord support hooks.
3. Disconnect the power cord (inboard side) and fuel gauge connector from the fuel tank.
4. Disconnect battery cables, remove battery and battery box.
5. Drain fuel tank if necessary, close fuel suction valve on bottom of fuel tank and disconnect fuel lines from diesel engine. Cap engine fuel ports.
6. Remove fuel tank and fuel tank support bracket.
7. Disconnect exhaust piping from engine.
8. Remove two front and two rear bolts holding the generator set to the service cart base.
9. Rig a suitable sling to the lifting eyes on the generator set.
10. Using a power lift, raise the generator set and remove from the service cart.

INSPECTION / REPAIR

Refer to the GENERATOR SET OWNER'S MANUAL for information on service and repair.

ASSEMBLY

Reassemble in reverse order of removal.



10.6 DIESEL GENERATOR SET REPAIR

Refer to OEM manual in supplemental documentation.

10.7 CIRCULATION HEATER REPLACEMENT

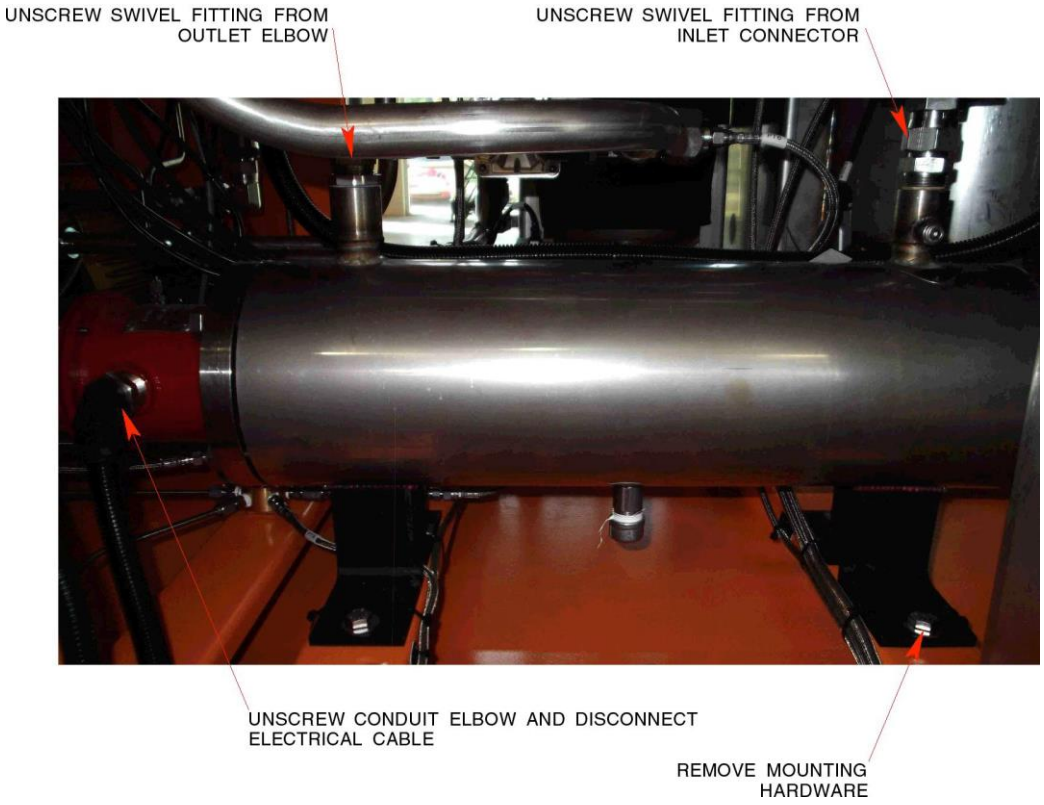
The following procedure describes the removal and reassembly of the circulation heater. Use caution when handling; the unit weighs approximately 80 lbs (36 kg).

REMOVAL FROM SERVICE CART

1. Place a bucket underneath the circulation heater to catch spilled PGW.
2. Remove both access doors and ridge beam from the coolant service cart.
3. Unscrew conduit elbow securing electrical cable to heater.
4. Unscrew fitting end swivel from inlet connector.
5. Unscrew fitting end swivel from outlet elbow.
6. Remove four capscrews, eight flat washers, four lockwashers, and four nuts securing pump and motor assembly to cart frame.
7. Rig a suitable sling to the heater.
8. Using a power lift, raise the heater and remove from the service cart.

ASSEMBLY

Reassemble in reverse order of removal.



10.8 ELECTRO-PNEUMATIC NITROGEN REGULATOR REPLACEMENT

REMOVAL FROM SERVICE CART

1. Disconnect power cord.
2. Unscrew all tube and hose fittings from N2 regulator base and controller.
3. Remove two capscrews, two flat washers, and two lockwashers securing N2 regulator to cart frame.
4. Remove from the service cart.

ASSEMBLY

Reassemble in reverse order of removal.

10.9 DRAIN VALVE REPLACEMENT

Before replacing the drain valve, it is necessary to drain the system. Connect a drain hose to the drain valve, and open it to release the coolant into a suitable container.

REMOVAL

To remove drain valve, unscrew it from the bottom of the reservoir.

INSTALLATION

To install drain valve, screw it into bottom of reservoir. Use teflon tape to seal pipe threads.

10.10 SOLENOID REPLACEMENT (TYPICAL)

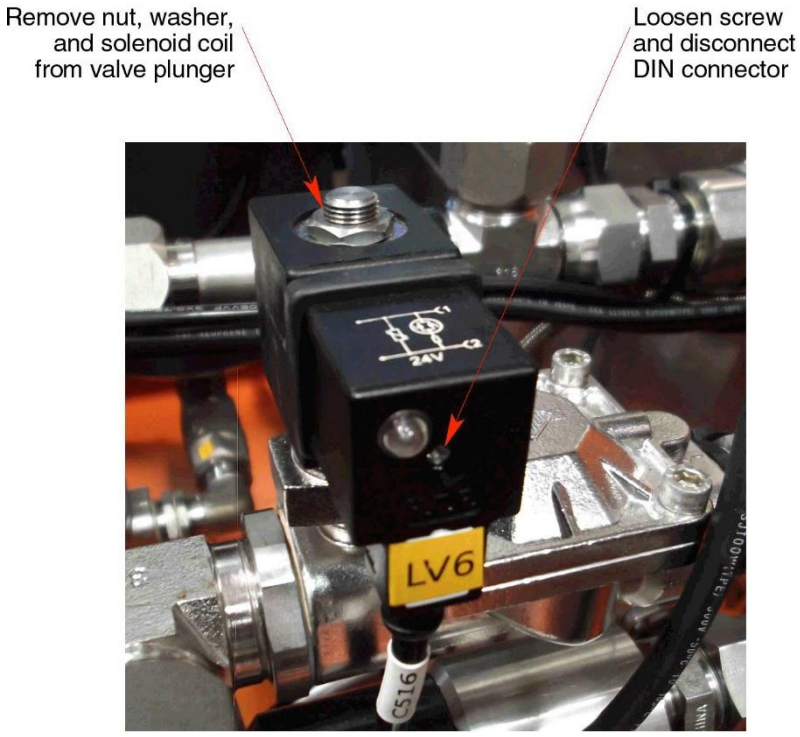
The following procedure is typical for replacement of the solenoids on the system valves.

REMOVAL

1. Loosen screw and disconnect DIN connector from solenoid coil.
2. Remove nut and flat washer and lift solenoid coil off valve plunger.

INSTALLATION

1. Install solenoid coil on valve plunger and secure with nut.
2. Connect DIN connector to solenoid body and secure with screw and flat washer.



10.11 SOLENOID VALVE REPLACEMENT (TYPICAL)

The following procedure is typical for replacement of the solenoid valves in the system.

REMOVAL

1. Remove screw and disconnect DIN connector from solenoid coil.
2. Remove nut and flat washer and lift solenoid coil off valve plunger.
3. Unscrew the appropriate fittings, and unscrew seal nuts from valve body.
4. Remove o-rings and valve body. Retain o-rings for reuse.

INSTALLATION

NOTE: Some valves are supplied with buna o-rings. These should be discarded and replaced with ERP o-rings.

1. Inspect o-rings for signs of damage or wear. Replace if necessary.
2. Install o-rings, seal nuts, and valve body.
3. Secure appropriate fittings, ensuring that all are tight.
4. Install solenoid coil on valve plunger and secure with nut.
5. Connect wiring cap to solenoid body and secure with screw and flat washer.

10.12 TEMPERATURE TRANSMITTER REPLACEMENT (TYPICAL)

No calibration is required when replacing temperature gauges.

REMOVAL

Unscrew and remove sensor.

INSTALLATION

Install sensor.

10.13 PRESSURE TRANSDUCER REPLACEMENT (TYPICAL)

If a pressure transducer is replaced, it must be bench calibrated prior to installation in cart (see 7.12 Calibration for more information).

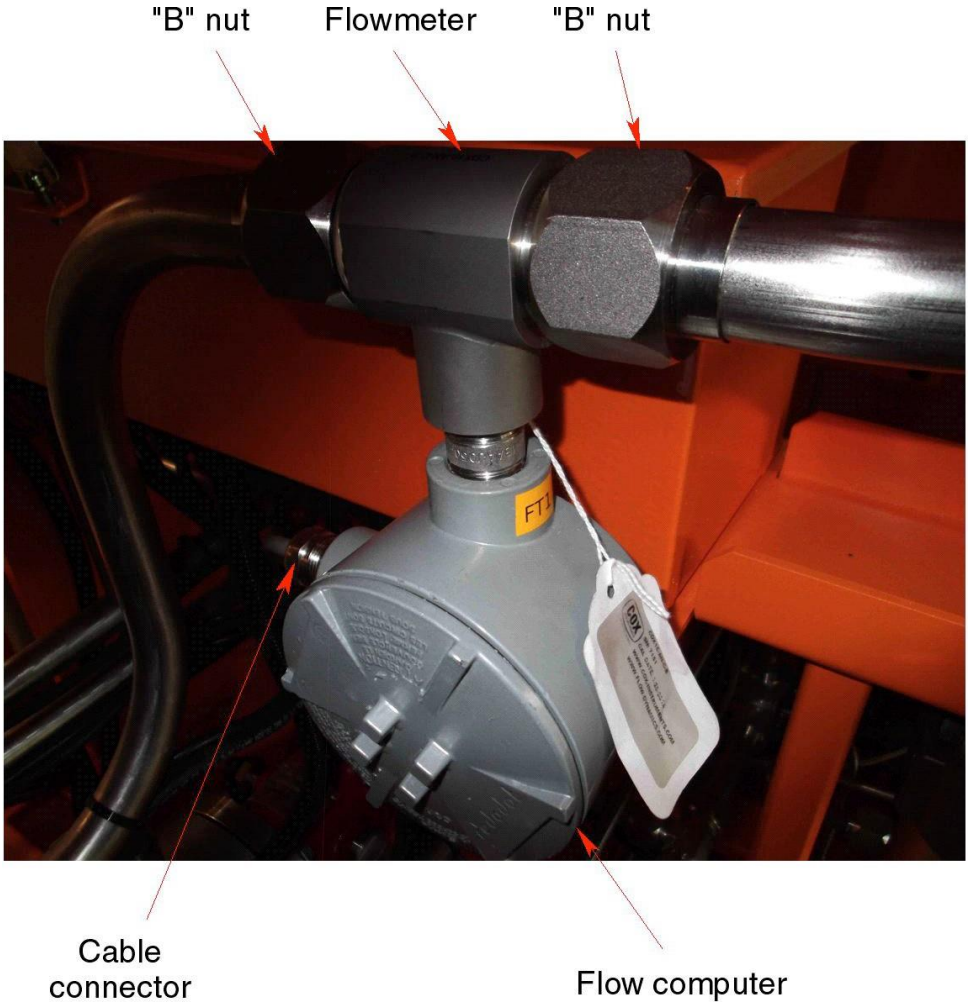
10.14 FLOWMETER REPLACEMENT

REMOVAL

1. Disconnect flowmeter cable connector.
2. Loosen 'B' nuts on either side of flow meter and remove from cart. Note flow arrow and direction.

INSTALLATION

1. Install flowmeter observing proper flow direction and secure by tightening 'B' nuts on either side.
2. Connect cable at flowmeter pick-off connector.



10.15 TOWER HORN REPLACEMENT

REMOVAL

1. Twist the horn module CCW and lift it straight up, removing it from the base.
2. Disconnect electrical leads from the base.
3. Remove two screws, two locknuts, and four flat washers. Remove horn base from top of cart.

INSTALLATION

1. Install beacon assembly on top of cart, feeding electrical leads through mounting hole.
2. Secure tower horn assembly in place with two screws, two locknuts, and four flat washers.
3. Connect electrical leads to assembly base.

10.16 GROUND CABLE REEL REPLACEMENT

REMOVAL

While supporting the ground cable reel, remove two capscrews, two locknuts, and four flat washers and remove ground reel cable from frame.

INSTALLATION

Position ground reel cable in place and secure with two locknuts, four flat washers, and two capscrews.

10.17 MAIN POWER DISCONNECT ENCLOSURE REPAIRS



CAUTION!

SHOCK HAZARD. Before performing any work in the disconnect enclosure, verify that the Variable Frequency Drive (VFD) bus capacitors have discharged. Measure the DC bus voltage across the -DC and +DC terminals on the lower Power Terminal Block. The voltage must be zero. Darkened LED / LCD displays do not indicate that the capacitors have discharged to a safe voltage level.

10.17.1 Variable Speed Drive (VFD) Replacement

REMOVAL

1. Ensure the Power Selector Switch is set to POWER OFF. Using a flat blade screwdriver or coin, rotate the latches on the front of the disconnect enclosure 90º CCW and open the door.
2. Snap cover and terminal guards off of the variable frequency drive (VFD).
3. Tag and disconnect all wiring from the VFD.
4. Remove four screws, lockwashers, and flat washers and remove the VFD.

INSTALLATION

1. Mount the VFD in the enclosure and secure with four flat washers, lock washers, and screws.
2. Connect all wiring to VFD (refer to electrical schematic).
3. Remove and discard any temporary tags.
4. Replace terminal guards and snap cover onto the VFD.
5. Set parameters listed in Appendix II, **1016 Config Info**, when powered.

10.17.2 Main Power Selector Switch (DISC A) Replacement

REMOVAL

1. Ensure the Power Selector Switch is set to POWER OFF. Using a flat blade screwdriver or coin, rotate the latches on the front of the disconnect enclosure 90º CCW and open the door.
2. Tag and disconnect all electrical wires from the switch.
3. Remove four screws, lockwashers, and flat washers and remove from enclosure.

INSTALLATION

1. Secure to the mounting panel in enclosure with four flat washers, lockwashers, and screws.
2. Connect the wires to the main switches and auxiliary contact block (refer to electrical schematic).
3. Remove and discard any temporary tags.

10.17.3 24 VDC Power Supply (PS1) Replacement

REMOVAL

1. Ensure the Power Selector Switch is set to POWER OFF. Using a flat blade screwdriver or coin, rotate the latches on the front of the disconnect enclosure 90o CCW and open the door.
2. Tag and disconnect all electrical wires from power supply.
3. Snap power supply off DIN rail and remove from enclosure.

INSTALLATION

1. Snap power supply onto DIN rail. Be sure rail latches are latched.
2. Reconnect all electrical wiring.
3. Remove and discard any temporary tags.

10.18 CONTROL PANEL REPAIR

10.18.1 HMI Touchscreen Replacement

REMOVAL

1. Using a flat blade screwdriver or coin, rotate the latch on the front of the control enclosure 90º CCW and open the door.
2. From behind the control enclosure door, tag and disconnect power and signal leads.
3. Remove retaining clamps from inside enclosure access door and remove HMI touchscreen.

INSTALLATION

Install in reverse order of removal.

10.18.2 Flow Sight Gauge Replacement

The following procedure is identical for all sight gauges.

REMOVAL

1. Place a suitable container underneath work area to catch residual coolant.
2. Disconnect swivel elbows from bulkhead connectors and remove sight gauge assembly.
3. Remove two elbows and two seal nuts from sight gauge.

INSTALLATION

1. Install two seal nuts and two elbows on ends of sight gauge.
2. Install sight gauge assembly onto bulkhead connectors.
3. Check coolant level in main reservoir and add coolant as necessary.

10.18.3 Emergency Stop Switch Replacement

The E-stop switch consists of a contact block and a pushbutton operator.

REMOVAL

1. Using a flat blade screwdriver or coin, rotate the latch on the front of the control enclosure 90º CCW and open the door.
2. Tag and disconnect electrical wires from the switch.
3. From the rear of the control enclosure door, disengage the top and bottom contact block lugs and remove block from stem of pushbutton operator.
4. Loosen two screws and remove wires from the rear of switch block.
5. Remove ring nut from rear of stem, and remove switch pushbutton through front of panel.

INSTALLATION

1. Install switch pushbutton in through front of panel and secure in rear with ring nut.
2. Connect electrical wires to contact block and secure with two screws.
3. Snap contact block onto rear of pushbutton operator.

10.18.4 Power On/Off Button Replacement

REMOVAL

1. Use a flat blade screwdriver or coin to rotate the latch on the front of the control enclosure 90o CCW and open the door.
2. From behind the control enclosure door, tag and disconnect wires from the rear of the switch.
3. Unscrew retaining nut and pull switch through the front panel.

INSTALLATION

1. Install in reverse order of removal.

10.18.5 Hour Meter Replacement

REMOVAL

1. Using a flat blade screwdriver or coin, rotate the latch on the front of the control enclosure 90º CCW and open the door.
2. From the rear of the control enclosure door, tag and disconnect electrical wires from rear of meter.
3. From rear of meter, remove two nuts and mounting ring, then remove meter from front of panel.

INSTALLATION

1. Install meter in front panel and secure with mounting ring and two nuts.
2. Connect electrical leads to rear of meter.
3. Remove and discard any temporary tags.

10.18.6 PLC Module Replacement

There are six (6) PLC modules. The PLC Base and Expansion I/O Modules are mounted side by side on the top DIN rail inside the control enclosure. Use the following procedure to remove/replace any of the units.



REMOVAL

1. Using a flat blade screwdriver or coin, rotate the latch on the front of the control enclosure 90º CCW and open the door. Locate the PLC modules at the top of the panel.
2. Disconnect the wires from the I/O module(s) or remove the removable terminal blocks from the PLC base unit be removed.
3. Using both hands, grab I/O module(s) firmly (one at a time).
4. While pressing the module(s) (one at a time) down against the top of the DIN rail, pull the bottom away from the DIN rail, and then raise slightly to clear the top of the rail.
5. Remove the module(s) from the enclosure.

INSTALLATION

1. Open the control enclosure door (see no. 1 above).
2. Reassemble in reverse order of removal.

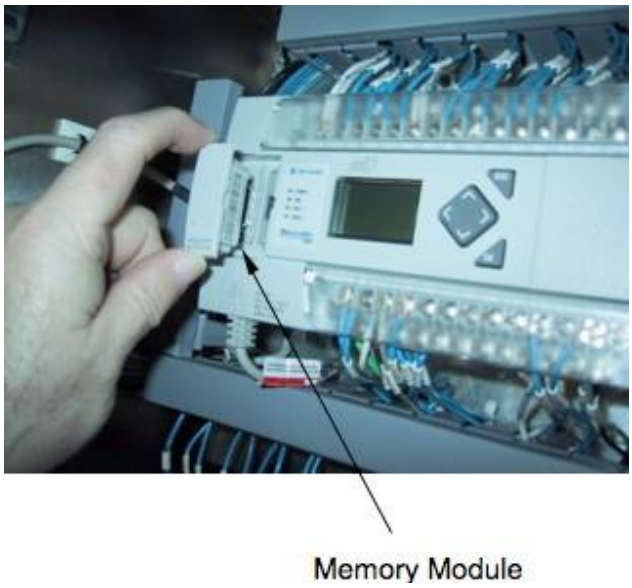
10.18.7 PLC Software Replacement

REMOVAL

1. Using a flat blade screwdriver or coin, rotate the latch on the front of the control enclosure 90º CCW and open the door. Locate the PLC module at the top of the panel.

WARNING!
DO NOT TOUCH MEMORY MODULE PC BOARD.

2. Unsnap Memory Module cover and remove as shown.



INSTALLATION

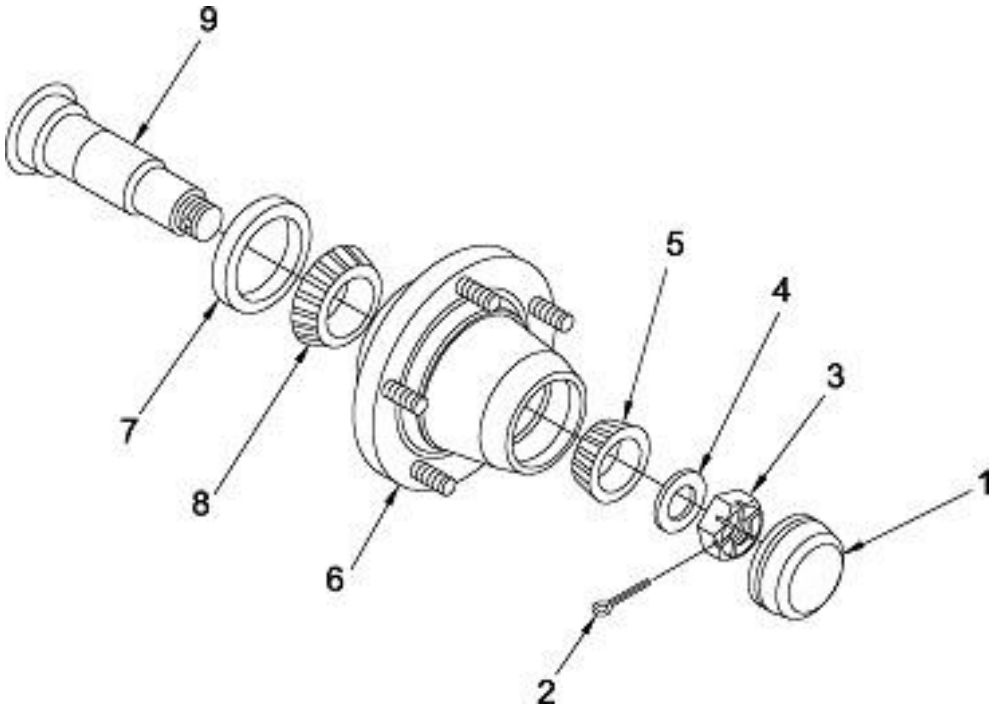
2. Insert new Memory Module into Memory Module socket connection and snap into place.

10.19 RUNNING GEAR REPAIR

10.19.1 Wheel Bearing Service

Perform the following procedures to repack the wheel bearings.

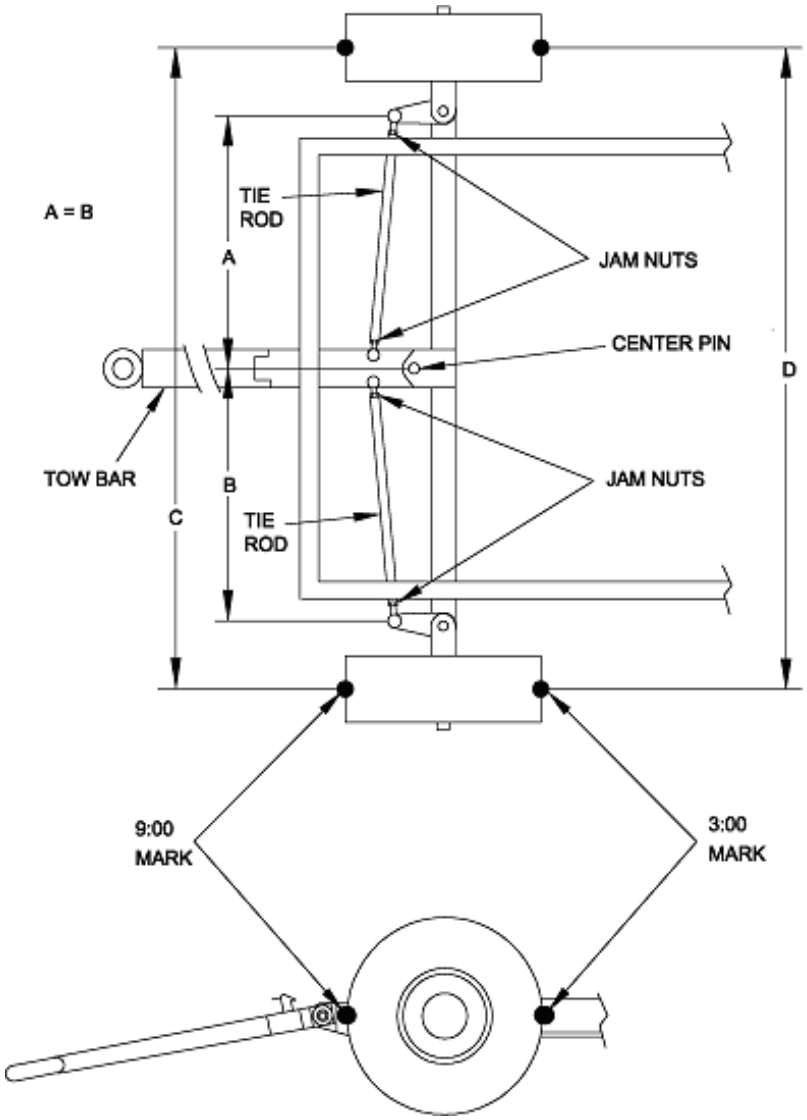
NOTE: The front wheel bearings may be serviced with the brakes applied, however, the brakes must be released to service the rear wheel bearings. Make certain to chock the front wheels while servicing the rear wheel bearings.



1. Park the test stand on level, hard ground, set the parking brakes and chock the wheels to prevent movement.
2. Loosen the wheel nuts.
3. Use a suitable jack to raise that wheel until the tire clears the ground, then remove the wheel nuts and the wheel.
4. Refer to Figure 33 and remove the hub cap (1), cotter pin (2), slotted nut (3) and washer (4).
5. Remove the outer bearing cone (5) and place it on a clean surface.
6. Pull the hub (6) off the spindle (9) while taking care not to damage the seal (7), then carefully pry the seal (7) out of the hub (6) and remove inner bearing cone (8).
7. Check the bearing races (still in the hub) for surface deterioration, pitting, cracks or discoloration. Light discoloration is acceptable. Severe discoloration indicates overheating.
8. Clean the bearing races by agitating them in a container of solvent. Do not spin the bearings. Doing so may cause damage to bearing or the bearing may fly apart.
9. Check the bearing cones for surface deterioration, cracks or other damage. Replace parts found unserviceable.
10. Pack the bearing cones with the specified bearing lubricant making certain to fill the gaps between the rollers with lubricant.
11. Install the inner bearing cone (8) in the hub (6), then install the seal (7) with the seal lip and spring inward.
12. Slide the hub assembly onto the spindle (9) taking care not to damage the seal (7).
13. Install the outer bearing cone (5) on the spindle (9) and push it into place with the washer (4).
14. Install slotted nut (3) and tighten it until heavy drag is felt while attempting to rotate the hub (6).
15. Back off slotted nut just enough that no drag is felt.
16. Rotate nut in tightening direction until slot in nut aligns with hole in spindle.
17. Install cotter pin (2). Bend ends of cotter pin to secure it.
18. Install hub cap (1), wheel and wheel nuts.
19. Lower wheel until tire makes firm contact with ground, then tighten wheel nuts.
20. Continue lowering test stand until tire supports test stand.
21. Repeat the above procedure with the remaining wheel bearings.

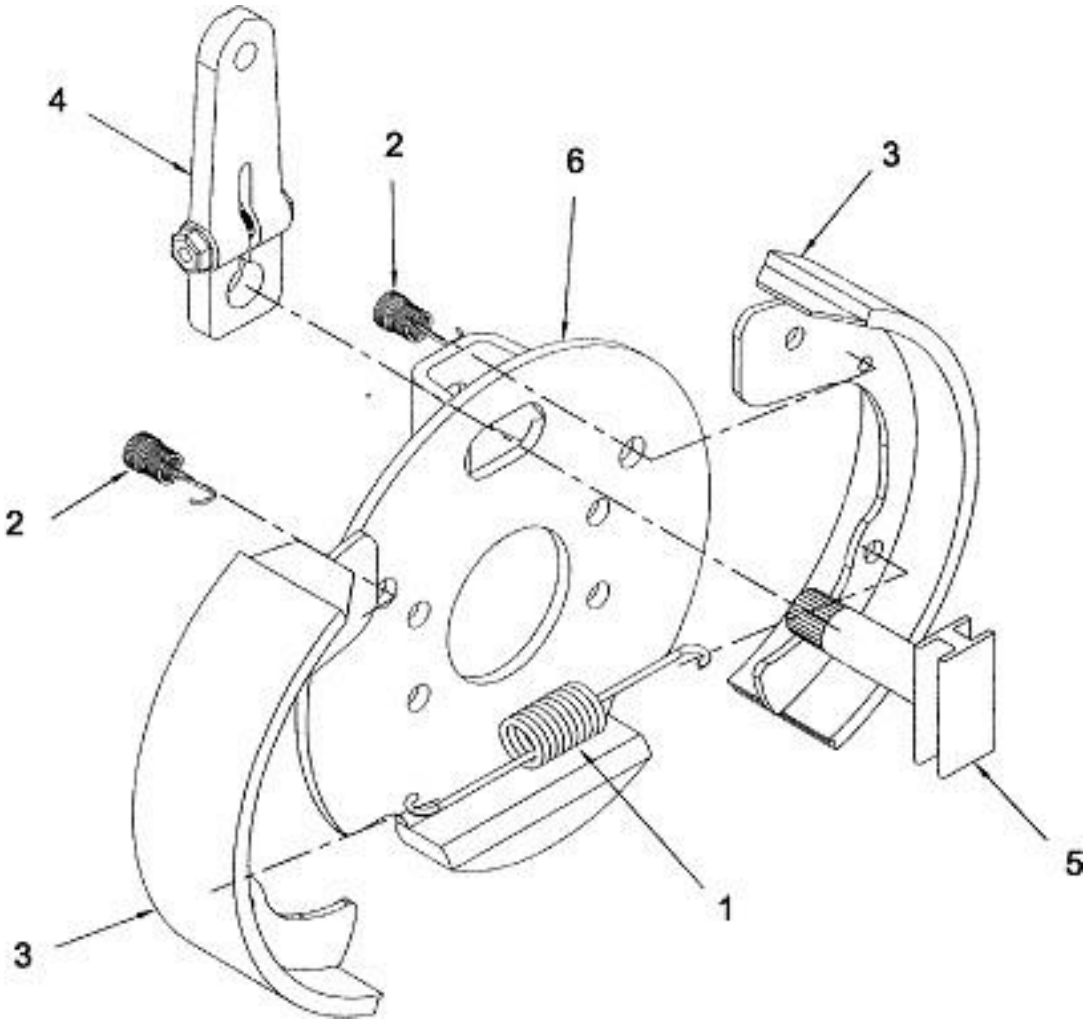
10.19.2 Wheel Alignment

To prevent premature wear of the front tires as well as excessive swaying of the loaded trailer, the front wheels must be aligned properly with each other and with the towbar. Perform the following procedures to align the test stand wheels.



1. Choose a smooth, level surface to perform the alignment procedures.
2. Position the lift trailer with the towbar lowered and centered.
3. Refer to Figure 34 and measure the length of each tie rod from the center pin to the removable pin at each wheel (A and B). The tie rods must be equal in length. If the tie rods are not equal in length, loosen the jam nuts and adjust the length to equalize the tie rods. If tie rods are equal in length, proceed to next step.
4. Place a mark in the middle of tread at the 9:00 o'clock position on the front side of each front tire.
5. Measure the distance "C" between the marks and record the measurement.
6. Move the trailer straight ahead until the marks on the front wheels are at the 3:00 o'clock position.
7. Measure the distance "D" between the marks.
8. Subtract the measurement "C" taken at the 9:00 position from the measurement "D" at the 3:00 position. The difference should be 1/8 inch. If the difference is greater than 1/8 inch, the tie rods must be lengthened. Be sure to lengthen both tie rods an equal amount to maintain the towbar in the centered position. If the difference is less than 1/8 inch, the tie rods must be shortened. Be sure to shorten both tie rods an equal amount to maintain the towbar in the centered position.
9. Loosen the jam nuts and adjust the length of the tie rods as necessary. Recheck the measurements when the adjustment is complete.

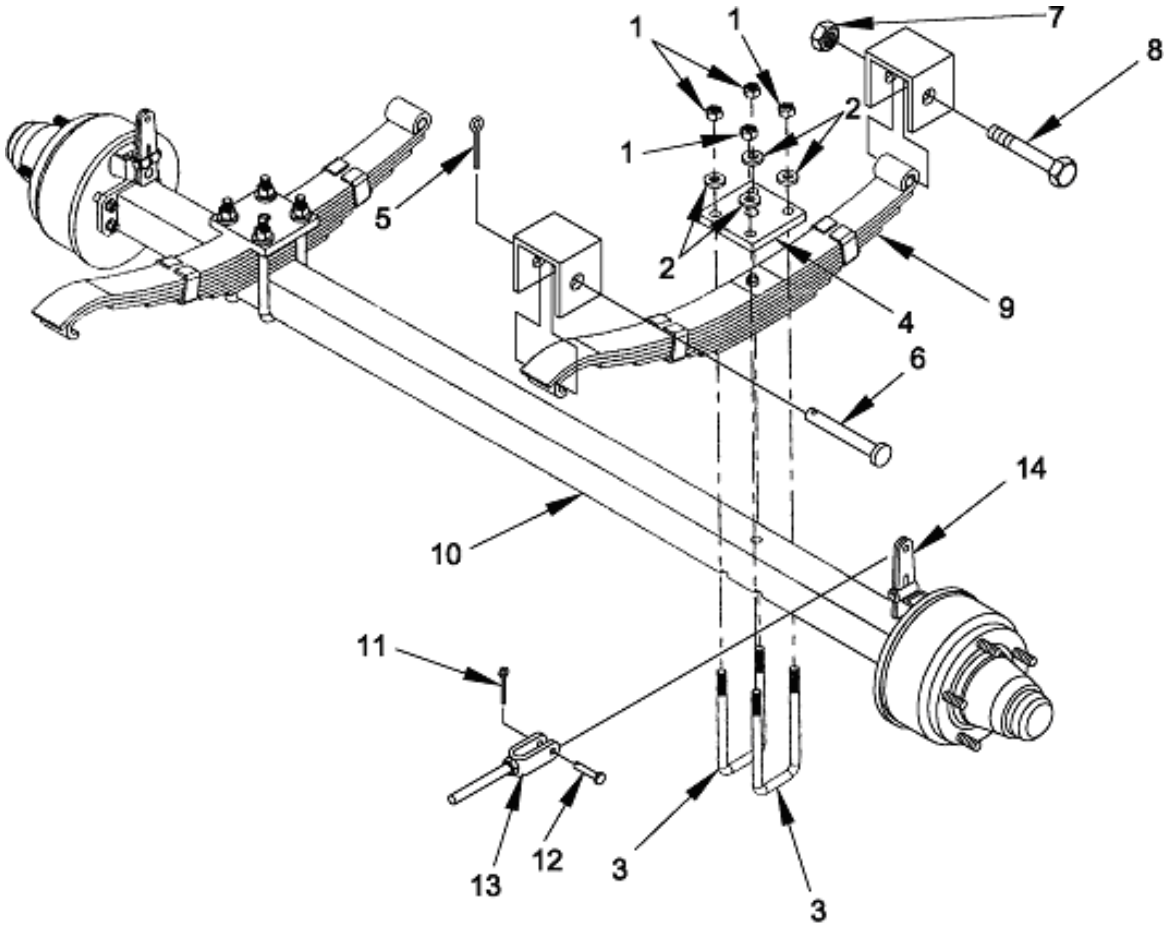
10.19.3 Brake Shoe Replacement



1. Park the test stand on level, hard ground, set the parking brakes and chock the wheels to prevent movement.
2. Loosen the wheel nuts.
3. Use a suitable jack to raise that wheel until the tire clears the ground, then remove the wheel nuts and the wheel.
4. Refer to Figure 33 and remove the hub cap (1), cotter pin (2), slotted nut (3) and washer (4).
5. Remove the outer bearing cone (5) and place it on a clean surface.
6. Pull the hub (6) off the spindle (9) while taking care not to damage the seal (7).
7. Refer to Figure 35 and disengage the two lining retainer springs (2).
8. Spread the top of the brake shoes (3) apart to disengage the camshaft (5), then remove the shoes and retract spring (1).
9. Unhook the shoes (3) from retract sping (1).
10. Assemble replacement shoes (3) and retract spring (1).
11. Spread the top of the shoes (3) apart and position them on camshaft (5) against backing plate (6).
12. Secure the shoes (3) with retaining springs (2).
13. Perform wheel bearing service and hub installation as outlined on page 82.
14. Back off the brake linkage adjustment by rotating the knob at the end of the brake lever counter- clockwise.
15. Rotate the adjustment knob clockwise to increase the braking force. Adjust the brake mechanism so that the brakes will hold the test stand stationary on a 15° incline.

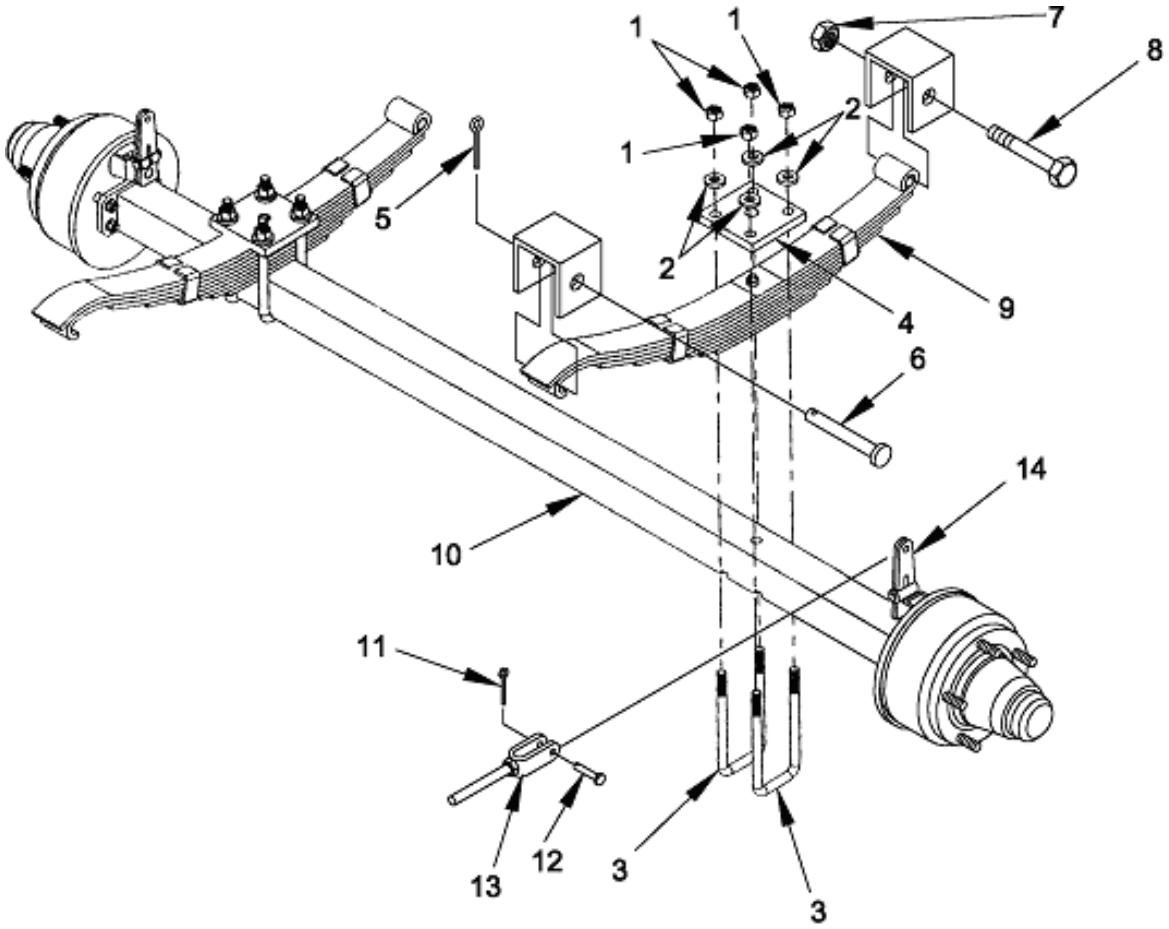
10.19.4 Spring Replacement

The following procedures outline replacement of a front or rear spring.



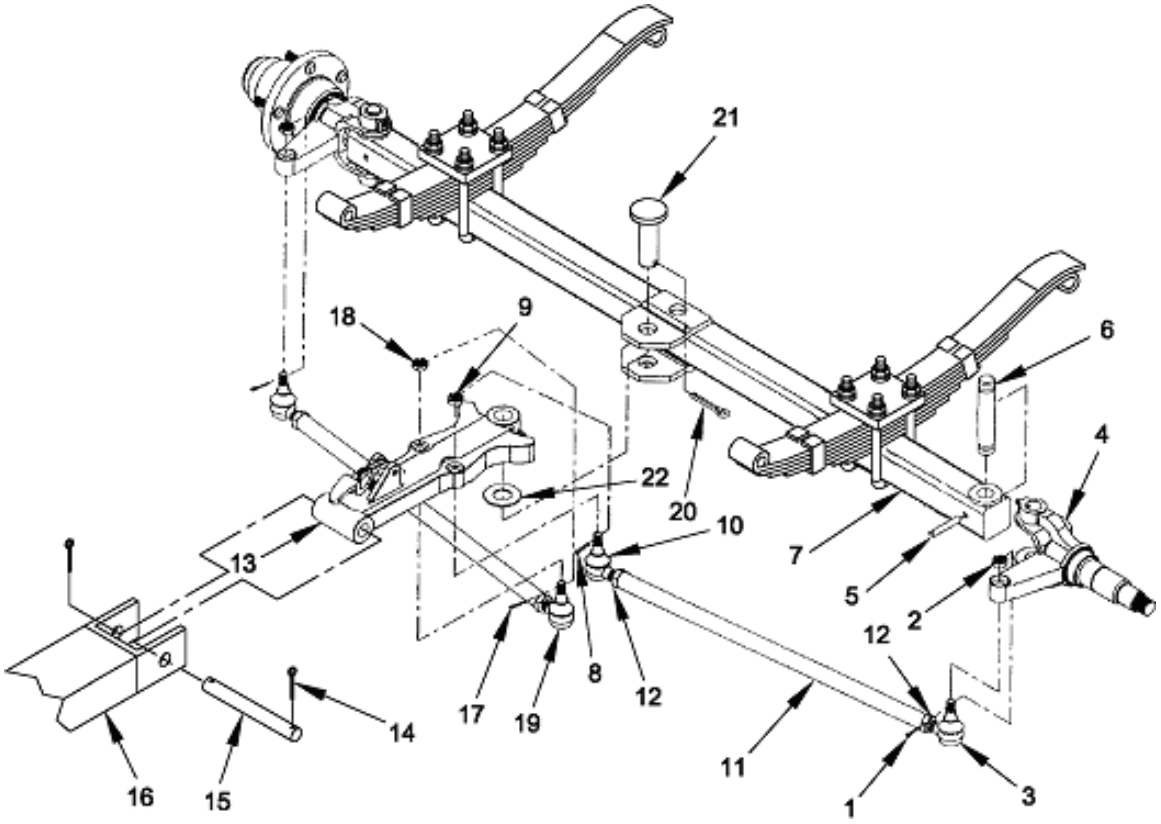
1. Park the test stand on level, hard ground, then apply the parking brake to prevent movement.
2. Disconnect test stand from tow vehicle.
3. Use a 2-ton minimum capacity jack to raise the corner of the test stand that requires the replacement spring. Raise the test stand until the tire clears the ground.
4. Place a jack stand under the frame (not the axle) to support the test stand in the raised position, then lower the test stand onto the jack stand. The tire should still just clear the ground.
5. Refer to Figure 36 and remove the four lock nuts (1), flat washers (2), u-bolts (3) and plate (4). This will separate the axle (10) from the spring (9).
6. Remove cotter pin (5), clevis pin (6), lock nut (7) and capscrew (8) to release spring (9) from frame brackets.
7. Position replacement spring (9) between frame brackets and secure with capscrew (8), lock nut (7), clevis pin (6) and new cotter pin (5).
8. Assemble u-bolts (3) and plate (4) around axle (10) and spring (9). Secure with flat washers (2) and lock nuts (1).
9. Use jack to raise test stand off jack stand, remove jack stand and lower test stand to ground.
10. Repeat steps c through i for any remaining springs needing replacement.

10.19.5 Rear Axle Replacement



1. Perform the following procedures to replace an entire rear axle assembly.
2. Park the test stand on level, hard ground, then block the front wheels to prevent movement.
3. Disconnect test stand from tow vehicle.
4. Use a 2-ton minimum capacity jack to raise the rear of the test stand. Raise the test stand until the tires clear the ground.
5. Place jack stands under both sides of the frame (not the axle) to support test stand in the raised position, then lower test stand onto jack stands. The tires should still just clear the ground.
6. Remove the rear tire/ wheel assemblies.
7. Refer to Figure 36 and remove the cotter pins (11) and clevis pins (12) to disconnect the brake linkage (13) from brake assembly levers (14).
8. Remove the lock nuts (1), flat washers (2), u-bolts (3) and plates (4). This will separate the rear axle (10) from the springs (9).
9. Maneuver a replacement axle assembly (10) under the springs (9).
10. Assemble u-bolts (3) and plates (4) around axle (10) and springs (9). Secure with flat washers (2) and lock nuts (1).
11. Connect brake linkage (13) to brake assembly levers (14) with clevis pins (12) and new cotter pins (11).
12. Install the tire/ wheel assemblies, then raise the test stand and remove the jack stands. Lower the test stand to the ground.
13. Back off the brake linkage adjustment by rotating the knob at the end of the brake lever counter- clockwise.
14. Rotate the adjustment knob clockwise to increase the braking force. Adjust the brake mechanism so that the brakes will hold the test stand stationary on a 15° incline.

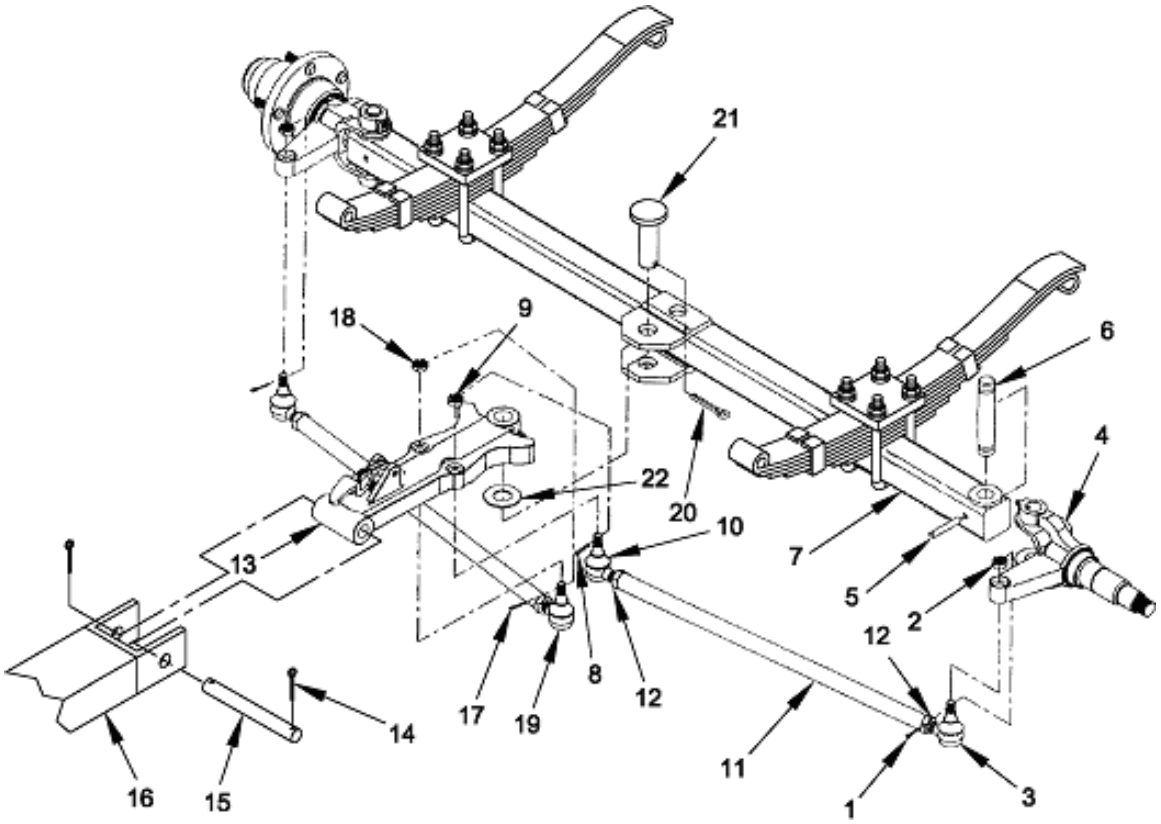
10.19.6 Steering Knuckle And King Pin Replacement



1. Park the test stand on level, hard ground, then apply the parking brake to prevent movement.
2. Disconnect test stand from tow vehicle.
3. Loosen the wheel nuts.
4. Use a suitable jack to raise that wheel until the tire clears the ground, then remove the wheel nuts and the wheel.
5. Refer to Figure 33 and remove the hub cap (1), cotter pin (2), slotted nut (3) and washer (4).
6. Remove the outer bearing cone (5) and place it on a clean surface.
7. Pull the hub (6) off the spindle (9) while taking care not to damage the seal (7)
8. Refer to Figure 37 and remove cotter pin (1) and slotted nut (2) to allow tie rod end (3) to be disconnected from steering knuckle (4).
9. Place a jack stand under the frame (not the axle) to support the test stand in the raised position, then lower the test stand onto the jack stand. The tire should still just clear the ground.
10. Use suitable drift and hammer to drive out spring pin (5), then tap king pin (6) down out of steering knuckle (4) and axle (7).
11. Using standard automotive grease, lubricate holes in replacement knuckle where it will rotate on king pin.
12. Position replacement knuckle (4) over end of axle (7) and install replacement king pin (6). Secure king pin with spring pin (5).
13. Connect tie rod end (3) to knuckle (4) and secure with slotted nut (2) and cotter pin (1).
14. Perform wheel bearing service and hub installation.
15. Install tire/ wheel assembly, then raise test stand and remove jack stands. Lower test stand to ground.
16. Repeat steps 3 through 12 to replace steering knuckle and king pin.
17. Perform front wheel alignment procedures.

10.19.7 Tie Rod End Replacement

1. The following procedures apply to both tie rods.
2. Park the test stand on level, hard ground, then apply the parking brake to prevent movement.
3. Disconnect test stand from tow vehicle.
4. Refer to Figure 37 and remove cotter pins (1 and 8) and slotted nuts (2 and 9).
5. Disconnect tie rod ends (3 and 10) from the steering lever (13) and knuckle (4).
6. Measure the length of the tie rod assembly (11) for reference during assembly.
7. Loosen the nuts (12), then remove the tie rod ends (3 and 10). Note which one of the tie rod ends has left hand threads for reference during assembly.
8. Thread replacement tie rod ends (3 and 10) through the nuts (1 and 12) and into the tie rod tube. Thread both tie rod ends an equal amount into the tie rod tube.
9. Adjust the length of the tie rod assembly to the measurement taken during disassembly. Leave the nuts (12) loose.
10. Attach the tie rod assembly (11) to the knuckle (4) and steering lever (13) with slotted nuts (2 and 9) and new cotter pins (1 and 8)..
11. Repeat steps 1 through 7 for the remaining tie rod assembly.
12. Perform front wheel alignment procedures.



10.19.8 Steering Lever And Pin Replacement

1. Park the test stand on level, hard ground and apply the parking brake to prevent movement.
2. Disconnect test stand from tow vehicle.
3. Refer to Figure 37 and remove cotter pins (8 and 17) and slotted nuts (9 and 18).
4. Disconnect tie rod ends (10 and 19) from the steering lever (13).
5. Remove cotter pin (14) and tow bar hinge pin (15) to release tow bar (16).
6. Remove cotter pin (20) and steering pivot pin (21) to release steering lever (13) and thrust washer (22).
7. Check the condition of the thrust washer (22). If it is worn, obtain a replacement.
8. Check the condition of the pivot pin hole in the steering lever (13). If the hole has been substantially enlarged through wear, have the hole drilled to restore the hole to round and have a bushing installed. If the hole is not worn, the steering lever may be reused as is.
9. Check the condition of the pivot pin (21) for wear. Replace worn pivot pins.
10. Position thrust washer (22) and steering lever (13) between axle mounting brackets.
11. Lubricate the pivot pin (21) with grease and insert it through the axle brackets, steering lever (13) and thrust washer (22). Secure it with a new cotter pin (20).
12. Connect tie rod ends (10 and 19) to the steering lever (13) with slotted nuts (9 and 18) and new cotter pins (8 and 17).
13. Perform wheel alignment procedures.

11.0 PREVENTATIVE MAINTENANCE SCHEDULE

11.1 GENERAL

The following tables provide general guidance for routine coolant service cart maintenance intervals. These recommendations are not intended to be all-inclusive. Use and operating environment may suggest additional specific maintenance activities as well as more (or less) frequent inspection and service or cleaning intervals. Only personnel experienced in electrical, piping, and mechanical systems should perform service and maintenance on this equipment. Additional information on individual components may be found in 7.0 OPERATION, 8.0 REGULAR MAINTENANCE and 10.0 REPAIR. If additional assistance is required, contact Malabar.

11.2 PREVENTATIVE MAINTENANCE TABLES

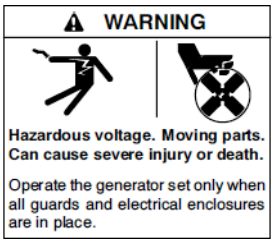
The maintenance schedule covers preventative maintenance recommendations for the models CSC. They do not include information on the Generator set. For Generator set preventative maintenance recommendations, see the Perkins Owners Manual, Maintenance Section, included in Appendix III of this manual.

CAUTION! - SHOCK HAZARD



The CSC cart has potentially fatal voltages applied during operation.

- Turn off the main Power Disconnect / Selector Switch before beginning any service procedure and if equipped, ensure that the generator is off.
- Never touch enclosure heater terminals unless the main Power Disconnect / Selector Switch is off and line cord disconnected. One heater terminal is connected directly to incoming line power and is live anytime the power is on, even if the heater is off.
- Before performing any work in the disconnect (lower) enclosure, verify that the Variable Frequency Drive (VFD) bus capacitors have discharged. Measure the DC bus voltage across the -DC and +DC terminals on the lower Power Terminal Block. The voltage must be zero. Darkened LED / LCD displays do not indicate that the capacitors have discharged to a safe voltage level.



CAUTION! - ROTATING EQUIPMENT HAZARD

Before accessing the main pump-motor shaft coupling (pump adapter), turn off the main Power Disconnect / Selector Switch to avoid sudden or unexpected starts while touching the shaft coupling.

CAUTION! - PRESSURE HAZARD

- Before loosening any tube, hose, or reservoir fittings, ensure that the internal system pressure is zero by turning off the main power disconnect / selector switch. The internal vent valve (LV8) will bleed the return side pressure to the sub reservoir. If the supply pressure gauge shows trapped pressure, use the purge valve located by the supply hose rack to depressurize the supply and return hoses. Connect the supply to return hose in runaround configuration to relieve pressure.

11.3 MAINTENANCE SCHEDULE

ITEM/SYSTEM	PROCEDURE/TASK	COMMENT/ACTION
DAILY		
Vacuum Trap	Visual Inspection: check level in bowl	Drain if more than 1/2 full
Frame / Structure	Check for loose fasteners	Tighten as required
Liquid System Components	Visual Inspection - check for evidence of damage or leaks on gauges, valves, hoses, fittings, etc.	• Tighten loose, leaking fittings (always use two wrenches) • Replace leaking gaskets • Repair or replace damaged components
Power Cord & Plug	Visual Inspection: look for signs of wear or damage	Replace if damaged
Hoses	Visual Inspection: look for signs of wear or damage	Replace if damaged
Parking Brake	Check that parking brake locks wheels	Adjust or repair as required for proper operation
QUARTERLY		
Emergency Stop Mushroom Button	Verify Operation. Run Cart (eunaround mode), press E-Stop mushroom button. Verify: • Both pump motors stop	**CAUTION:** Discontinue cart use if Emergency Stop does not function properly • Repair if malfunction occurs
Hardware	Check: • Hinges • Latches • Handles • Gas Struts	If needed: • Lubricate hinges w/light oil • Adjust / Tighten latches • Tighten handle attachments • Replace defective struts
Supply Reservoir	Visual Inspection: look for torn insulation or damaged level gauge	• Patch or replace any torn insulation • Repair or replace damaged level indicator
ANNUALLY		
Wiring	• Visually inspect electrical enclosures for loose wire connections • Check all power terminal screws for tightness	Check / Tighten all screwed wire terminals
Electrical Enclosure Vents	Inspection: Remove & inspect two vent filters from inside of the electrical enclosure side louvers	• Clean filters. Blow out dust w/compressed air or wash w/mild detergent if oily, dry. **CAUTION: NEVER** blow compressed air around any electrical devices or in any electrical enclosure
Cabinet / Frame	Clean exterior surfaces. Use mild soap with a sponge or soft cloth	• DO NOT use abrasive cleaners • Remove all cleaning agent residue
Cabinet Interior and Drip Pan	Remove debris from inside of the cart enclosure using a vacuum cleaner Wipe the drip pan clean	
Steering Mechanism	Lubricate	See 8.0 Maintenance
Parking Brake Mechanism	Lubricate	See 8.0 Maintenance
Wheel Bearings	Lubricate	See 8.0 Maintenance
Pressure Transducers	Calibrate	See 7.0 Operation for Calibration procedures

12.0 PROVISION OF SPARES

12.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

Malabar International
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
E-mail: sales@malabar.com
Website: www.malabar.com

12.2 RECOMMENDED SPARE PARTS LISTS

Reference the following page(s) for Replacement Parts and Kits available.

13.0 IN SERVICE SUPPORT

Contact Malabar, Inc. for technical services and information. See Section 1.3 – Manufacturer.

14.0 GUARANTEES/LIMITATION OF LIABILITY

I. Seller warrants each new product of its manufacture to be free from defects in material or workmanship, under proper, reasonable, and normal use and service.

II. The warranty period shall be as follows:
   A. For Malabar equipment, with the exception of Tripod Jacks, the warranty period is one (1) year after date of shipment.
   B. For Malabar Tripod Jacks, the warranty period is three (3) years after date of shipment.

III. Where Buyer claims an alleged defect in material or workmanship and so advises Seller in writing within ten (10) days after discovery thereof, then and in such event, Buyer shall return said equipment, transportation prepaid, to the Seller, provided such return is timely and within the above-mentioned warranty period. This warranty and liability of the Seller is expressly limited solely to replacement or repair of defective parts or goods, and return at Buyer's expense to Buyer after finding by Seller the product was defective prior to original shipment or, at the option of Seller, to providing refund to Buyer of the purchase price for said product.

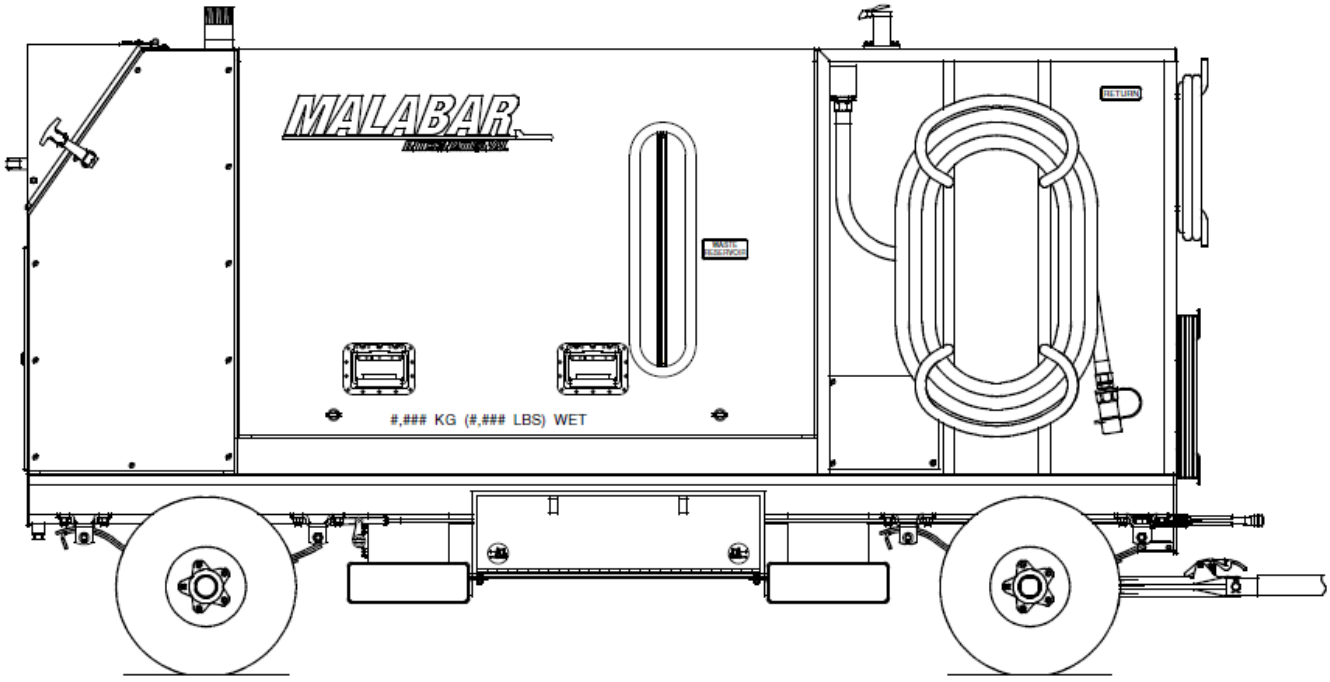
IV. It is further expressly understood and agreed that:
   A. THERE IS NO WARRANTY, REPRESENTATION OF CONDITION OF ANY KIND, EXPRESS OR IMPLIED, (INCLUDING NO WARRANTY OF MERCHANTABILITY OR OF FITNESS) EXCEPT THAT THE MATERIAL SHALL BE OF THE QUALITY SPECIFIED IN APPLICABLE SPECIFICATIONS, AND NONE SHALL BE IMPLIED BY LAW. Except as otherwise provided herein, quality shall be in accordance with Seller's specifications. Final determination of the material for the use contemplated by Buyer is the sole responsibility of Buyer and Seller shall have no responsibility in connection with such suitability, and
   B. Buyer's sole and exclusive remedy shall be repair or replacement of defective parts or goods by the Seller. Should the goods, in the judgment of Seller, preclude the remedying of the warranted defects by repair or replacement, the Buyer's sole and exclusive remedy shall be the refund of the purchase price, and
   C. Seller shall not be liable for prospective profits or special, indirect or consequential damages, nor shall any recovery of any kind against Seller be greater in amount than the purchase price of the specific material sold and causing the alleged loss, damage or injury. Buyer assumes all risk and liability for loss, damage or injury to persons or property of Buyer or others arising out of use or possession of any product or part sold hereunder, and
   D. Seller shall in no way be deemed or held to be obligated, liable or accountable upon or for any guarantees or warranties, express or implied, or created by statute or by operation of law or otherwise, in any manner of form beyond its express agreement above set forth, and
   E. No warranty herein shall apply to any product which shall have been repaired or altered, unless such alteration or repair has been made by Seller or if, after return to and inspection by Seller, the product is found by Seller to have been subject to misuse, negligence or accident, and
   F. No warranty of any nature is made by Seller as to any component forming a part of the product sold and Buyer shall receive only such warranties offered by such other manufacturer of such component, and
   G. Seller does not assume nor does Seller authorize any other person to assume for it any other liability or make any warranty in connection with the sale of its products.

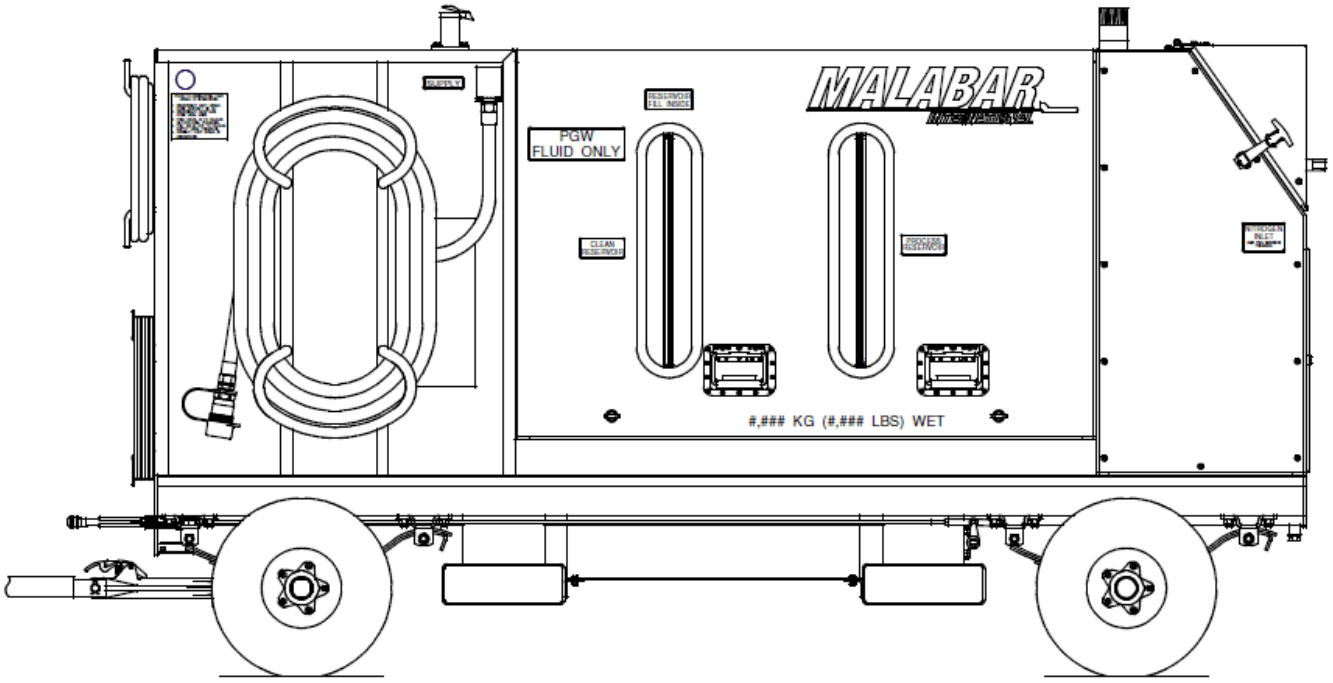
15.0 APPENDICIES

APPENDIX I	Hydraulic Schematic
APPENDIX II	Electrical Schematic
APPENDIX III	Control System Operation
APPENDIX IV	Allen Bradley MicroLogic 1400 Programmable Controllers
APPENDIX V	American Sensor Technology
APPENDIX VI	Beijer Electronics Touch Screen
APPENDIX VII	Cox Ground Teel
APPENDIX VIII	Exact Flow Dual Rotor Turbine Flow Meter
APPENDIX IX	Gast Vacuum Pump
APPENDIX X	Gransow Solenoid Valve
APPENDIX XI	Mean Well Power Supply
APPENDIX XII	Oberdorfer Pump
APPENDIX XIII	Omega Solenoid Valve
APPENDIX XIV	Perkins Engine Operation and Maintenance Manual
APPENDIX XV	Tescom Electro Pneumatic Nitrogen Regulator
APPENDIX XVI	Wattco Circulation Heater
APPENDIX XVII	Declaration of Conformity

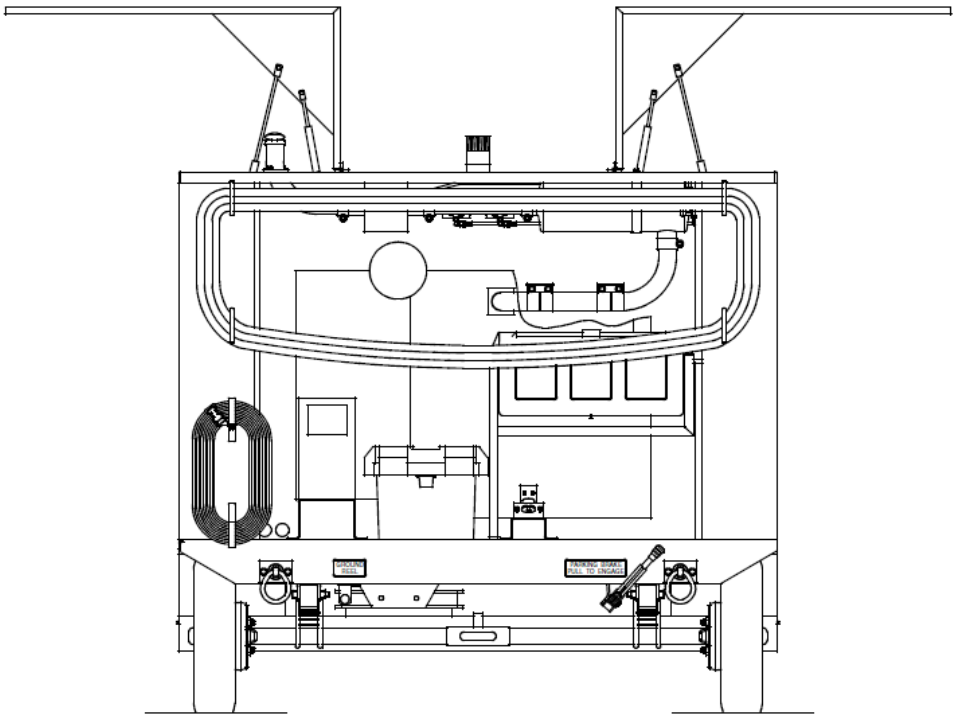
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Coolant Service Cart – Side Views

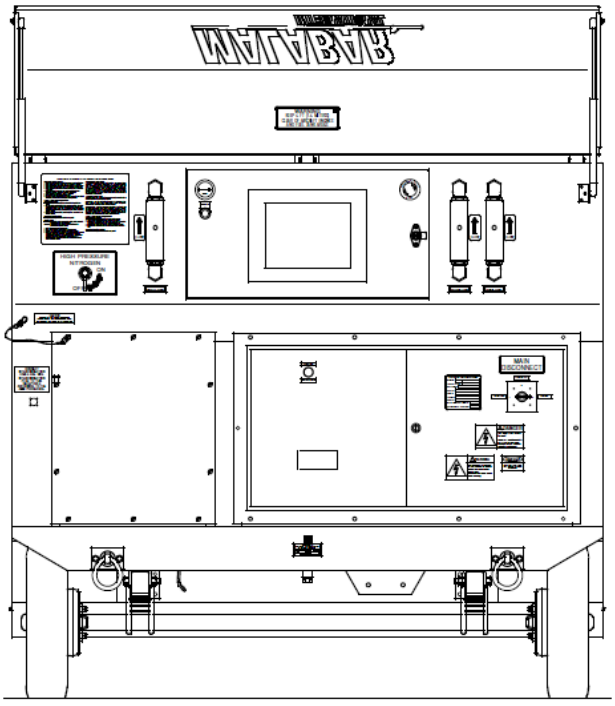




Coolant Service Cart



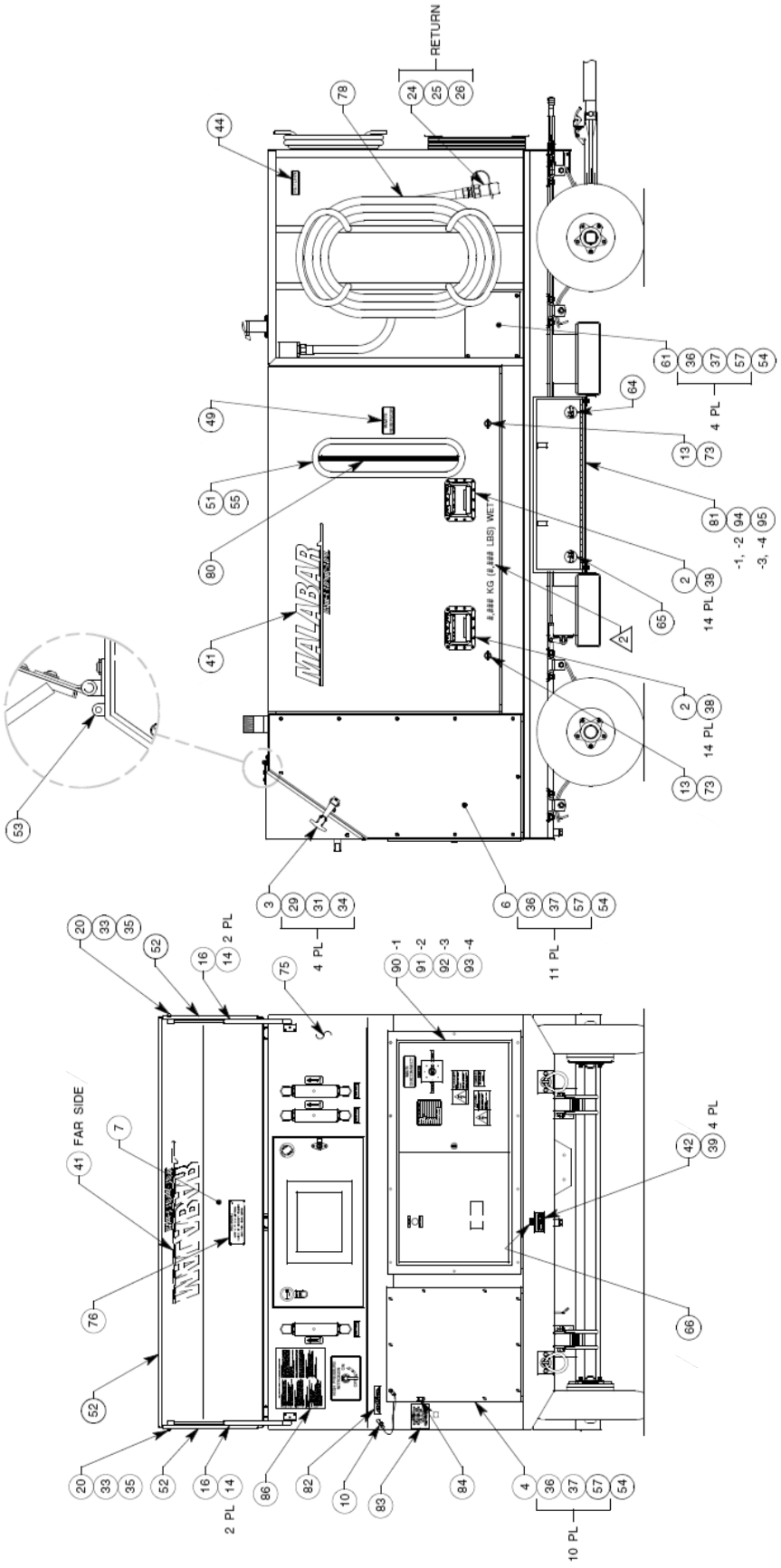
Front View



Rear View

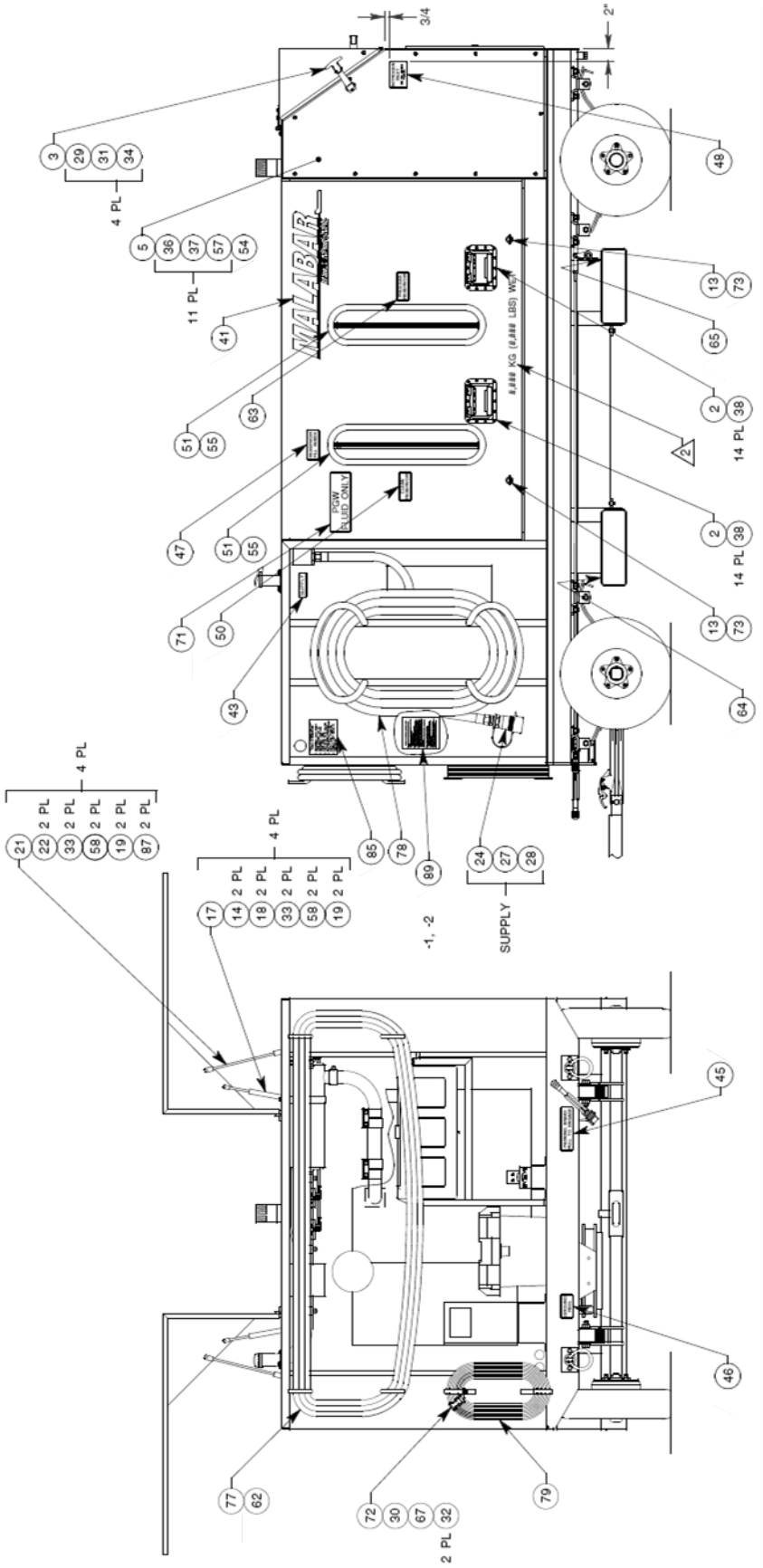
Parts List Illustration – Coolant Service Cart

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



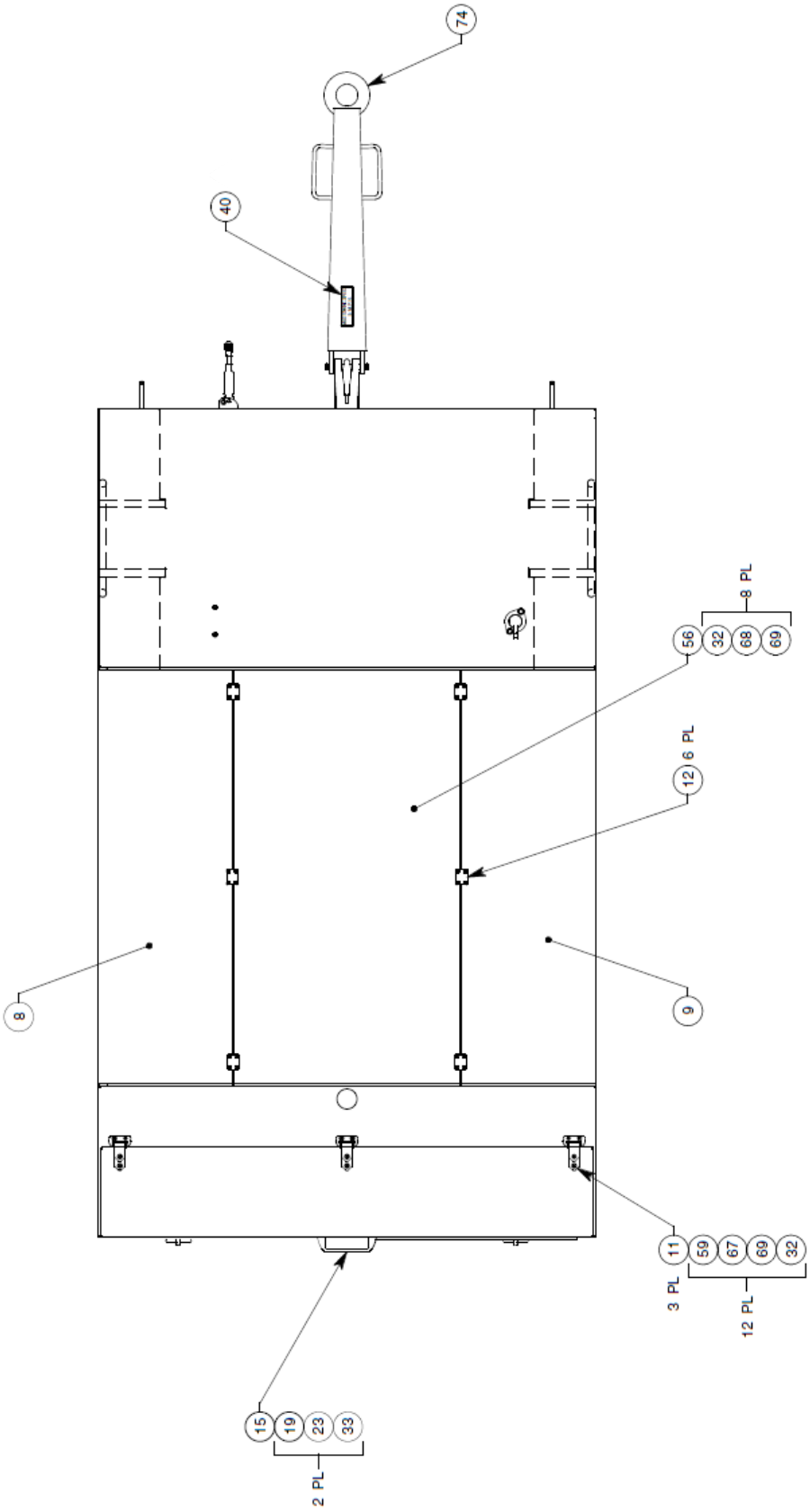
Parts List Illustration –Coolant Service Cart

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List Illustration – Coolant Service Cart

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List – Coolant Service Cart

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
2	26425	WING HANDLE	4
3	491-088	RUBBER HOOD CATCH WITH BRACKET	3
4	1016080	REAR PANEL	1
5	1011082	SIDE PANEL	1
6	1011081	SIDE PANEL	1
7	1016084	CONTROL HOOD	1
8	1016090	WING DOOR	1
9	1016091	WING DOOR	1
10	1006197	DUST CAP LANYARD ASSEMBLY	1
11	390-104	HINGE	3
12	390-105	HINGE	6
13	494-034	COMPRESSION LATCH	4
14	394-068	BALL SOCKET, M6, 10MM	12
15	494-033	HANDLE	1
16	490-038	GAS STRUT, 40 LBS	2
17	490-048	GAS STRUT, 40 LBS	4
18	394-069	BALL STUD, 10MM	8
19	364-007	SPLIT LOCKWASHER, SST, 5/16	18
20	394-087	BALL STUD, 10MM, 1.19 LG	2
21	490-049	GAS STRUT, 356N, 80 LBS	4
22	394-088	BALL STUD, 13MM, 1.79 LG	8
23	343-020	PHMS, SST, 5/16-18 X 1/2 LG	2
24	721-163	CONNECTOR, SST, 1” 37º X 1” MPT	2
25	735-068	QD NIPPLE, SST, 1” FPT	1
26	735-069	DUST CAP	1
27	736-133	QD COUPLER, SST, 1” FPT	1
28	736-134	DUST PLUG	1
29	326-032	BHCS, SST, 10-32 X 1/2 LG	8
30	326-033	BHCS, SELF LOCK, SST, 1/4-20 X 3/4 LG	2
31	362-055	FLATWASHER, SST, #10 SAE	8
32	362-038	FLAT WASHER, 1/4 SAE	32
33	362-048	FLAT WASHER, 5/16 SAE	20
34	359-012	HEX NUT, SST, 10-32	8
35	359-031	ACORN NUT, 5/16-18	2
36	390-103	SCREW, SLOTTED WITH WEAR WASHER	44
37	390-102	RECEPTACLE, SST, CLIP-ON	44
38	390-047	RIVET, BUTTON HD, 3/16 DIA X 1/4 GRIP	56
39	390-042	RIVET, DRIVE, 1/8 DIA X 1/4 LG	4
40	75940	STICKER, TOWING	1
41	55998-2	STICKER, MALABAR	3
42	55997-3	NAMEPLATE	1
43	1003137	STICKER, SUPPLY	1
44	1003138	STICKER, RETURN	1

Parts List – Coolant Service Cart

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
45	1003139	STICKER, PARKING BRAKE	1
46	1003140	STICKER, GROUND REEL	1
47	1003141	STICKER RESERVOIR FILL	1
48	1006194	STICKER, N2 INLET	1
49	1006198	STICKER, WASTE RESERVOIR	1
50	1006199	STICKER ,CLEAN RESERVOIR	1
51	1016208	WINDOW	1
52	999-039	EDGE TRIM, 1/32-1/8 GRIP X 105” LG	AR
53	260-097	RUBBER SEAL, 68” LG	AR
54	999-047	NEOPRENE STRIP, 450” LG	AR
55	749-034	WEATHER STRIP, 110” LG	AR
56	1011089A	RIDGE BEAM WELDMENT	1
57	369-006	RETAINER	44
58	359-020	HEX NUT, SST, 5/16-18	16
59	324-019	BHCS, SST, 14/-20 X 3/4 LG	17
60	1016013	PIPING ASSEMBLY (NOT SHOWN)	25
61	1011086	PANEL	2
62	1011167	STICKER, ELECTRIC SHOCK	1
63	106198	STICKER, PROCESS RESERVOIR	1
64	499-149	STICKER, FORLIFT POINT RIGHT	2
65	499-150	STICKER, FORLIFT POINT LEFT	2
66	75938	STICKER, CE	1
67	359-022	HEX NUT, SST, 1/4-20	19
68	324-017	HHCS, SST, 14/-20 X 3/4 LG	8
69	364-008	SPLIT LOCKWASHER, SST, 1/4	69
71	PF56208	STICKER, USE PGW FLUID ONLY	1
72	837724	STRAP	2
73	1011155	PAWL	4
74	1016015	FRAME/RUNNING GEAR ASSEMBLY	1
75	1016016	CONTROL PANEL ASSEMBLY	1
76	1011169	STICKER, WARNING	1
77	450-771	ELECTRICAL CORD	1
78	1016116	DELIVERY HOSE ASSEMBLY	2
79	1016050	INTERCONNECTION CABLE	1
80	260-103	PVE TUBE, CLEAR, 1 OD X 120 LG	AR
81	499-154	POCKET PH METER	1
82	PF56209	STICKER, HOSE DRAINING PROCEDURE	1
83	1016174	STICKER, INNERCONNECTION	1
84	394-003	PIPE CLAMP, 1/2	1
85	1016180	STICKER, PURGE VALVE	1
86	1016181	STICKER, CSC OPERATING INSTRUCTIONS	1
87	394-101	BALL SOCKET, M8 THE, 13MM SOCKET	8

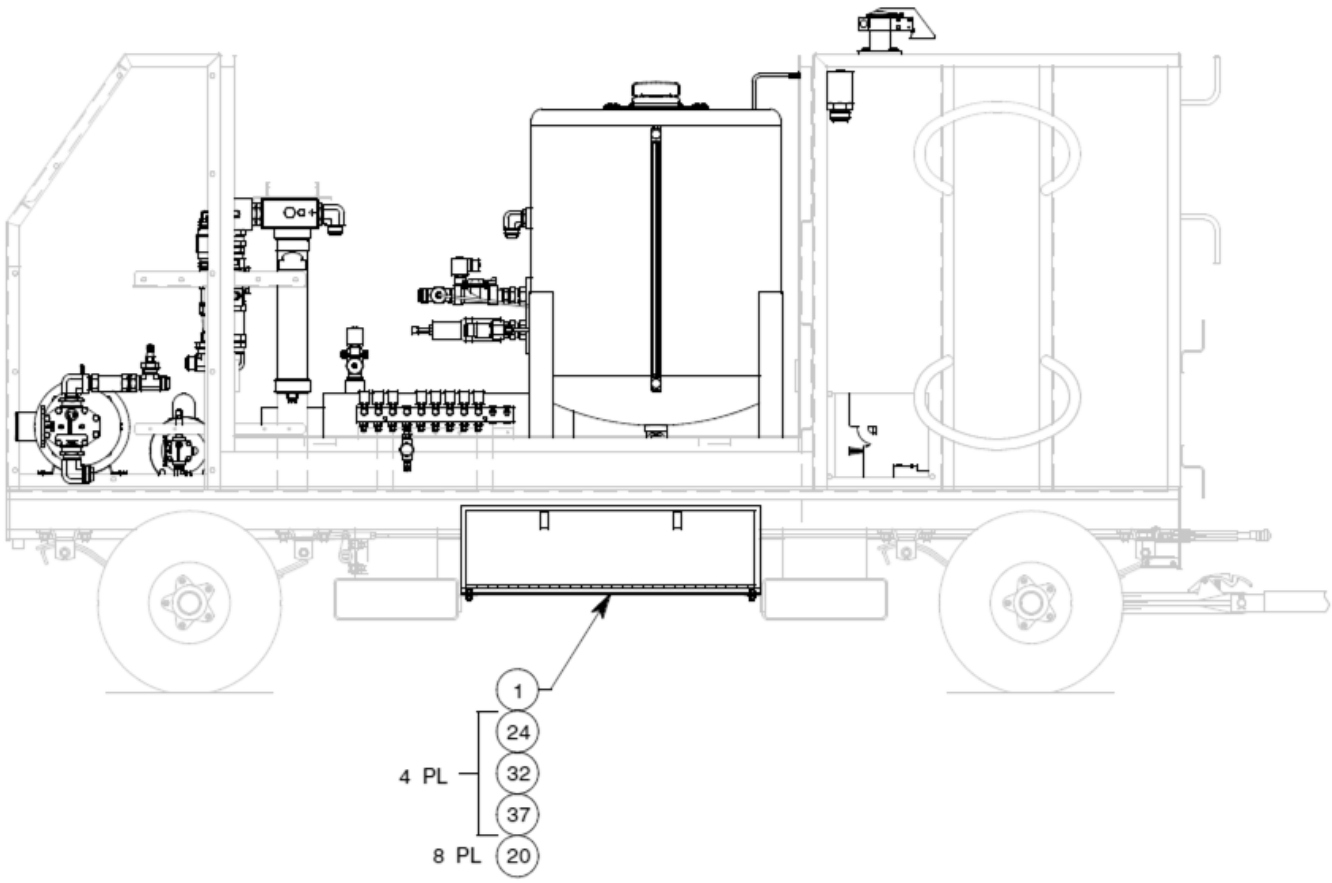
Parts List – Coolant Service Cart

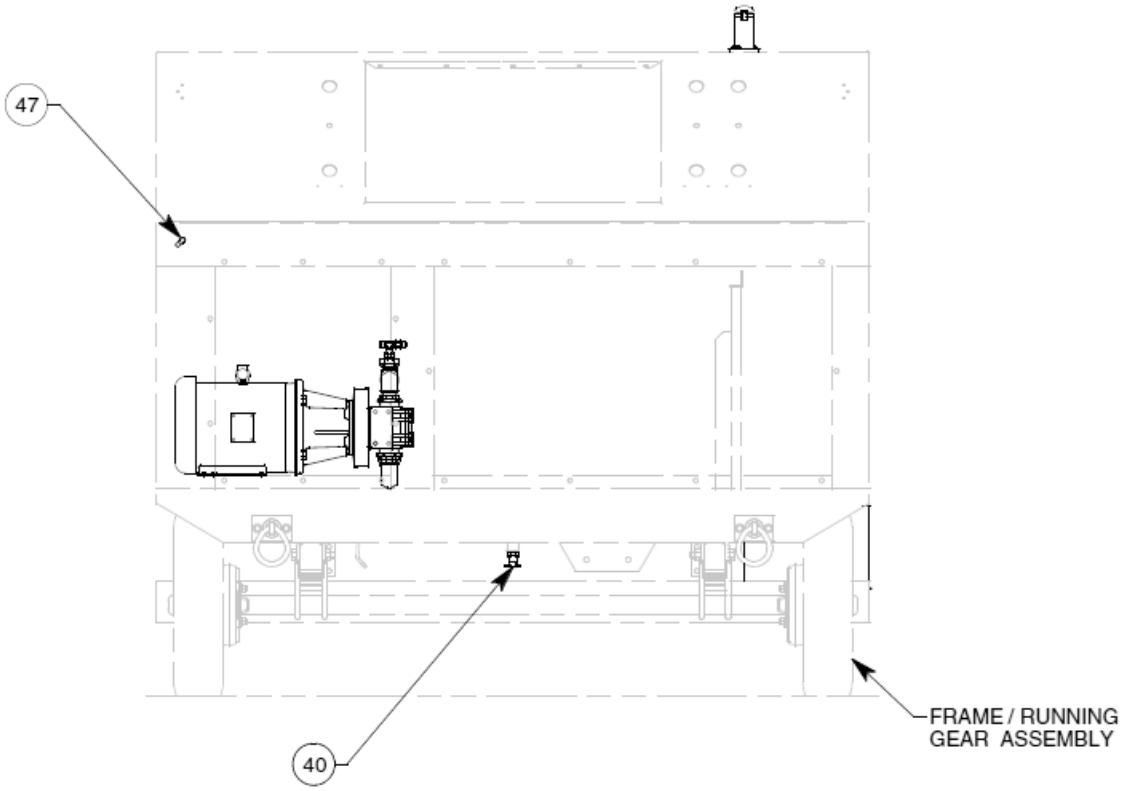
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

The Following Parts are Application Specific			**-1**	**-2**	**-3**	**-4**
Item	**Part Number**	**Description**	**Qty**			
89	1016182	STICKER, GENSET OP. INSTRUCTIONS	1	1	---	---
90	1016012-1	ELECTRICAL INTERCONNECT ASSEMBLY	1	---	---	---
91	1016012-2	ELECTRICAL INTERCONNECT ASSEMBLY	---	1	---	---
92	1016012-3	ELECTRICAL INTERCONNECT ASSEMBLY	---	---	1	---
93	1016012-4	ELECTRICAL INTERCONNECT ASSEMBLY	---	---	---	1
94	1016014	SUB COMPONENT ASSEMBLY	1	1	---	---
95	1016014-1	SUB COMPONENT ASSEMBLY	---	---	1	1

Parts List Illustration – Sub Component Assembly

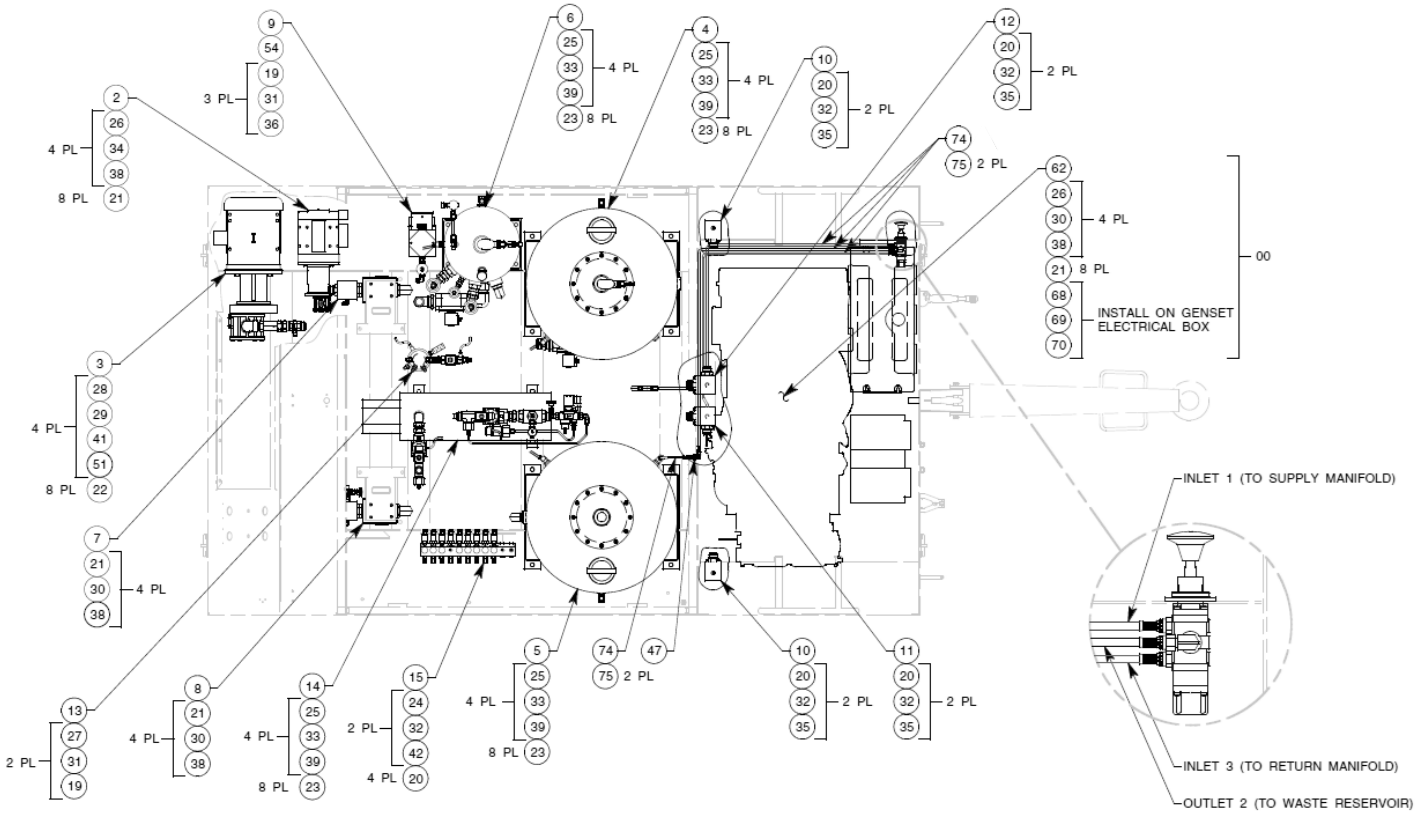
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

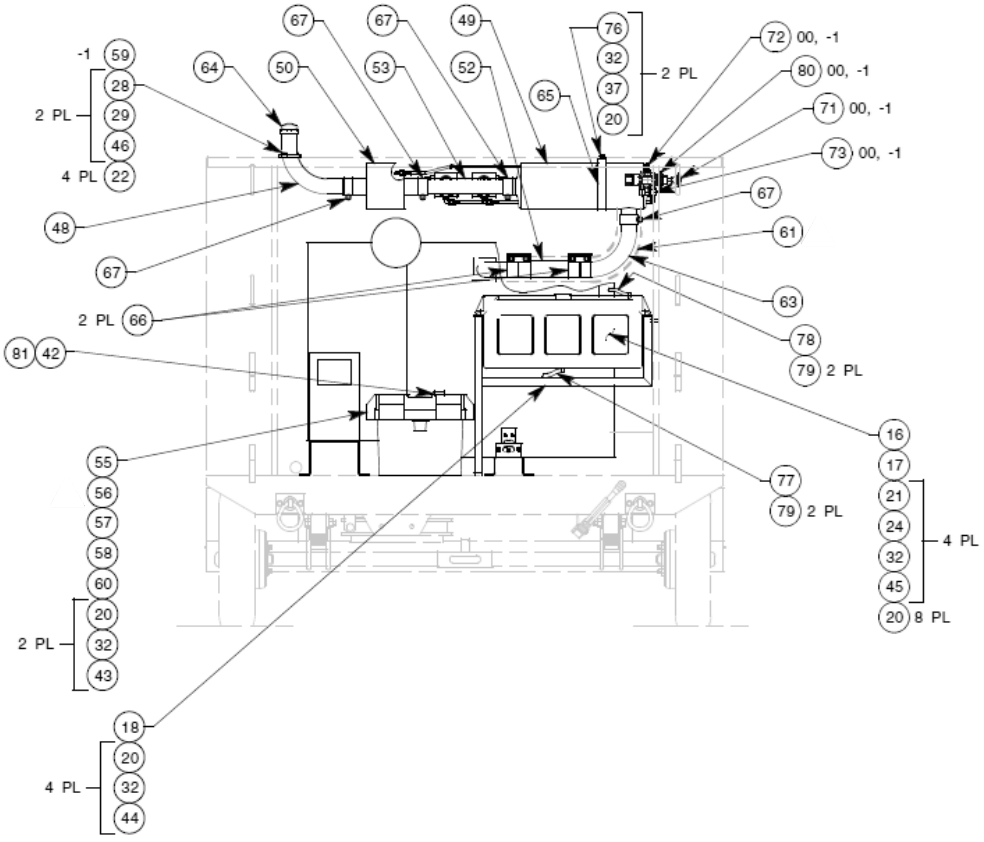




Parts List Illustration – Sub Component Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.





Parts List– Sub Component Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

			GENSET	
			WITH	W/OUT
Item	**Part Number**	**Description**	**Qty**	
	1016014	**SUB COMPONENT ASSEMBLY**; consist of:		
1	1011117	TOOL BOX	1	1
2	1016124	TOP OFF MOTOR/PUMP ASSEMBLY	1	1
3	1016123	MAIN MOTOR/PUMP ASSEMBLY	1	1
4	1016099-1	CLEAN RESERVOIR ASSEMBLY	1	1
5	1016099-2	WASTE RESERVOIR ASSEMBLY	1	1
6	1016099-3	SUB RESERVOIR ASSEMBLY	1	1
7	1016125	SUPPLU FILTER ASSEMBLY	1	1
8	1016126	RETURN FILTER ASSEMBLY	1	1
9	1006147	VACUUM PUMP ASSEMBLY	1	1
10	1016128	OUTLET MANIFOLD ASSEMBLY	2	2
11	1016129	RETURN MANIFOLD ASSEMBLY	1	1
12	1016130	SUPPLY MANIFOLD ASSEMBLY	1	1
13	1016146	N2 REGULATOR ASSEMBLY	1	1
14	1016127	HEATER ASSEMBLY	1	1
15	1016030	PRESSURE TRANSDUCER MANIFOLD ASSEMBLY	1	1
16	1011114	FUEL LEVEL SENSOR ASSEMBLY	1	---
17	499-133	FUEL TANK	1	---
18	1011148	FUEL TANK WELDMENT	1	---
19	362-055	FLATWASHER, SST, #10 SAE	5	5
20	362-038	FLATWASHER, SST, 1/4 SAE	36	20
21	362-048	FLATWASHER, SST, 5/16 SAE	28	16
22	362-049	FLATWASHER, SST, 3/8 SAE	12	12
23	362-057	FLATWASHER, SST, 1/2 SAE	32	32
24	359-022	HEX NUT, SST, 1/4-20	10	6
25	351-036	HEX NUT, SST, 1/2-13	16	16
26	359-020	HEX NUT, SST, 5/16-18	8	4
27	342-005	HHCS, SST, 10-32 X 1/2 LG	2	2
28	359-023	HEX NUT, SST, 3/8-16	6	6
29	363-037	SPLIT LOCKWASHER, SST, 3/8	6	6
30	363-040	SPLIT LOCKWASHER, SST, M8	12	8
31	363-035	SPLIT LOCKWASHER, SST, #10	5	5
32	364-008	SPLIT LOCKWASHER, SST, 1/4	26	14
33	363-038	SPLIT LOCKWASHER, SST, 1/2	16	16
34	364-007	SPLIT LOCKWASHER, SST, 5/16	4	4
35	326-035	BHCS, SST, 1/4-20 X 5/8 LG	8	8
36	324-027	HHCS, SST, 10-32 X 3/4 LG	3	3
37	324-012	HHCS, SST, 1/4-20 X 1 LG	6	4
38	324-010	HHCS, SST, 5/16-18 X 1 LG	16	12
39	324-027	HHCS, SST, 1/2-13 X 1-1/2 LG	16	16
40	424-005	DRAIN COCK VALVE, 1/2 MPT	1	1
41	324-085	HHCS, SST, 3/8-16 X 3 LG	4	4
42	324-048	HHCS, SST, 1/4-20 X 2-3/4 LG	3	3
43	324-079	HHCS, SST, 1/4-20 X 1-1/4 LG	2	---

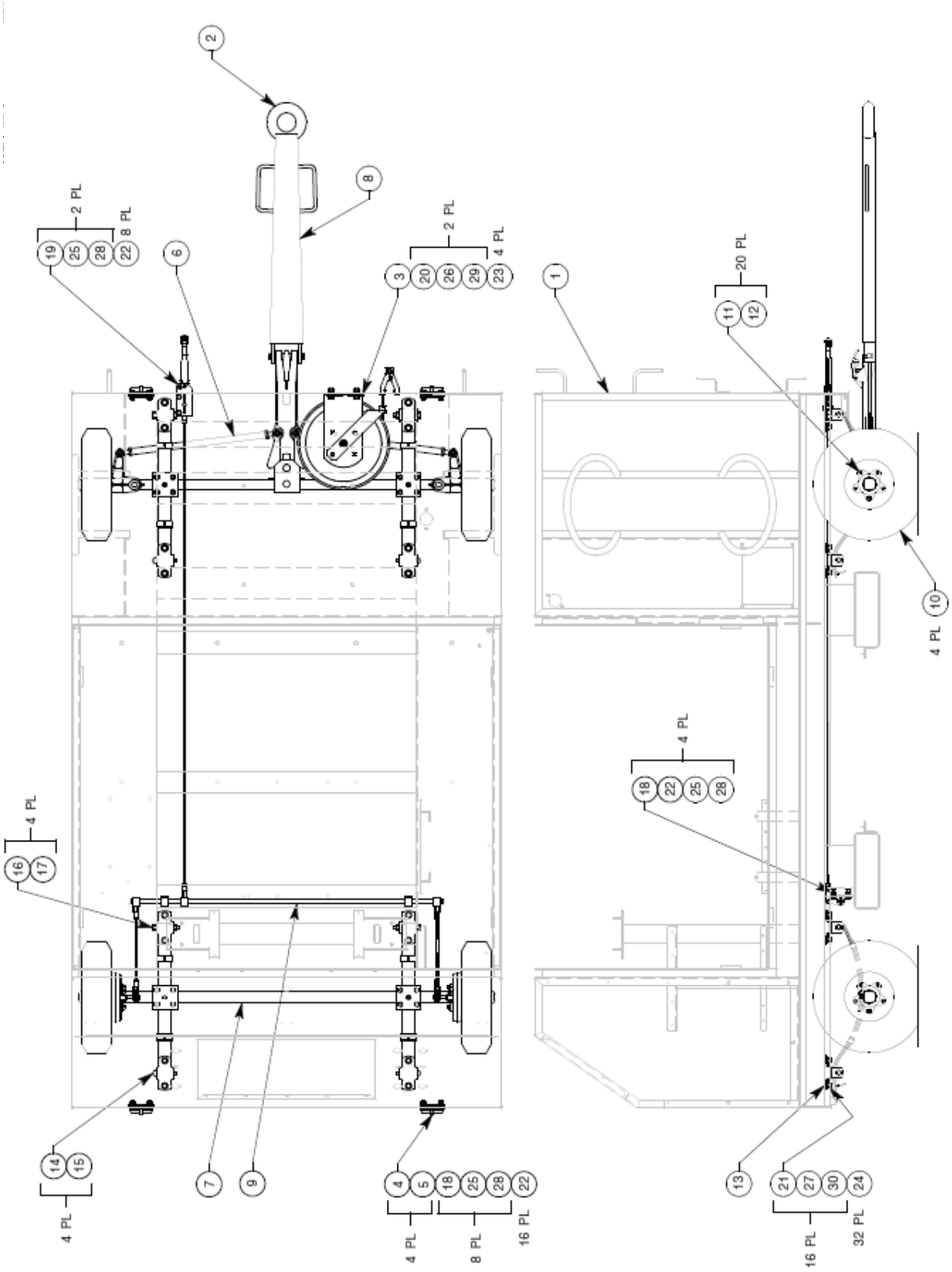
Parts List– Sub Component Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

			GENSET	
			WITH	**W/OUT**
44	324-062	HHCS, SST, 1/4-28 X 5/8 LG	4	---
45	324-037	HHCS, SST, 1/4-20 X 1-1/2 LG	4	---
46	324-023	HHCS, SST, 3/8-16 X 1 LG	2	2
47	721-198	ELBOW, BULKHEAD, 1/4 37º	2	2
48	1011055	ELBOW WELDMENT	1	---
49	499-161	MIFFLER	1	---
50	499-164	SPARK ARRESTOR	1	---
51	1016117	SPACER	4	4
52	1011058	FLEX TUBE	1	---
53	1011060	STRAIGHT EXHAUST PIPE	1	---
54	1011170	CABLE ASSEMBLY	1	1
55	1011213	BATTERY CABLE ASSEMBLY	1	---
56	1011214	BATTERY CABLE ASSEMBLY	1	---
57	26176	BATTERY	1	---
58	450-127	BATTERY BOX	1	---
59	1011151	EXHAUST COVER FLANGE	---	1
60	450-528	BATTERY TERMINAL ADAPTER, POSITIVE	1	---
61	499-146	EXHAUST WRAP	AR	---
62	1011057	GENERATOR SET	1	---
63	1011059	ELBOS	1	---
64	499-166	STACK CAP	1	---
65	499-162	MUFFLER MOUNTING BRACKET	1	---
66	394-097	FLEX CLAMP	2	---
67	394-098	EXHAUST CLAMP	4	---
68	450-709	CORD GRIP, 1 NPT X .88-1.065 GRIP	1	---
69	450-641	RING AND RETAINER ASSEMBLY	1	---
70	450-678	CONDUIT LOCKNUT, 1 NPT	1	---
71	421-054	THREE WAY SELECTOR VALVE	1	1
72	722-148	ELBOW, 1/4 MALE 37º X 1/4 MPT, SST	3	3
73	714-073	NIPPLE, 1/4 MPT X 1/4 FPT, SST	1	1
74	485-086	HOSE, 5/16 OD X 3/16 ID, 210 LG	AR	AR
75	487-074	FITTING, STRAIGHT CRIMP, 3/16	8	8
76	390-057	INSERT, 1/4 -20	2	---
77	485-120	HOSE, 5/16 OD X 9/16 ID, 26 LG	AR	---
78	485-094	HOSE, 3/16 OD X 13/32 ID, 31 LG	AR	---
79	394-029	HOSE CLAMP, WORM DRIVE, 7/32-5/8 DIA	4	---
80	361-013	FLATWASHER, 1 SAE	1	1
81	390-058	SPACER 1/4 CLEAR ID X 1/2 LG	1	1

Parts List Illustration – Frame/Running Gear Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



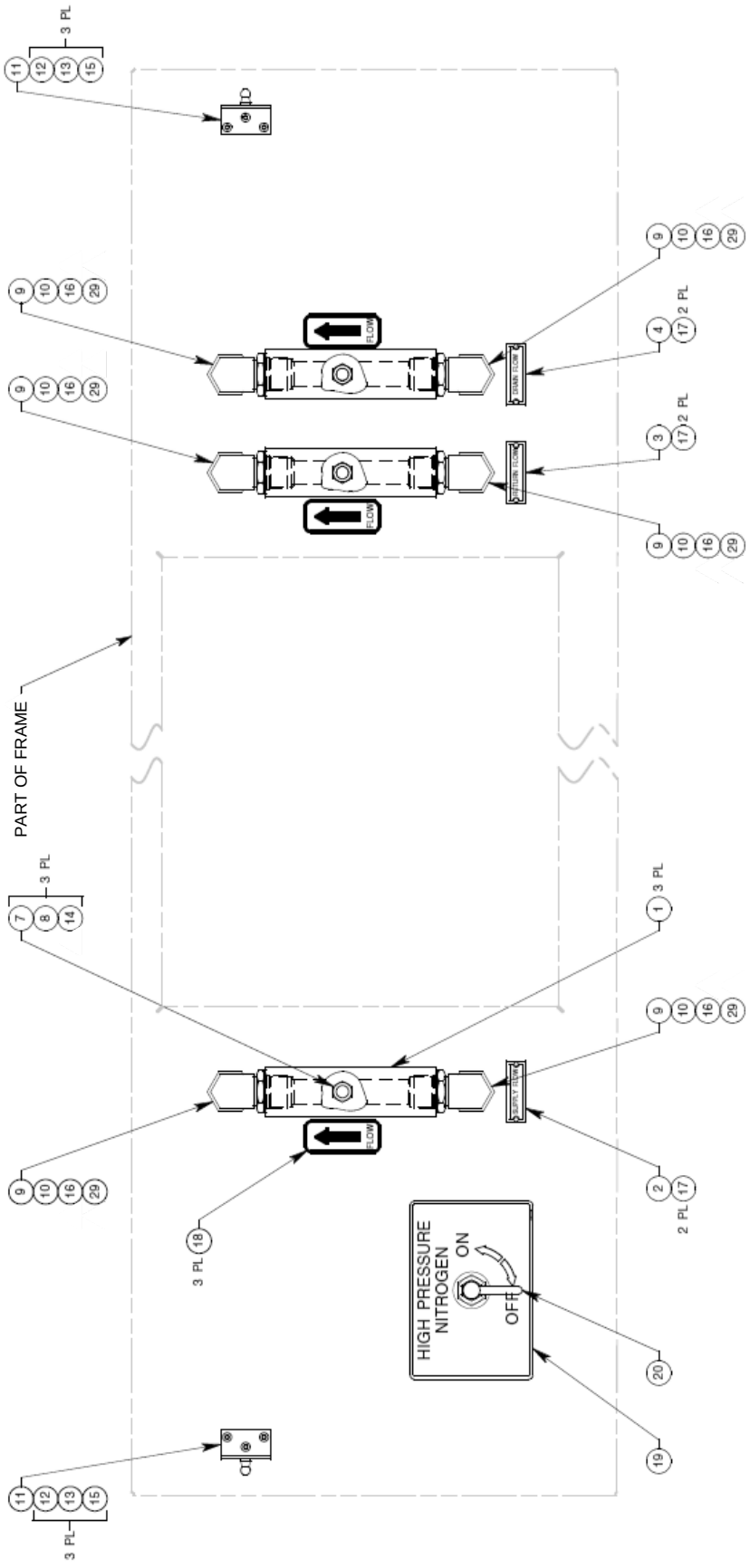
Parts List – Frame/Running Gear Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016015	**FRAME/RUNNING GEAR ASSEMBLY**; consist of:	
1	1016035	FRAME	1
2	1011025A-3	FOUR WHEEL RUNNING GEAR	1
3	26240	STATIC GROUND REEL	1
4	396-018	TIE DOWN NUT PLATE	4
5	396-017	TIE DOWN RING	4
6	14-1395	FRONT AXLE ASSEMBLY	1
7	17-1345	REAR AXLE ASSEMBLY	1
8	46-3502	DRAWBAR ASSEMBLY	1
9	91-5901	BRAKE CONTROL KIT	1
10	21-3705	WHEEL AND TIRE ASSEMBLY	4
11	4601-47	HEX NUT, 3/8-24	20
12	4700-4	SPLIT LOCKWASHER, 3/8	20
13	4251	SPRING BRACKET	8
14	5403-1	RIVET	4
15	4800-3	COTTER PIN, 1/8 X 1”	4
16	4901-19	HHCS, 9/16-12 X 1-1/4 LG, SST	4
17	4601-33	HEX NUT, 9/16-12	4
18	324-014	HHCS, 3/8-16 X 1-1/4 LG, SST	12
19	324-050	HHCS, 3/8-16 X 2-1/4 LG, SST	2
20	324-052	HHCS, 7/16-14 X 1-1/4 LG, SST	2
21	324-055	HHCS, 1/2-13 X 1-1/2 LG, SST	16
22	362-049	FLAT WASHER. 3/8 SAE, SST	32
23	362-059	FLAT WASHER. 7/16 SAE, SST	4
24	362-057	FLAT WASHER. 1/2 SAE, SST	32
25	359-023	HEX NUT, 3/8-16, SST	14
26	359-035	HEX NUT, 7/16-14, SST	2
27	351-036	HEX NUT, 1/2-13, SST	16
28	363-037	SPLIT LOCKWASHER, 3/8 SAE, SST	14
29	364-016	SPLIT LOCKWASHER, 7/16 SAE, SST	2
30	363-038	SPLIT LOCKWASHER, 1/2 SAE, SST	16

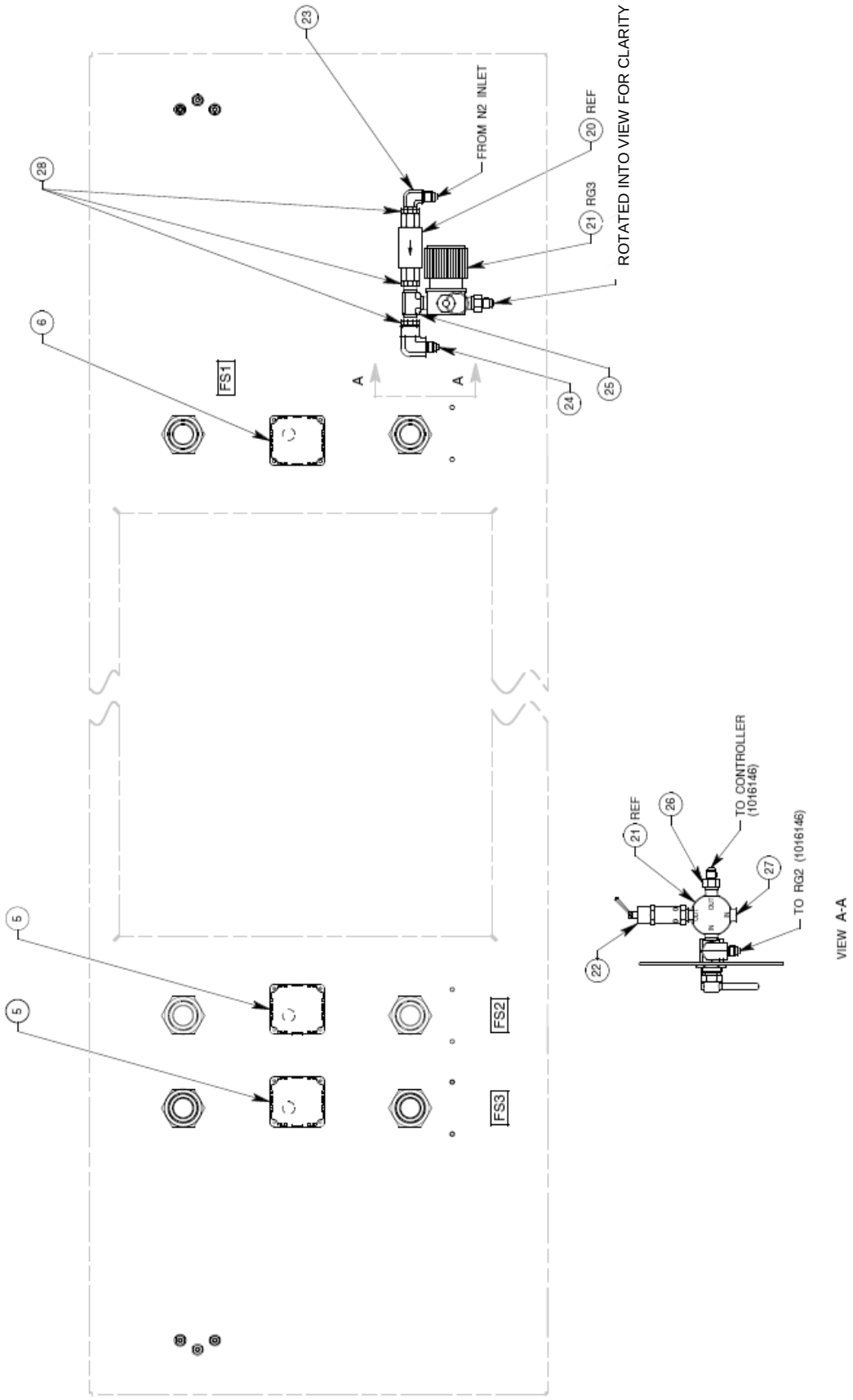
Parts List Illustration – Control Panel Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List Illustration – Control Panel Assembly

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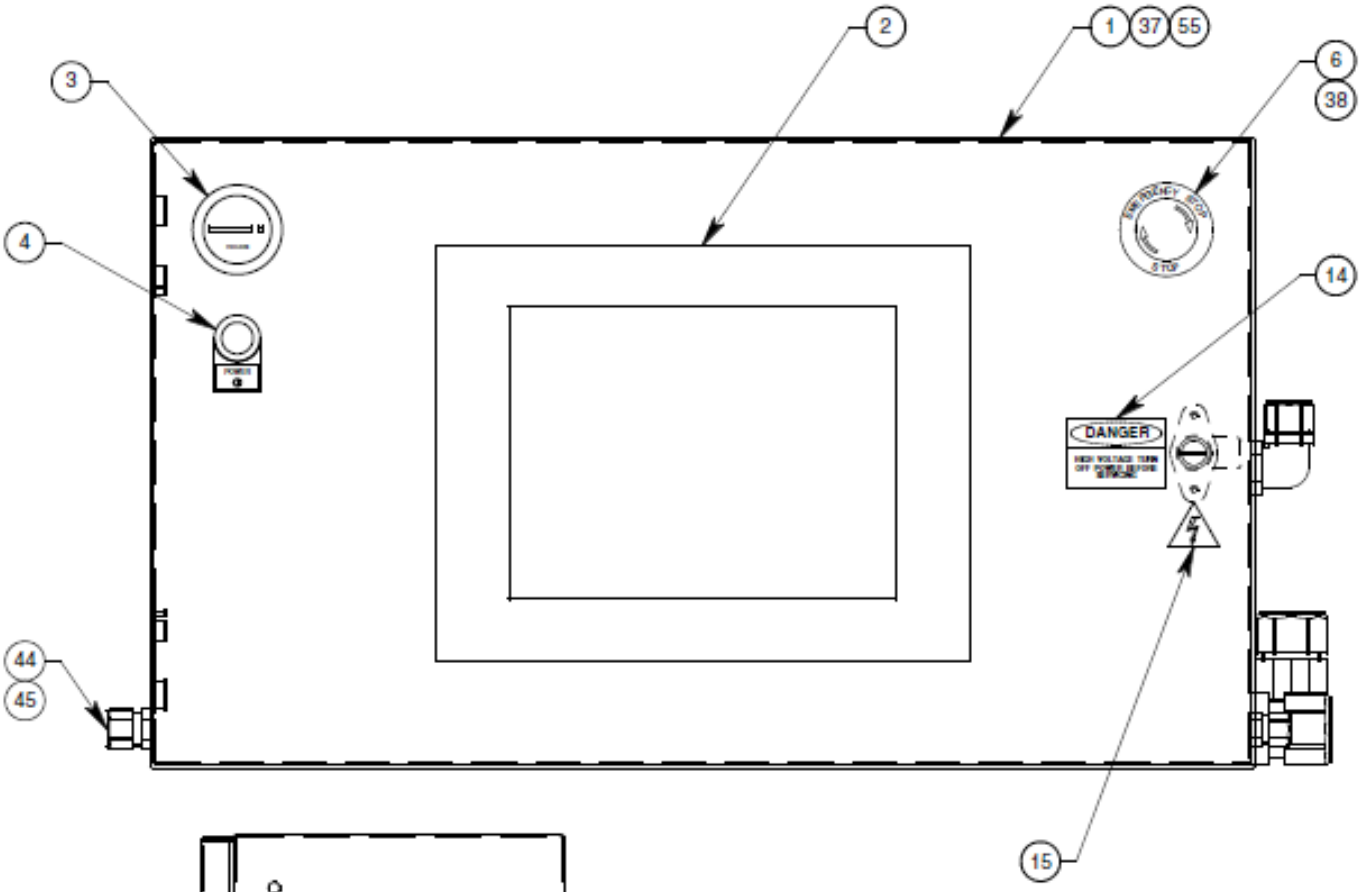
Parts List– Control Panel Assembly

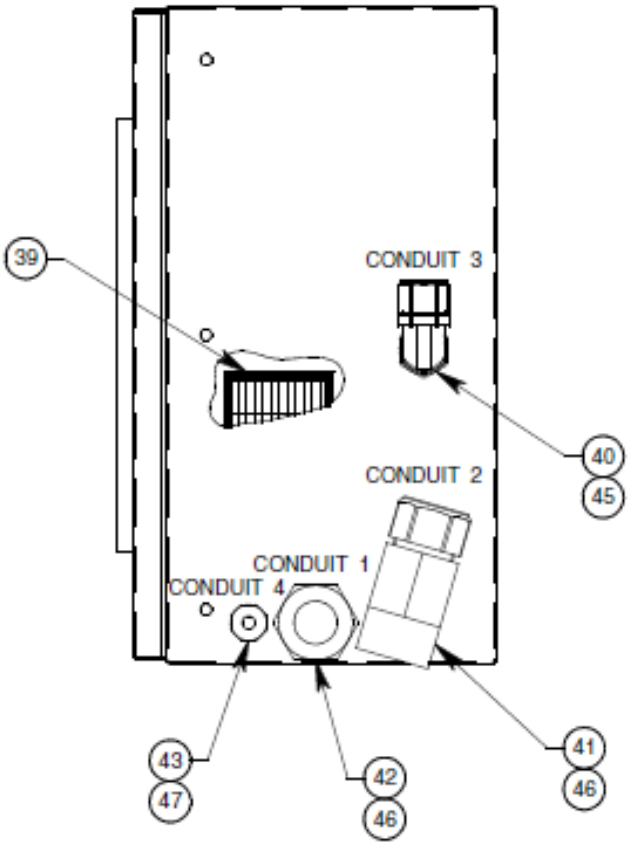
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016016	**CONTROL PANEL ASSEMBLY**; consist of:	
1	1011187	FLOW SIGHT, 6.93 LG	3
2	1006169	PLACARD, SUPPLY FLOW	1
3	1006172	PLACARD, RETURN FLOW	1
4	1006174	PLACARD, DRAIN FLOW	1
5	1013232-2	ENCLOSURE	2
6	1013232-1	ENCLOSURE	1
7	1013231	LEX FIXTURE	3
8	450-744	LED INDICATOR	3
9	722-144	ELBOW, 1 SWIVEL X 1 SAE	6
10	721-171	CONNECTOR, BULKHEAD, 1 MALE 37º	6
11	394-070	BALL BRACKET, 10MM	2
12	326-032	BHCS, 10-32 X 1/2 LG, SST	6
13	359-012	HEX NUT, 10-32	6
14	352-010	NUT, HEX JAM, 1/2-20	3
15	362-055	FLATWASHER, #10 SAE	6
16	362-062	FLATWASHER, 1-1/4 SAE, SST	6
17	390-088	RIVET, BUTTONHEAD, 3/32 X 1/4 GRIP	6
18	101617	STICKER, FLOW	3
19	106179	STICKER, HIGH PRESSURE N2 ON/OFF	1
20	424-033	BALL VALVE, 1/4 FPT	1
21	473-106	NITROGEN REGULATOR	1
22	425-011	AIR RELIEF VLAVE, 100 PSIG, 1/4 MPT	1
23	722-148	ELBOW, 1/4 MALE 37º X 1/4 FPT	1
24	722-111	ELBOW, 1/4 MALE 37º X 1/4 MPT	1
25	713-033	TEE, 1/4 MPT	1
26	721-138	CONNECTOR, 1/4 MALE 37º X 1/4 MPT	1
27	717-064	SOCKET PLUG, 1/4 MPT	1
28	719-055	SEAL NUT, 1/4 FPT	3
29	55930-916	O-RING	6

Parts List Illustration – Control Enclosure Assembly

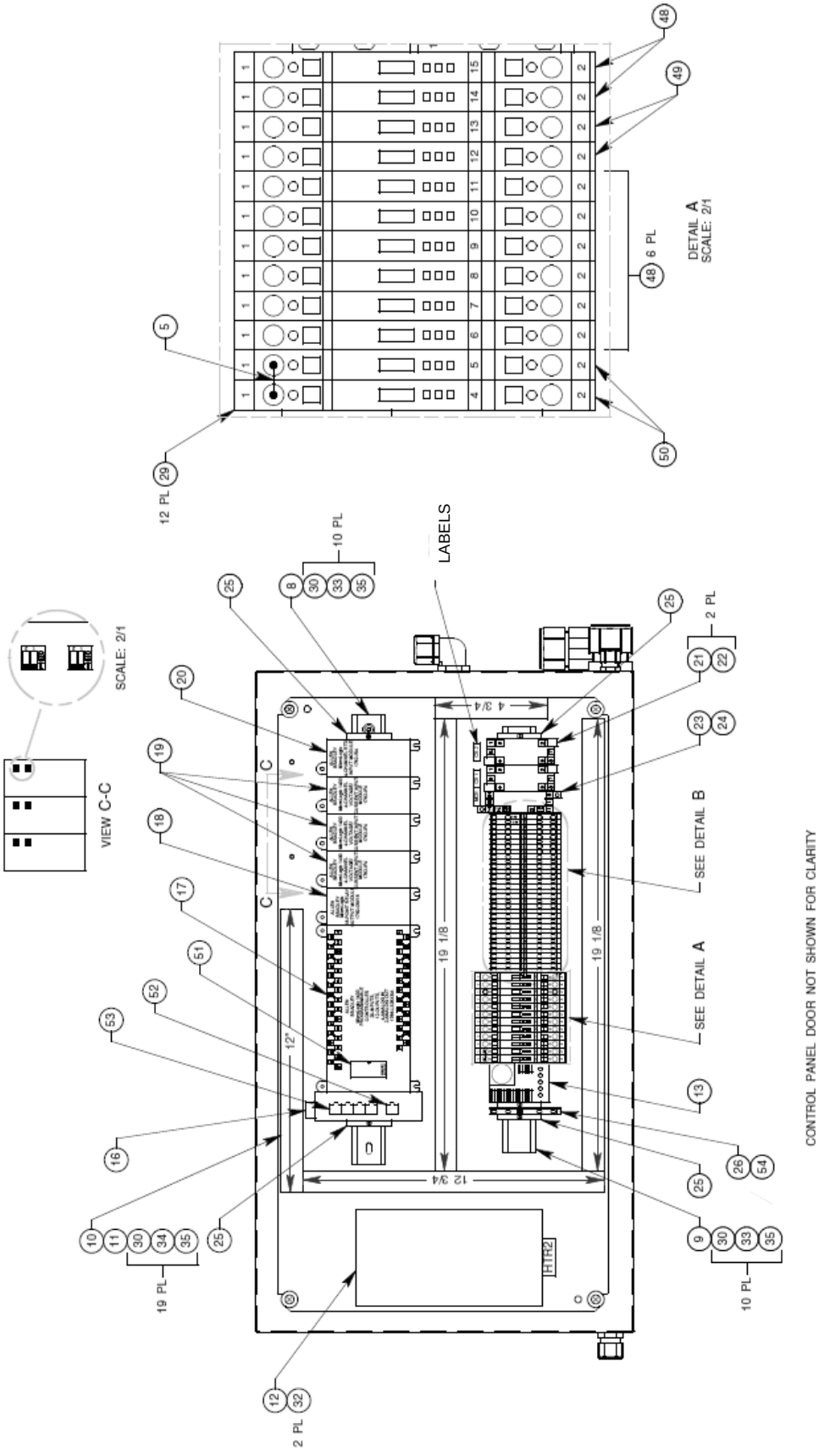
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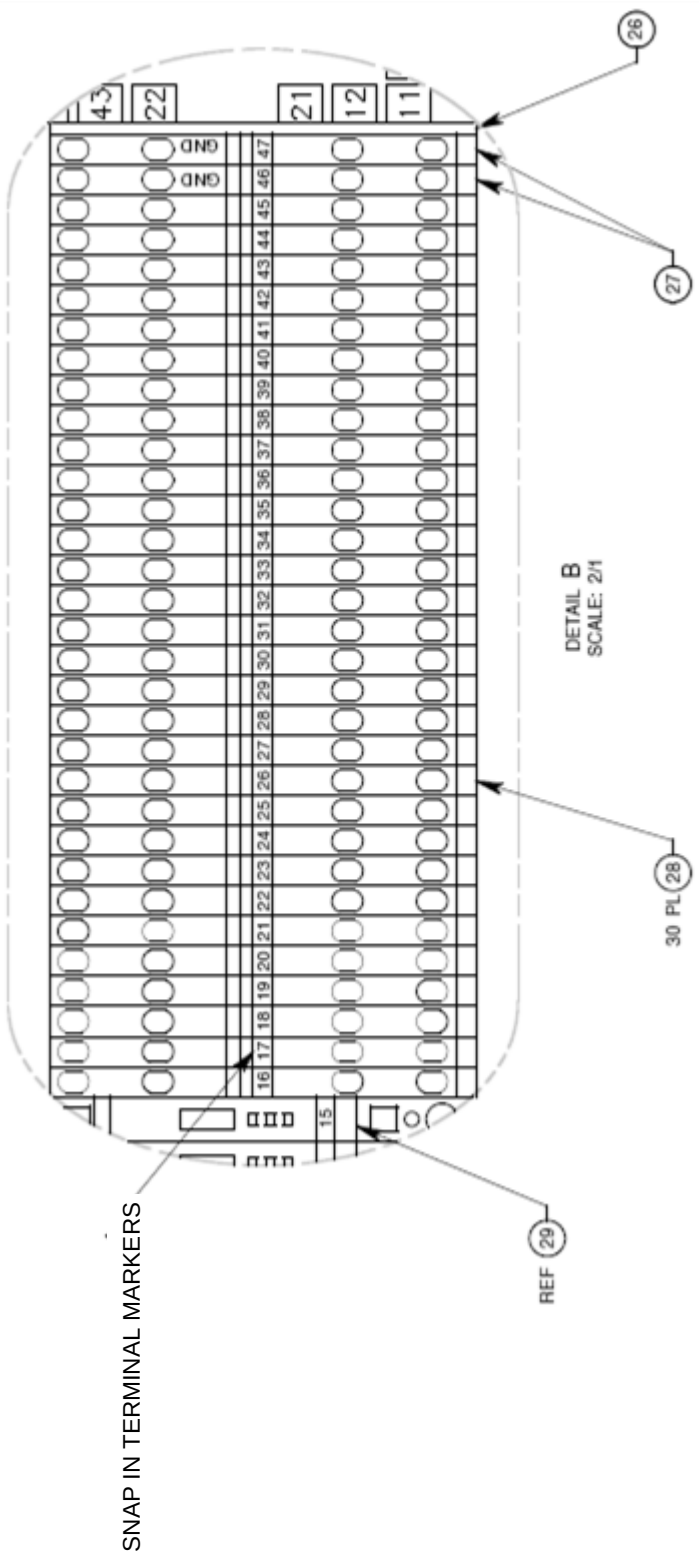
Parts List Illustration – Control Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List Illustration – Control Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List– Control Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016017	**CONTROL ENCLOSURE ASSEMBLY**; consist of:	
1	1011019	CONTROL ENCLOSURE	1
2	452-060	TOUCH SCREEN	1
3	26332	HOUR METER	1
4	450-791	ILLUMINATED OPERATOR/CONTACT BLOCK	1
5	450-404	JUMPER, FUSE BLOCK, 2 POLE	1
6	450-842	E-STOP SWITCH	1
8	1011146-7	DIN RAIL, 19 LG	1
9	1011146-8	DIN RAIL, 18 LG	1
10	450-690	WIRING DUCT, PVC, 75" LG	AR
11	450-348	WIRING DUCT COVER, 75" LG	AR
12	450-788	ENCLOSURE HEATER	1
13	450-789	ENCLOSURE HEATER THERMOSTAT	1
14	499-096	STICKER, HIGH VOLTAGE	1
15	499-099	STICKER, ELECTRICAL SHOCK	1
16	452-063	ETHERNET SWITCH	1
17	452-052	PLC BASE UNIT	1
18	452-054	OUTPUT MODULE	1
19	452-064	CURRENT/VOLTAGE INPUT MODULE	3
20	452-065	RTD INPUT MODULE	1
21	450-479	RELAY SOCKET, 8 BLADE	2
22	450-478	RELAY, DPDT, 10A	2
23	450-801	RELAY, (4) NO + (2) NC, FORCE GUIDED	1
24	450-802	RELAY SOCKET, 6 POLE	1
25	450-401	END ANCHOR	5
26	450-403	END COVER	2
27	450-400	TERMINAL BLOCK, LG3Q	2
28	450-391	TERMINAL BLOCK, L3Q	30
29	450-388	FUSE BLOCK	12
30	326-028	BHCS, 10-32 x 3/8 LG	39
32	326-032	BHCS, 10-32 x 1/2 LG	2
33	362-055	FLAT WASHER, #10 SAE	20
34	361-026	FLAT WASHER, #10, 3/4 OD	19
35	363-035	SPLIT LOCKWASHER, #10	39
36	450-527	JUMPER, L3Q 10 POLE	3
37	491-053	CABLE, 1/16 SST NYULON COATED, 20 LG	AR
38	499-097	STICKER, E-STOP, YELLOW	1
39	1011164	STICKER, CONTROL ENCLOSURE FUSES	1
40	450-542	CONDUIT FITTING, ELBOW, 17mm, x 1/2 NPT	1
41	450-775	CONDUIT FITTING, ELBOW, 29mm, x 1 NPT	1
42	450-778	CONDUIT FITTING, STRAIGHT, 29mm, x 1 NPT	1
43	450-713	CONDUIT FITTING, STRAIGHT, 8mm, x 1/4 NPT	1
44	450-669-	CORD CONNECTOR, 1/2 NPT, .17-.45 GRIP	1
45	450-581	LOCKNUT, 1/2 NPT, NYLON	2

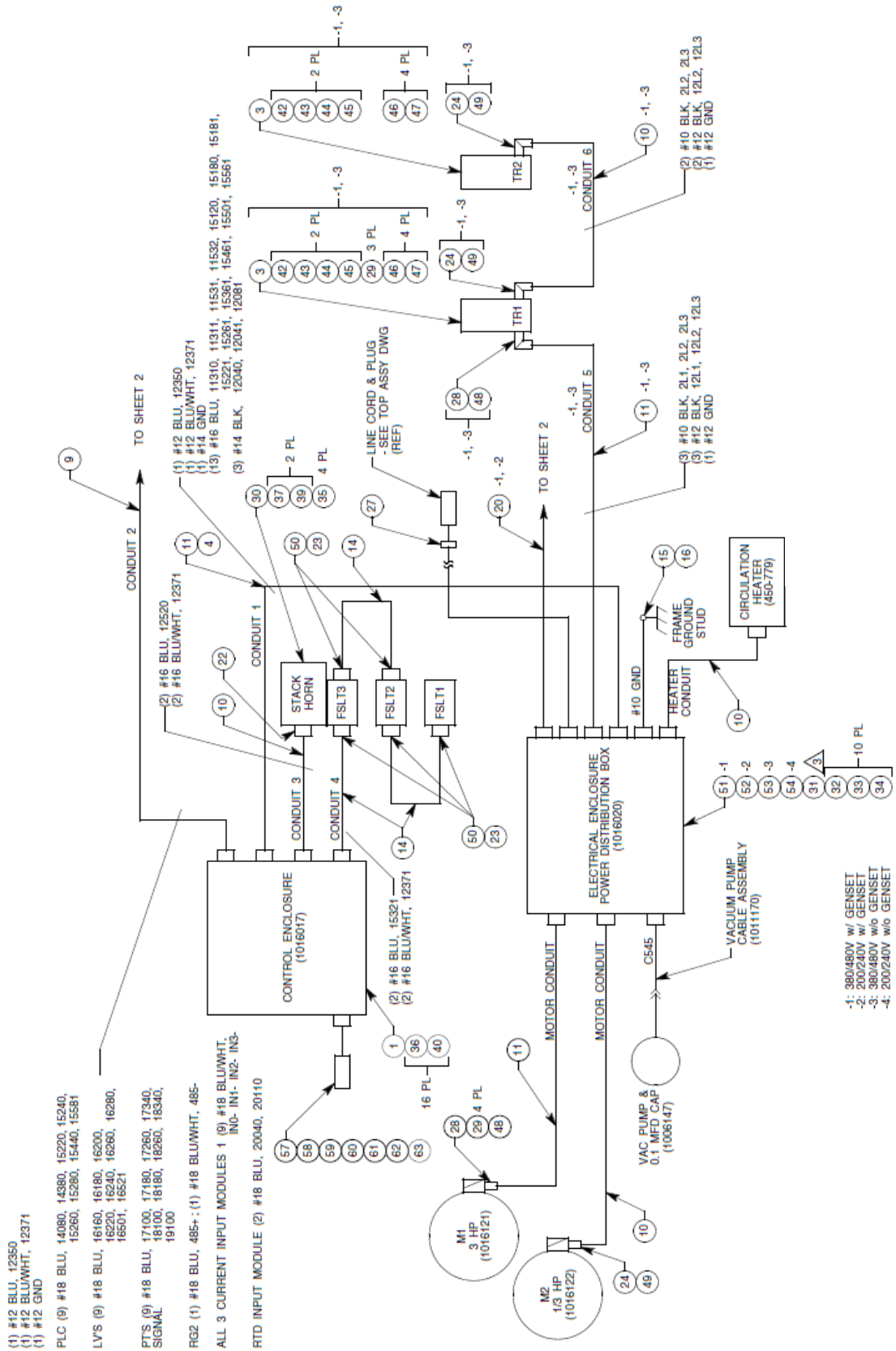
Parts List– Control Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
51	1016153	LOAD MEMORY MODULE	1
52	450-804	ETHERNET CABLE, 0.3MM	1
53	450-805	ETHERNET CABLE, 1.5MM	1
54	450-816	MULTI TERMINAL BLOCK, L3QS	1
55	491-054	COMPRESSION SLEEVE, 1/16 CABLE	2

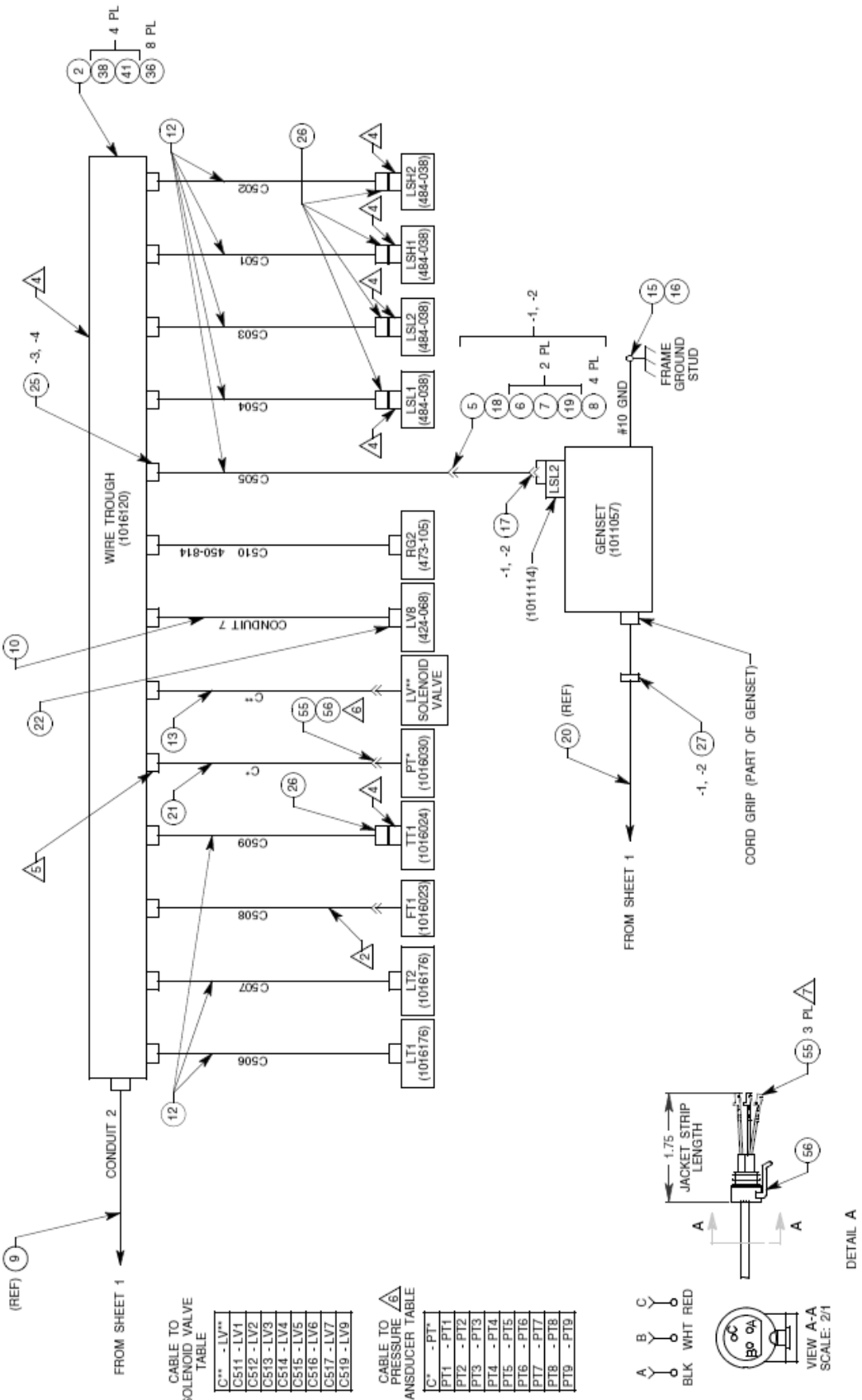
Parts List Illustration – Electrical Interconnect Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List Illustration – Electrical Interconnect Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List – Electrical Interconnect Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016012	**ELECTRICAL INTCONNECT ASSEMBLY**; consist of:	
1	1016017	CONTROL ENCLOSURE	1
2	106120	WIRING TROUGH	1
4	450-526	CABLE, 2 COND, DRN, 18 AWG, 240 LG	AR
9	450-776	CONDUIT, FLEX, 29MM X 30 LG	AR
10	450-541	CONDUIT, FLEX, 17MM X 155 LG	AR
11	450-655	CONDUIT, FLEX, 23MM X 115 LG	AR
12	EC-1170-06	CABLE, 3 COND 18 AWG X 630 LG	AR
13	450-721	CABLE & CONN, DIN 43650 FORM A, 3M	8
14	450-748	CONDUIT, FLEX, 8MM X 96 LG	AR
15	329-015	STUD, 3/8-16 X 1-1/4 LG, BRASS	2
16	351-035	HEX NUT, 3/8-16, BRASS	2
21	450-423	CABLE, 3 COND, DRN, 22 AWG X 700 LG	AR
22	450-543	CONDUIT FITTING, 17MM X 1/2 MPT, STR	2
23	450-743	CONDUIT FITTING, 8MM, PG7, STR	5
26	450-669	CORD GRIP, 1/2 NPT X .17-.45 GRIP	5
30	450-790	STACK HORN	1
31	999-051	NEOPRENE STRIP, 130 LG	AR
32	390-106	SLOTTED SCREW W/ WEAR WASHER	10
33	390-102	CLIP-ON RECEPTACLE	10
34	369-006	RETAINER	10
35	362-051	FLATWASHER, SST, #8 SAE	4
36	362-038	FLATWASHER, SST, 1/4 SAE	24
37	353-025	HEX LOCKNUT, SST, 8-32	2
38	353-020	HEX LOCKNUT, SST, 1/4-20	4
39	326-030	BHCS, SST, 8-32 X 1-3/4 LG	2
40	326-033	BHCS, SST, 1/4-20 X 3/4 LG	16
41	324-012	HHCS, SST, 1/4-20 X 1 LG	4
50	450-462	LOCKNUT, PF7/1/4 FPT, NYLON	5
55	450-438	FEMALE TERMINAL, 20/22 AWG	27
56	450-437	FEMALE CONN, METRIPACK 150, 3 PIN	9
57	1016054	SIGNAL CABLE	1
58	326-018	BHCS, SST, #4-40 X 1/2 LG	4
59	535-026	HEX LOCKNUT, SST, #4-40	4
60	362-037	FLATWASHER, SST, #4 SAE	8
61	324-064	PHMS, SST, 6-32 X 1/2 LG	1
62	362-063	FLATWASHER, SST, #6 SAE	1
63	353-027	HEX LOCKNUT, SST, 6-32	

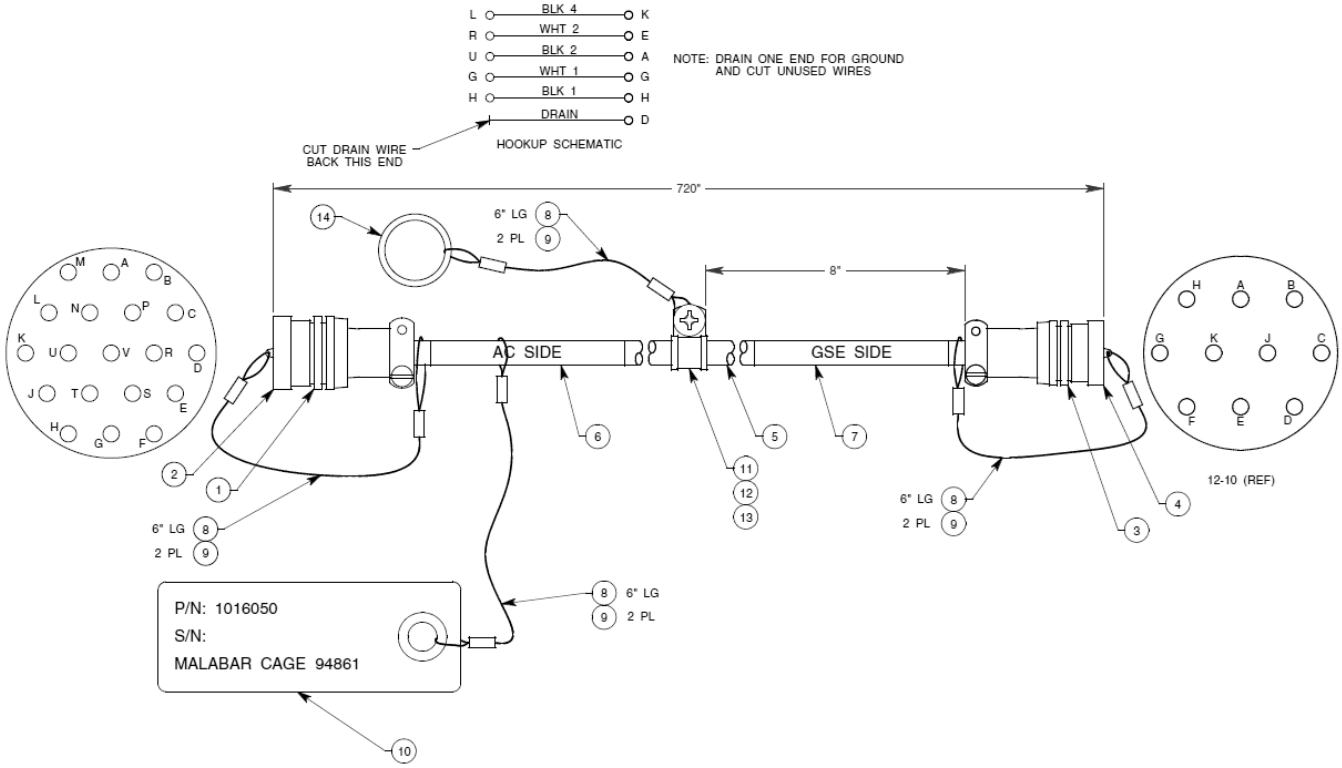
Parts List – Electrical Interconnect Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

The Following Parts are Application Specific			**-1**	**-2**	**-3**	**-4**
Item	**Part Number**	**Description**	**Qty**			
3	450-676	TRANSFORMER	2	---	2	---
5	450-296	FEMALE CONN, METRIPACK 150, 2 PIN	1	1	---	---
6	450-299	TPA, 2 POSITION	2	2	---	---
7	450-298	FEMALE TERMINAL, 16/18 AWG	2	2	---	---
8	450-301	CABLE SEAL, BLUE	4	4	---	---
17	482-097	CONNECTOR & PIGTAIL	1	1	---	---
18	450-308	MALE CONNECTOR, METRIPACK 150, 2 PIN	1	1	---	---
19	450-328	MALE TERMINAL, 16/8 AWG	2	2	---	---
20	450-714	CABLE, TYPE W, 4 COND, 8 AWG X 180 LG	AR	AR	---	---
24	540-542	CONDUIT FITTING, 90º, 17MM X 1/2 MPT	3	1	3	1
25	450-701	PLUG	---	---	1	1
27	390-087	GROMMET, 1-1/4 ID	2	2	1	1
28	450-670	CONDUIT FTG, 90º, 23MM X 3/4 MPT	2	1	2	1
29	450-838	WALL NUT	7	4	7	4
42	324-010	HHCS, SST, 5/16-18 X 1 LG	4	---	4	---
43	353-021	HEX LOCKNUT, SST, 5/16-18	4	---	4	---
44	324-027	HHCS, SST, 10-32 X 3/4 LG	4	---	4	---
45	353-019	HEX LOCKNUT, SST, 10-32	4	---	4	---
46	362-048	FLATWASHER, SST, 5/19 SAE	8	---	8	---
47	362-055	FLATWASHER, SST, #10 SAE	8	---	8	---
48	450-580	LOCKNUT, 3/4 FPT, NYLON	2	1	2	1
49	450-581	LOCKNUT, 1/2 FPT, NYLON	3	1	3	1
51	1016020-1	ELECTRICAL ENCLOSURE	1	---	---	---
52	1016020-2	ELECTRICAL ENCLOSURE	---	1	---	---
53	1016020-3	ELECTRICAL ENCLOSURE	---	---	1	---
54	1016020-4	ELECTRICAL ENCLOSURE	---	---	---	1

Parts List –Interconnection Cable

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

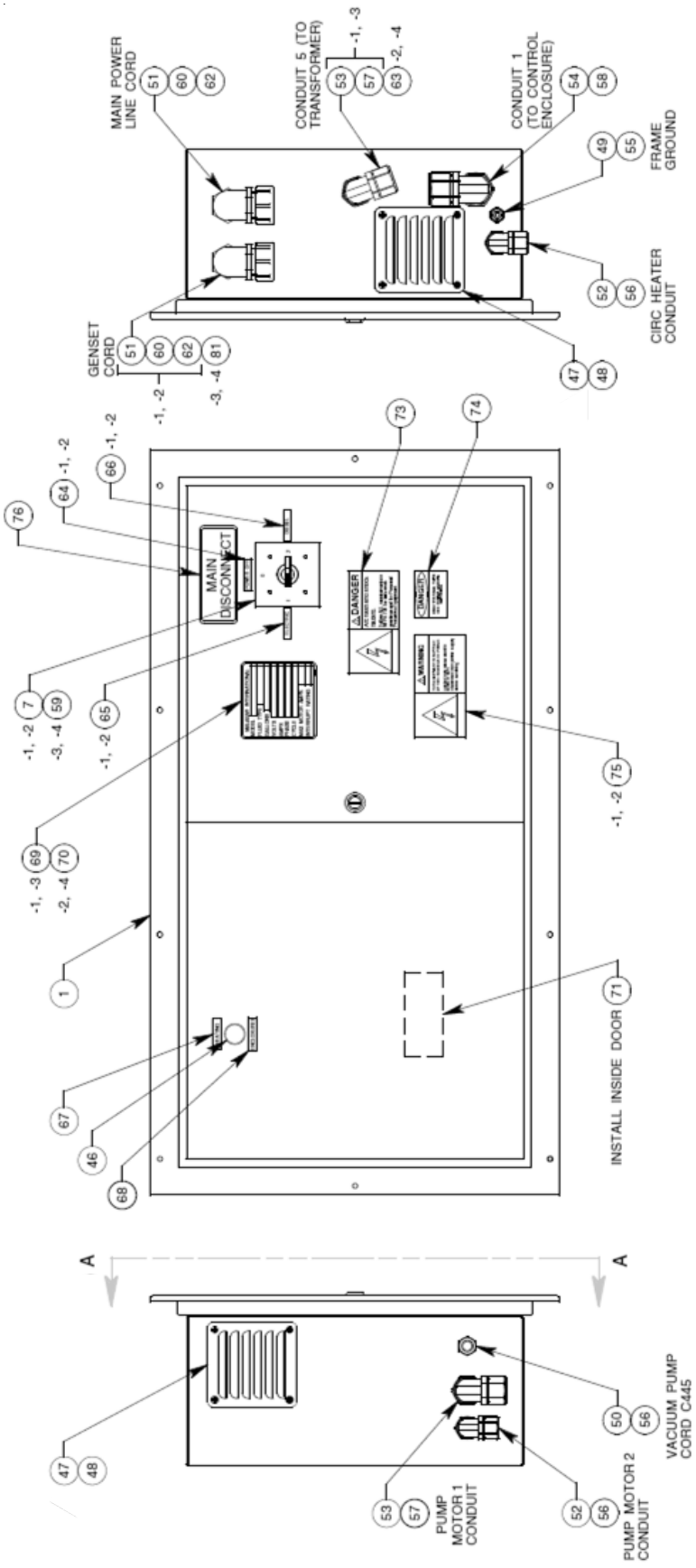


Item	Part Number	Description	Qty
	1016050	**INTCONNECTION CABLE**; consist of:	
1	450-794	PLUG, 14 SHELL SIZE	1
2	450-797	PLUG DUST CAP WITH CHAIN	1
3	450-795	PLUG, 12 SHELL SIZE	1
4	450-798	PLUG DUST CAP WITH CHAIN	1
5	450-800	TRAY CABLE, 720 LG	Ar
6	1016052	STICKER, AC SIDE INTERCONNECTION	1
7	1016051	STICKER, GSE SIDE INTERCONNECTION	1
8	491-027	CABLE, 24 LG	Ar
9	491-028	SLEEVE, KRIMP	8
10	999-054	WARNING STREAMER	1
11	394-047	LOOP CLAMP, 3/8 DIA	1
12	343-019	PHMS, 1/4-20 X 3/4 LG, SST	1
13	353-020	HEX LOCKNUT, 1/4-20 SST	1
14	488-004	KEY RING	1

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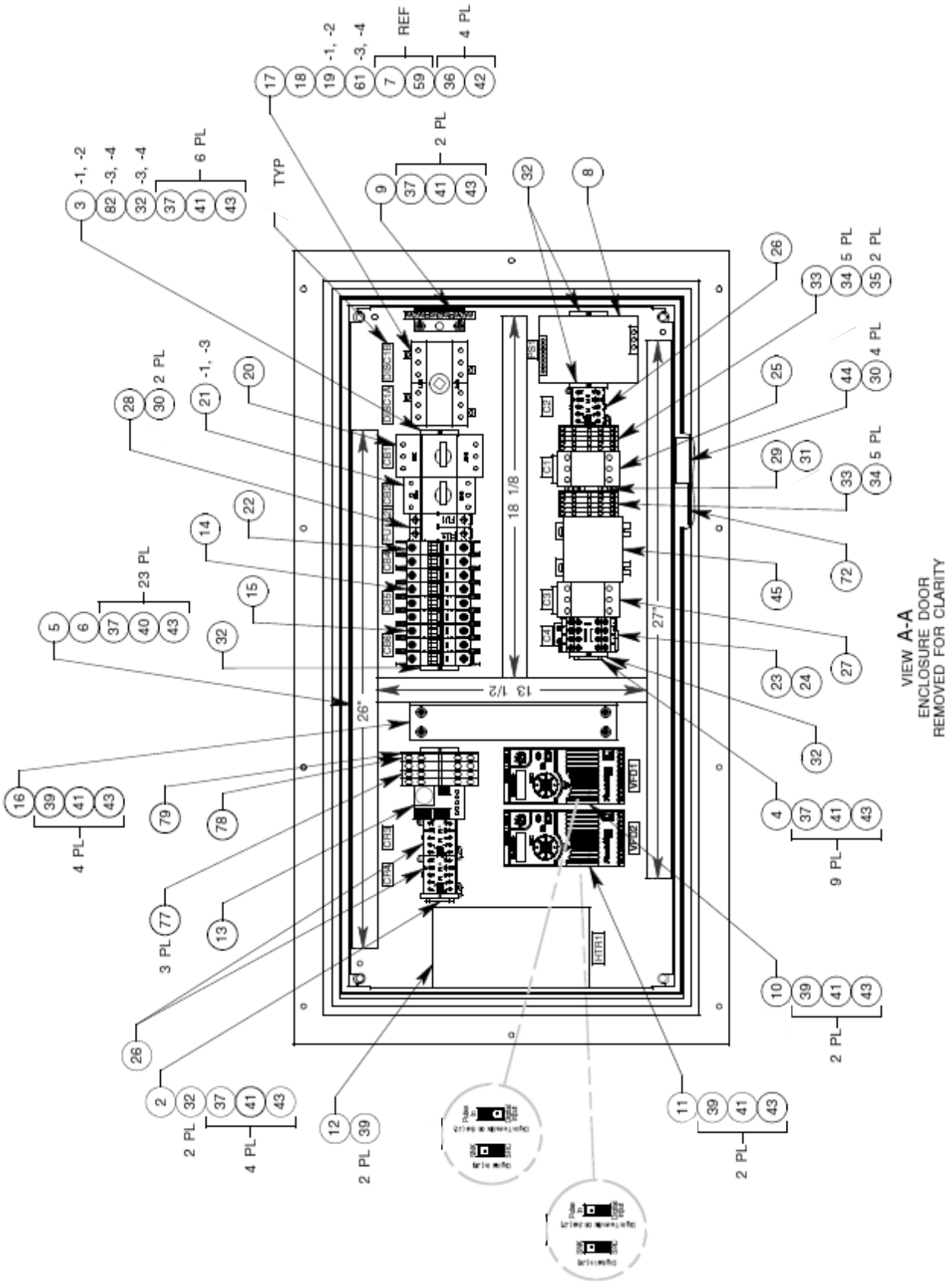
Parts List Illustration – Electrical Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List Illustration – Electrical Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List– Electrical Enclosure Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016020	**ELECTRICAL INCLOSURE ASSEMBLY**; consist of:	
1	1016022	ELECTRICAL ENCLOSURE	1
2	1011146-10	DIN RAIL, 7-3/4 LG	1
4	1011146-6	DIN RAIL, 17-1/2 LG	1
5	450-813	WIRING DUCT, PVC, 85 LG	AR
6	450-818	WIRING DUCT, COVER, 85 LG	AR
8	452-050	POWER SUPPLY, 24VDC	1
9	450-537	GROUND BAR KIT, 11 POSITION	1
10	452-061	POWERFLEX 523 VDF, 3 HP	1
11	452-062	POWERFLEX 523 VDF, 0.5 HP	1
12	450-788	ENCLOSURE HEATER	1
13	450-789	ENCLOSURE HEATER THERMOSTAT	1
14	450-809	CIRCUIT BREAKER, 1.5A	1
15	450-810	CIRCUIT BREAKER, 10A	1
16	452-066	EMC/EMI INPUT RFI FILTER	1
17	450-601	METAL SHAFT EXTENSION	1
20	450-686	CIRCUIT BREAKER, 45A	1
22	450-780	CIRCUIT BREAKER, 25A	1
23	450-8111	CONTACTOR, 9A	1
24	450-812	AUXILIARY CONTACT BLOCK	1
25	450-783	CONTACTOR, 9A, 24VDC	1
26	450-685	CONTACTOR, 3 POLE, 240 VAC COIL	3
27	450-785	HEATER CONTACTOR, 23A, 24VDC	1
28	450-687	FUSE BLOCK, CLASS CC, 2 POLE	1
29	450-388	FUSE BLOCK	1
30	450-693	FUSE, CLASS CC, 8A	6
31	450-493	FUSE, 5 x 20mm, 5A	1
33	450-403	END COVER	2
34	450-391	TERMINAL BLOCK, L3Q	10
35	450-385	JUMPER, L3Q, 2 POLE	2
36	326-019	BHCS, 8-32 x 1/2 LG	4
37	326-028	BHCS, 10-32 x 3/8 LG	44
39	326-032	BHCS, 10-32 x 1/2 LG	10
40	361-026	FLAT WASHER, #10, 3/4 OD	23
41	362-055	FLAT WASHER, #10 SAE	29
42	364-012	SPLIT LOCKWASHER, #8	4
43	363-035	SPLIT LOCKWASHER, #10	44
44	450-770	PLASTIC BOX	1
45	450-782	CIRCULATION HEATER CONTROLLER	1
46	450-684	PANEL LIGHT	1
47	499-085	LOUVER PLATE KIT	2
48	499-087	FILTER	2
49	450-460	CORD GRIP, PG7	1
50	450-669	CORD GRIP, 1/2 NPT X .17-.45	1

Parts List– Electrical Enclosure Assembly

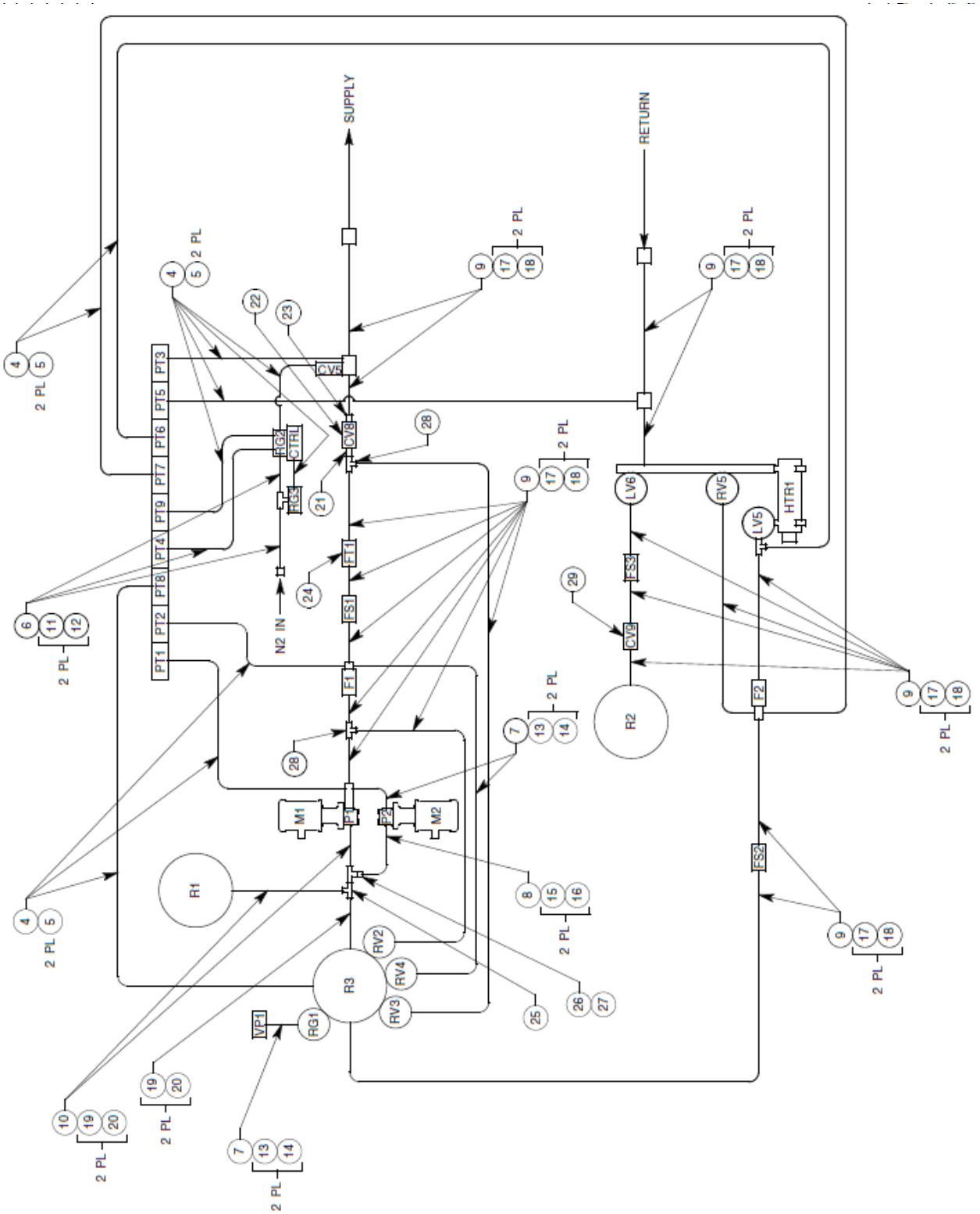
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
52	450-542	CONDUIT FTG, ELBOW, 17MM X 1/2 NPT	2
54	450-775	CONDUIT FTG, ELBOW, 29MM X 1 NPT	1
55	450-462	LOCKNUT, PG7, NYLON	1
56	450-581	LOCKNUT, 1/2 NPT, NYLON	3
58	450-777	LOCKNUT, 1 NPT, NYLON	1
67	499-135	LEGEND PLATE, "HEATING"	1
68	499-156	LEGEND PLATE, "ENCLOSURES"	1
71	1011165	STICKER, MAIN CB ENCLOSURE FUSES	1
72	1011220	STICKER, SPARE FUSES	1
73	499-100	STICKER, ARC FLASH	1
74	499-096	STICKER, HIGH VOLTAGE	1
76	1003190	STICKER, MAIN DISCONNECT	1
77	450-806	TERMINAL BLOCK	3
78	450-807	GROUND TERMINAL BLOCK	1
79	450-808	END COVER	1

The Following Parts are Application Specific			**-1**	**-2**	**-3**	**-4**
Item	**Part Number**	**Description**	**Qty**			
3	1011146-9	DIN RAIL, 12 LG	1	1	---	---
7	450-630	SWITCH OPERATOR	1	1	---	---
18	450-610	INSERT, EXTENSION	1	1	---	---
19	450-688	CHANGEOVER SWITCH, BASE MOUNT	1	1	---	---
21	450-689	CIRCUIT BREAKER, 20A	1	---	1	---
32	450-401	END ANCHOR	6	6	7	7
51	450-709	CORD GRIP, 1 NPT X .88-1.065	2	2	1	1
53	450-670	CONDUIT FTG, ELBOW, 23MM X 3/4 NPT	2	1	2	1
57	450-580	LOCKNUT, 3/4 NPT, NYLON	2	1	2	1
59	450-710	SWITCH OPERATOR (OFF/ON)	---	---	1	1
60	450-678	CONDUIT LOCKNUT, 1 NPT	2	2	1	1
61	450-707	DISCONNECT SWITCH, BASE MOUNT	---	---	1	1
62	450-641	RING AND RETAINER	2	2	1	1
63	499-142	HOLE PLUG, 1-1/8	---	1	---	1
64	499-124	LEGEND PLATE, "POWER OFF"	1	1	---	---
65	499-125	LEGEND PLATE, "ELECTRIC"	1	1	---	---
66	499-126	LEGEND PLATE, "DIESEL"	1	1	---	---
69	1016172-1	STICKER, SYSTEM DATA (1016, HV)	1	---	1	---
70	1016172-2	STICKER, SYSTEM DATA (1016, LV)	---	1	---	1
75	499-129	STICKER, WARNING / TWO SRC OF POWER	1	1	---	---
81	499-136	HOLE PLUG	---	---	1	1
82	1011146-11	DIN RAIL, 13 LG	---	---	1	1

Parts List Illustration – Piping Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



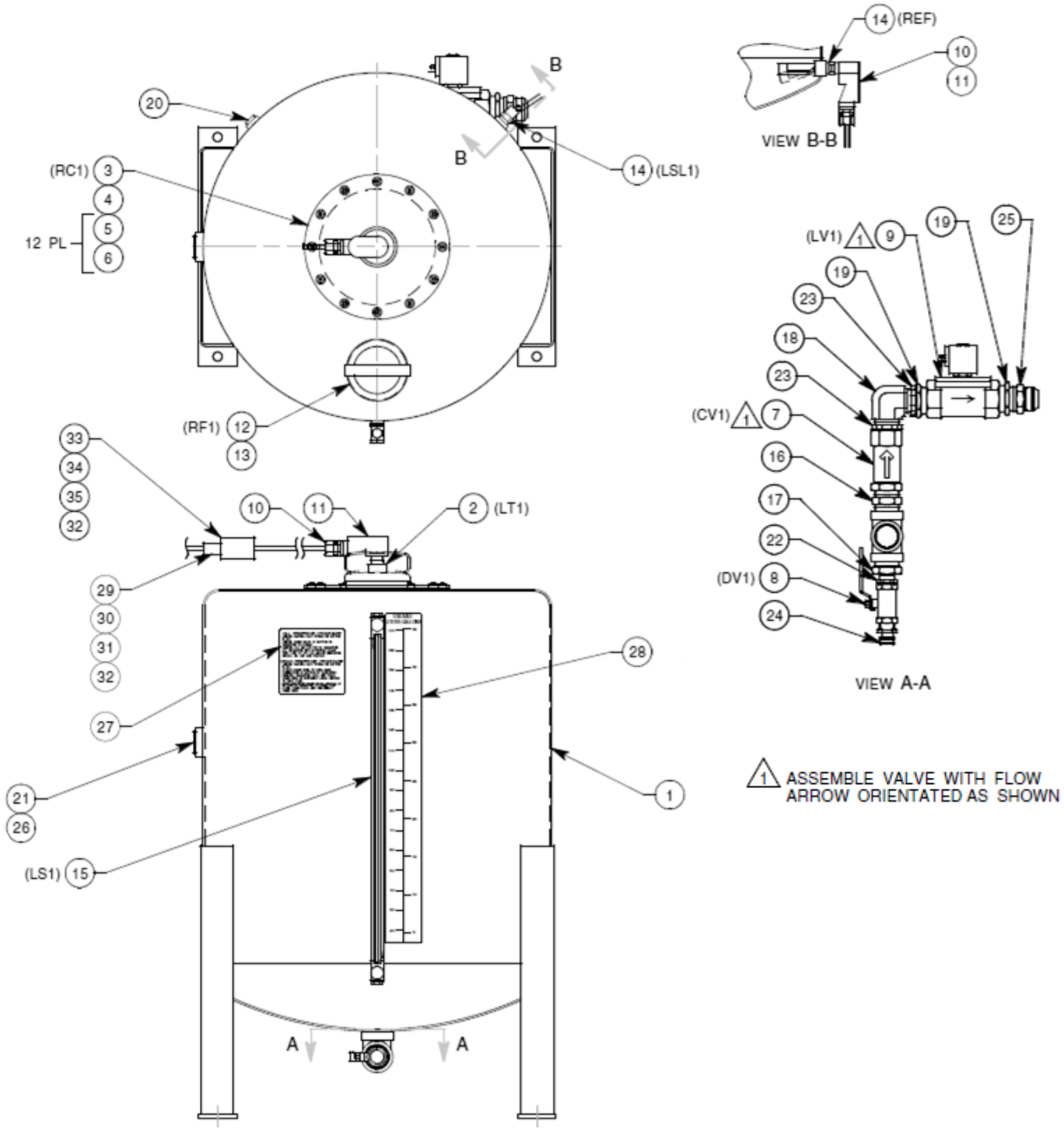
Parts List– Piping Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016013	**PIPING ASSEMBLY**; consist of:	
4	485-086	OSE, 5/16 OD X 3/16 ID, 700 LG	AR
5	487-074	FITTING, STRAIGHT, SRIMP, 3/16 HOSE	20
6	732-003	TUBE, 1/4 X .035 WALL X 180 LG	AR
7	732-024	TUBE, 3/8 X .035 WALL X 180 LG	AR
8	732-011	TUBE, 1/2 X .035 WALL X 36 LG	AR
9	732-028	TUBE, 1 X .049 WALL X 1000 LG	AR
10	732-034	TUBE, 1-1/4 X .049 WALL X 120 LG	AR
11	729-106	NUT, 1/4 37º	6
12	729-107	SLEEVE, 1/4 37º	6
13	729-092	NUT, 3/8 37º	6
14	729-091	SLEEVE, 3/8 37º	6
15	729-094	NUT, 1/2 37º	2
16	729-093	SLEEVE, 1/2 37º	2
17	729-119	NUT, 1 37º	36
18	729-120	SLEEVE, 1 37º	36
19	729-129	NUT, 1-1/4 37º	6
20	729-130	SLEEVE, 1-1/4 37º	6
21	721-225	CONNECTOR, 1 F 37º X 1 MPT	1
22	422-109	CHECK VALVE, 1 FPT	1
23	721-163	CONNECTOR, 1 M 37º X 1 MPT	1
24	1016023	FLOWMETER	1
25	723-079	UNION TEE, 1-1/4 M 37º	1
26	723-080	TEE,1-1/4 M 37º X 1-1/4 F 37º	1
27	729-150	REDUCER, 1-1/4 F 37º X 1/2 M 37º	1
28	723-052	UNION TEE, 1 M 37º	2
29	422-078	CHECK VALVE, 1 M 37º	1

Parts List Illustration – Clean Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



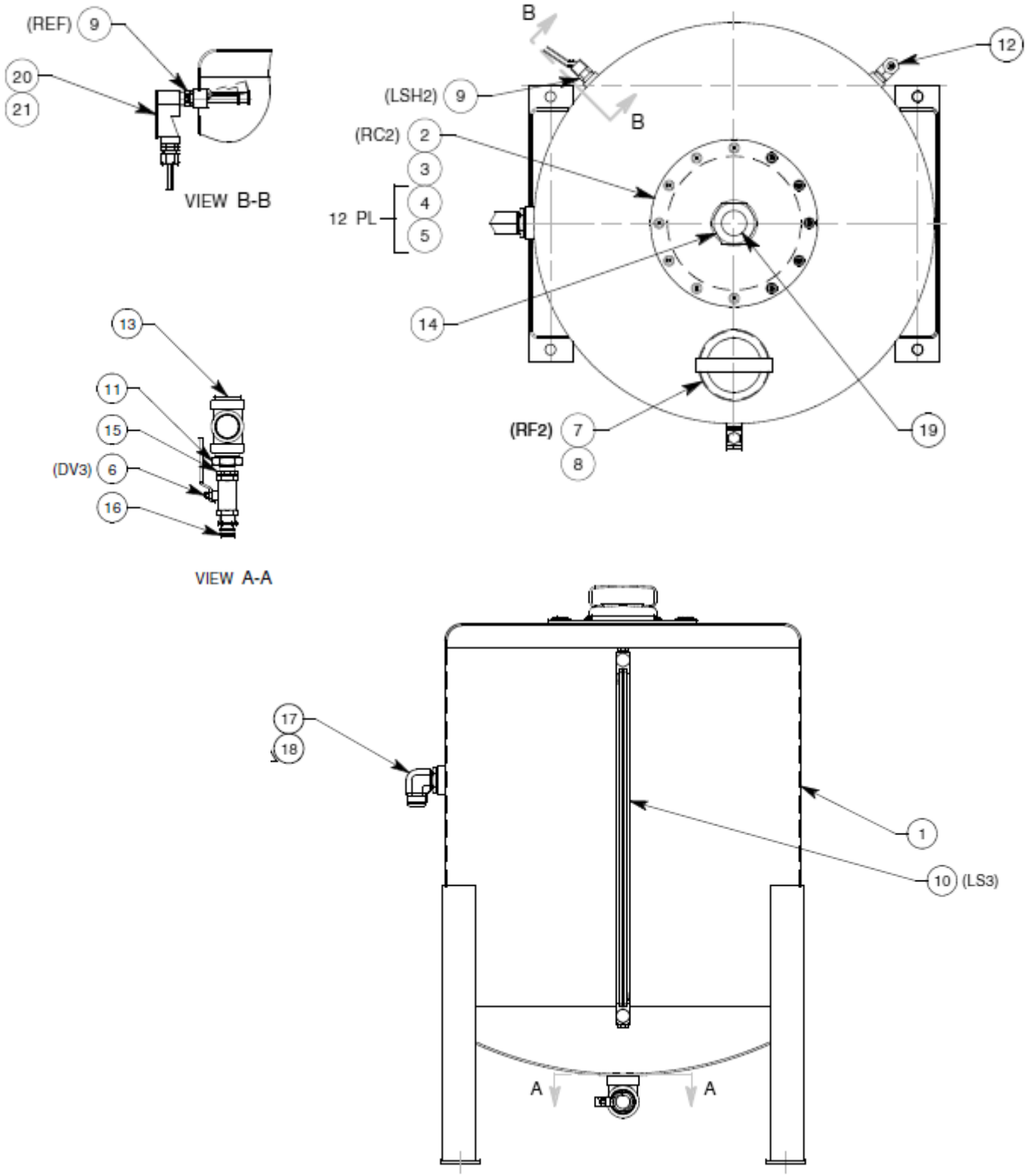
Parts List– Clean Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016099-1	**CLEAN RESERVOIR ASSEMBLY**; consist of:	
1	1016158	RESERVOIR WELDMENT	1
2	1016176	LEVEL SENSOR	1
3	1016156	RESERVOIR COVER	1
4	1016156-2	RESERVOIR COVER GASKET	1
5	326-040	BHSCS, 1/4-28 X 1/2 LG	12
6	362-038	FLAT WASHER, 1/4 SAE	12
7	422-104	CHECK VALVE, 1-1/4 FPT	1
8	424-071	BALL VALVE, 3/4 FPT	1
9	424-084	SHUTOFF VALVE, 1-1/2 FPT	1
10	450-669	CORD GRIP, 1/2 NPT X .17-.45	2
11	450-704	CONDUIT BODY, 1/2 SLB, ALUMINUM	2
12	483-030	STRAINER	1
13	483-033	VENTED CAP	1
14	484-038	FLUID LEVEL SWITCH, 1/2 MPT	1
15	484-042	FLUID SIGHT GAUGE, 1/0-20	1
16	711-113	NIPPLE, 1-1/4 MPT	1
17	711-126	NIPPLE, 1-1/4 MPT X 3/4 MPT	1
18	712-110	ELBOW, 1-1/4 MPT	1
19	714-065	REDUCER, 1-1/4 FPT X 1-1/2 MPT	2
20	717-093	HOLLOW HEX PLUG, 1/2 MPT	1
21	717-080	SOCKET HEAD PLUG, 1 SAE W/ O-RING	1
22	719-058	SEAL NUT, 3/4 FPT	1
23	719-060	SEAL NUT, 1-1/4 FPT	2
24	719-081	CONNECTOR, 3/4 MPT X 3/4 HOSE BARB	1
25	721-195	CONNECTOR, 1-1/4 M 37º X 1-1/4 MPT	1
26	55930-916	O-RING, 1 SAE	1
27	1016177	STICKER, FILL/DRAIN RESERVOIR	1
28	1016178	STICKER, LEVEL INDICATION	1
29	450-306	MALE CONNECTOR, METRI-PACK 3 PIN	1
30	450-307	MALE TERMINAL, 22/20 AWG	3
31	450-303	CABLE SEAL, TAN	3
32	450-300	TPA 3 POSITION	2
33	450-297	FEMALE CONNECTOR, METRI-PACK 3 PIN	1
34	450-298	FEMALE TERMINAL, 18 AWG	3
35	450-327	CABLE SEAL, RED	3

Parts List Illustration – Waste Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



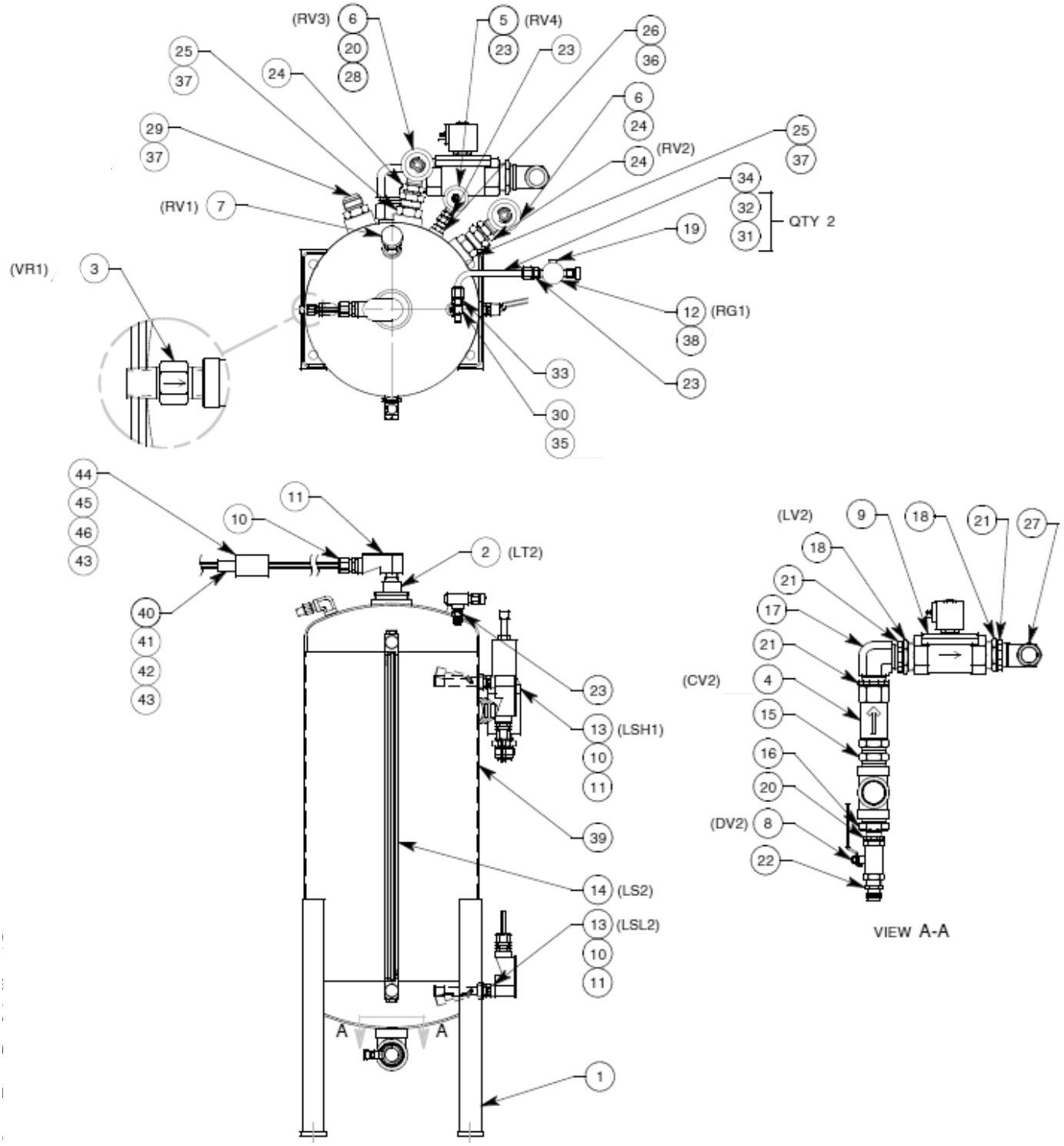
Parts List– Waste Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016099-2	**WASTE RESERVOIR ASSEMBLY**; consist of:	
1	1016158	RESERVOIR WELDMENT	1
2	1016156	RESERVOIR COVER	1
3	1016156-2	RESERVOIR COVER GASKET	1
4	326-040	BHSCS, 1/4-28 X 1/2 LG	12
5	365-009	SEALING WASHER, 1/4	12
6	424-071	BALL VALVE, 3/4 FPT	1
7	483-030	STRAINER	1
8	483-033	VENTED CAP	1
9	484-038	FLUID LEVEL SWITCH, 1/2 MPT	1
10	484-042	FLUID SIGHT GAUGE, 1/0-20	1
11	711-126	NIPPLE, 1-1/4 MPT X 3/4 MPT	1
12	722-173	ELBOW, 1/4 MALE 37º X 1/2 MPT	1
13	717-085	HOLLOW HEX PLUG, 1-1/4 MPT	1
14	1016101	MODIFIED HOLLOW HEX PLUG, 2 MPT	1
15	719-058	SEAL NUT, 3/4 FPT	1
16	719-081	CONNECTOR, 3/4 MPT X 3/4 HOSE BARB	
17	722-153	ELBOW, 1 MALE 37º X 1 SAE O-RING	1
18	55930-916	O-RING, 1 SAE	1
19	423-075	RELIEF VALVE, AIR, 3/4 MPT	1
20	450-669	CORD GRIP, 1/2 NPT X .17-.45	1
21	450-704	CONDUIT BODY, 1/2 SLB, ALUMINUM	1

Parts List Illustration – Sub Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



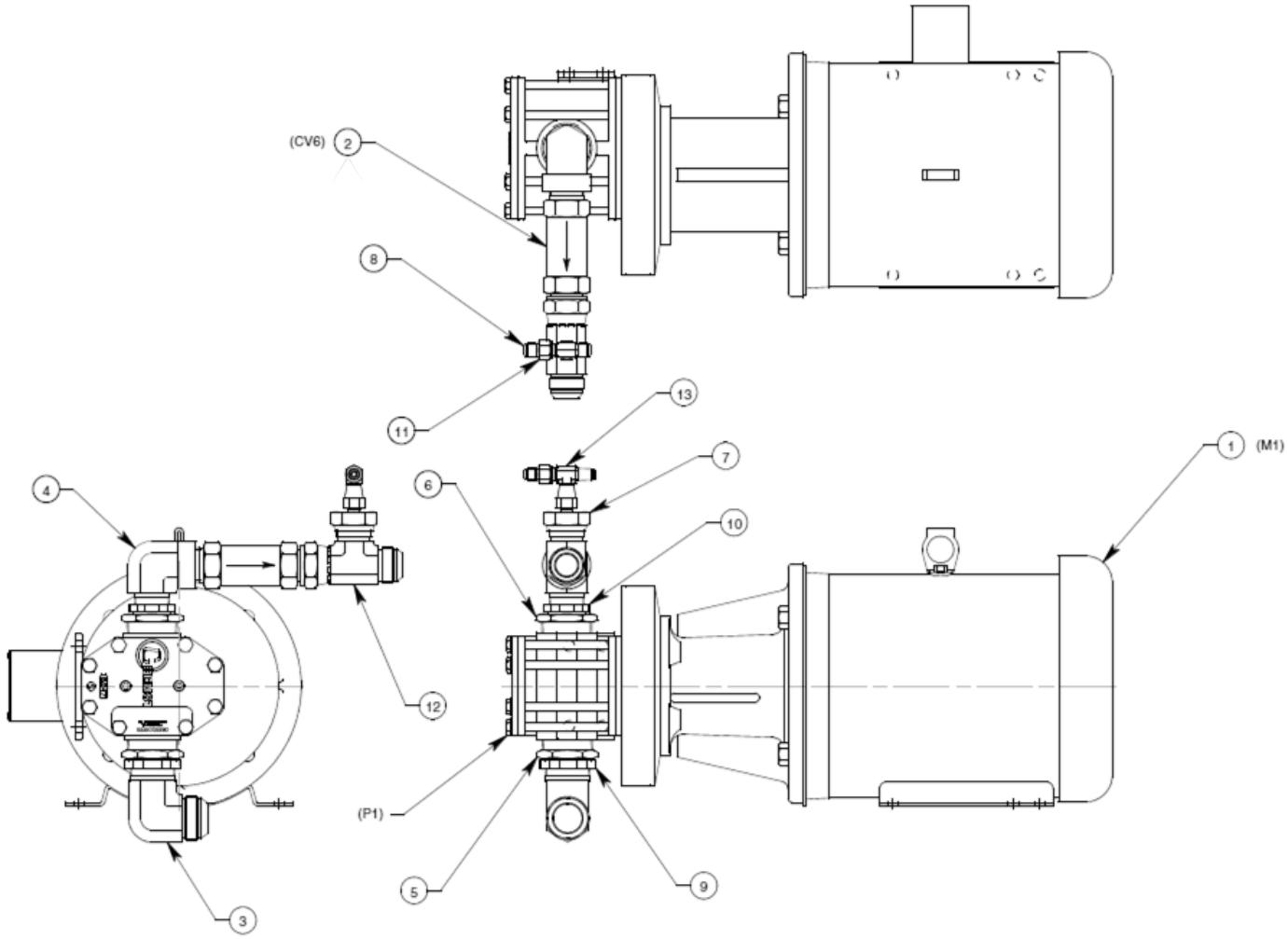
Parts List– Sub Reservoir Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016099-3	**CLEAN RESERVOIR ASSEMBLY**; consist of:	
1	1016157	RESERVOIR WELDMENT	1
2	1016176	LEVEL SENSOR	1
3	422-079	CHECK VALVE, 1/4 MPT	1
4	422-104	CHECK VALVE, 1-1/4 FPT	1
5	423-085	RELIEF VALVE, 1/4 FPT	1
6	423-086	RELIEF VALVE, 3/4 FPT	2
7	423-075	RELIEF VALVE, AIR, 3/4 MPT	1
8	424-071	BALL VALVE, 3/4 FPT	1
9	424-084	SHUTOFF VALVE, 1-1/2 FPT	1
10	450-669	CORD GRIP, 1/2 NPT X .17-.45	3
11	450-704	CONDUIT BODY, 1/2 SLB, ALUMINUM	3
12	473-100	VACUUM REGULATOR	1
13	484-038	FLUID LEVEL SWITCH, 1/2 MPT	2
14	484-042	FLUID SIGHT GAUGE, 1/0-20	1
15	711-113	NIPPLE, 1-1/4 MPT	1
16	711-126	NIPPLE, 1-1/4 MPT X 3/4 MPT	1
17	712-110	ELBOW, 1-1/4 MPT	1
18	714-065	REDUCER, 1-1/4 FPT X 1-1/2 MPT	2
19	717-006	HOLLOW HEX PLUG, 1/4 MPT	1
20	719-058	SEAL NUT, 3/4 FPT	2
21	719-060	SEAL NUT, 1-1/4 FPT	3
22	719-081	CONNECTOR, 3/4 MPT X 3/4 HOSE BARB	1
23	721-124	CONNECTOR, 3/8 MALE 37º X 1/4 MPT	4
24	721-162	CONNECTOR, 1 MALE 37º X 3/4 MPT	3
25	721-165	CONNECTOR, 1 37º SWIVEL X 1 M SAE	2
26	721-174	CONNECTOR, 3/8 37º SWIVEL X 3/8 M SAE	1
27	722-118	ELBOW, 1-1/4 MALE 37º X 1-1/4 MPT	1
28	722-151	ELBOW, 1 MALE 37º X 3/4 MPT	1
29	721-159	CONNECTOR, 1 MALE 37º X 3/4 MPT	1
30	723-075	TEE, 1/4 M 37º X 1/4 M SAE 1/4 M 37º	1
31	729-091	SLEEVE, 3/8 37º	2
32	729-092	NUT, 3/8 37º	2
33	729-144	RUDUCER, , 3/8 MALE 37º X 1/4 FEMALE 37º	1
34	732-024	TUBE, 3/8 X .035 WALL X 4 LG	AR
35	55930-904	O-RING, 1/4 SAE	1
36	55930-906	O-RING, 3/8 SAE	1
37	55930-916	O-RING, 1 SAE	3
38	1006175	PLACARD, VACUUM ADJUST	1
39	499-101	ARMAFLEX INSULATION	1
40	450-306	MALE CONNECTOR, METRI-PACK 3 PIN	1
41	450-307	MALE TERMINAL, 22/20 AWG	3
42	450-303	CABLE SEAL, TAN	3
43	450-300	TPA 3 POSITION	2
44	450-297	FEMALE CONNECTOR, METRI-PACK 3 PIN	1
45	450-298	FEMALE TERMINAL, 18 AWG	3
46	450-327	CABLE SEAL, RED	3

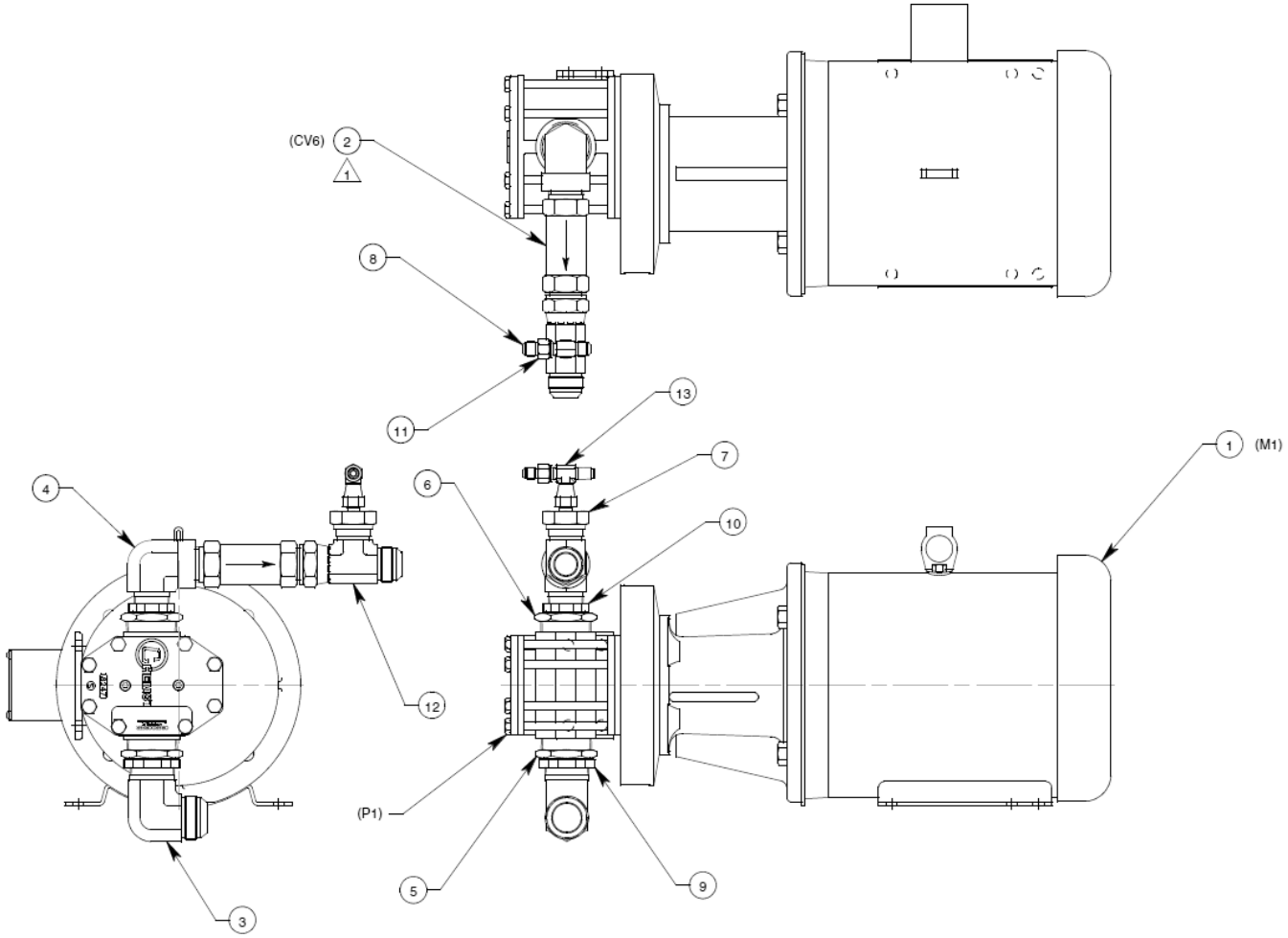
Parts List Illustration – Main Motor/Pump Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Parts List – Main Motor/Pump Assembly

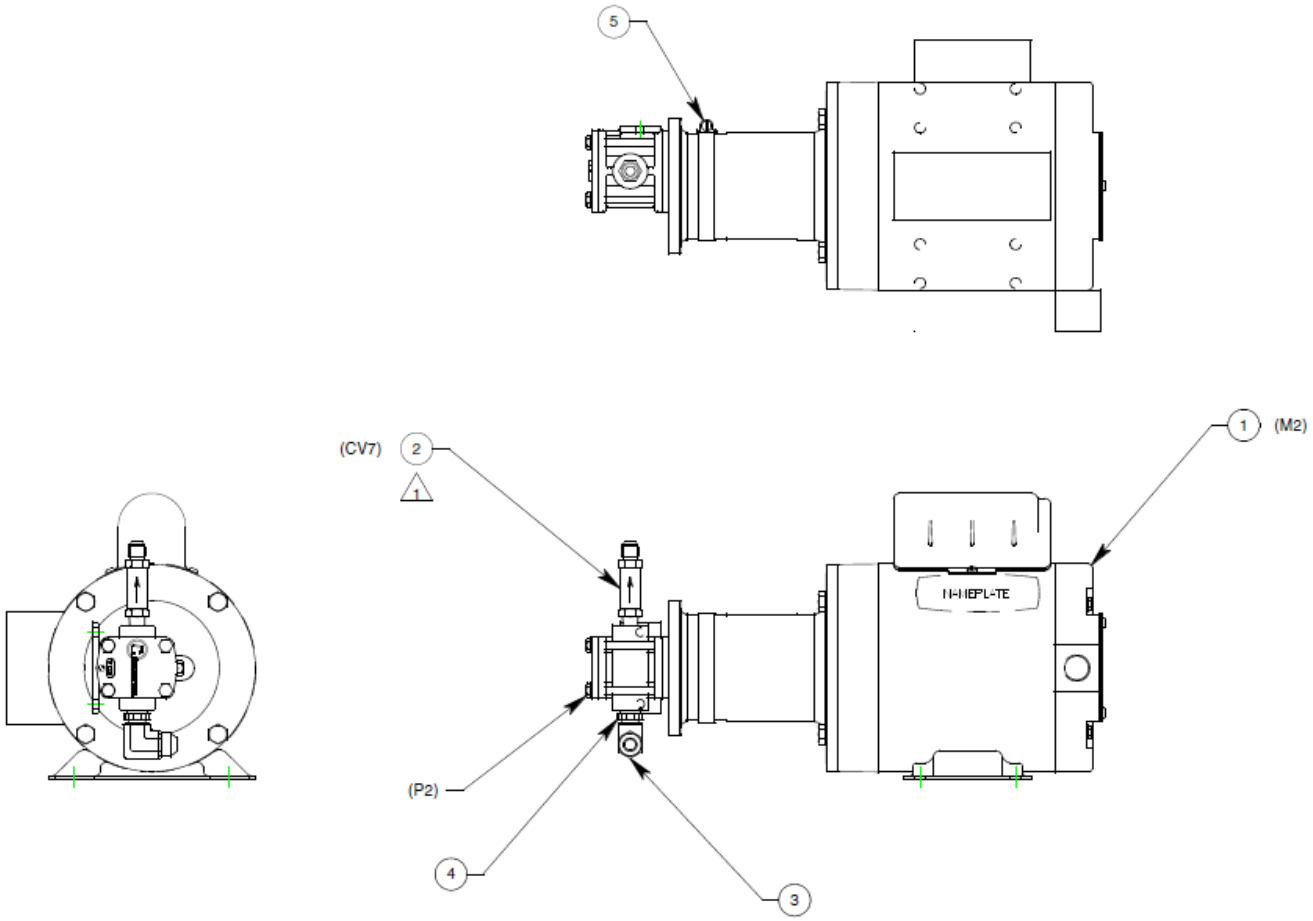
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
	1016123	**MOTOR/PUMP ASSEMBLY**; consist of:	
1	1016121	PUMP WITH ELECTRIC MOTOR, 20 GPM	1
2	422-087	CHECK VALVE, 1 MPT IN X 1 37º MALE OUT	1
3	722-118	ELBOW, 1-1/4 37º X 1-1/4 MPT	1
4	712-105	ELBOW, 1 FPT X 1 MPT	1
5	714-065	REDUCER, 1-1/4 FPT X 1-1/2 MPT	1
6	714-064	REDUCER, 1 FPT X 1-1/2 MPT	1
7	729-126	REDUCER, 1 FEMALE 37º X 3/8 MALE 37º	1
8	714-048	REDUCER INSERT, 3/8 F 37º X 1/4 M 37º	1
9	719-060	SEAL NUT, 1/4 FPT	1
10	719-059	SEAL NUT, 1 FPT	1
11	729-092	NUT, 3/8 – 37º	1
12	723-061	TEE, 1 F 37º X 1 M 37º X 1 M 37º	1
13	723-076	TEE, 3/8 M 37º X 3/8 F 37º X 3/8 M 37º	1

Parts List – Top Up Motor/Pump Assembly

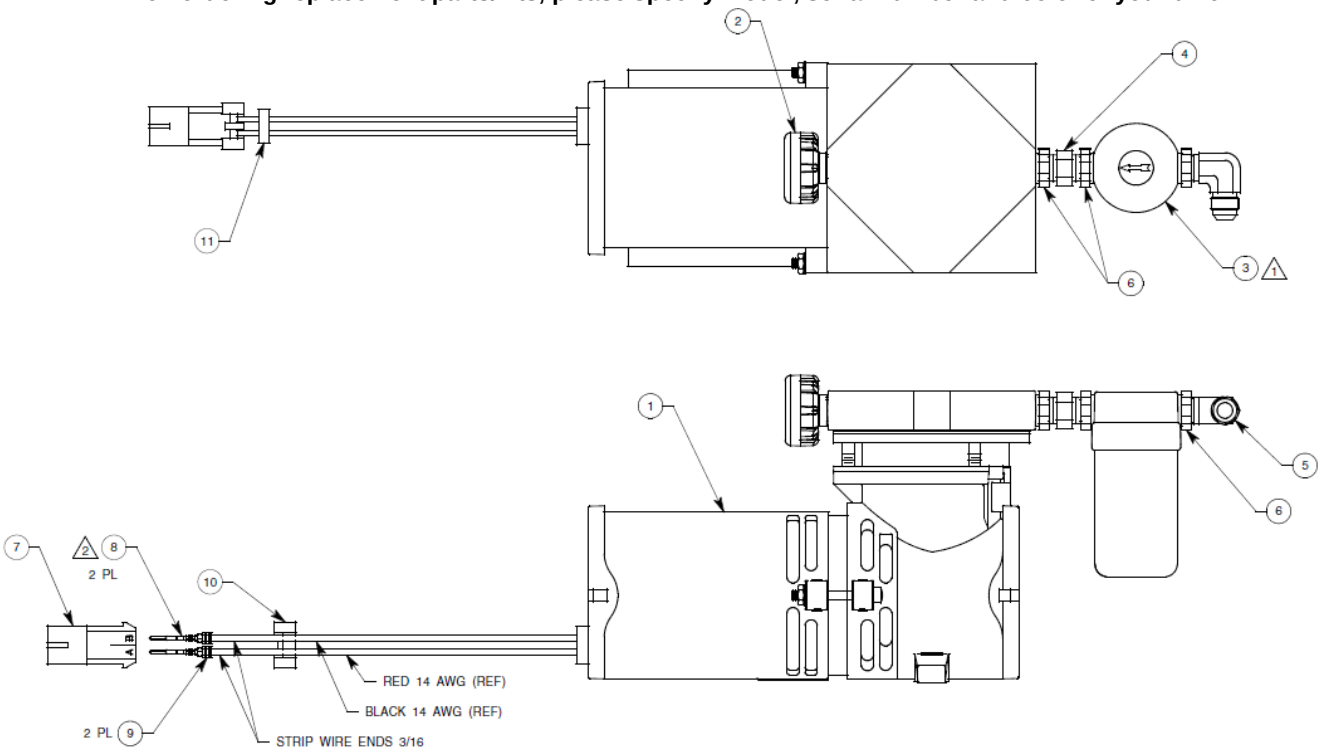
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
	1016124	**TOP UP MOTOR/PUMP ASSEMBLY**; consist of:	
1	1016122	PUMP WITH ELECTRIC MOTOR, 0.6 GPM	1
2	422-076	CHECK VALVE, 1/4 MPT IN X 3/8 37º MALE OUT	1
3	722-118	ELBOW, 1/2 M 37º X 1/4 MPT	1
4	719-055	SEAL NUT, 1/4 FPT	1
5	394-012	HOSE CLAMP, 2-1/2 – 3-1/2	1

Parts List – Vacuum Pump Assembly

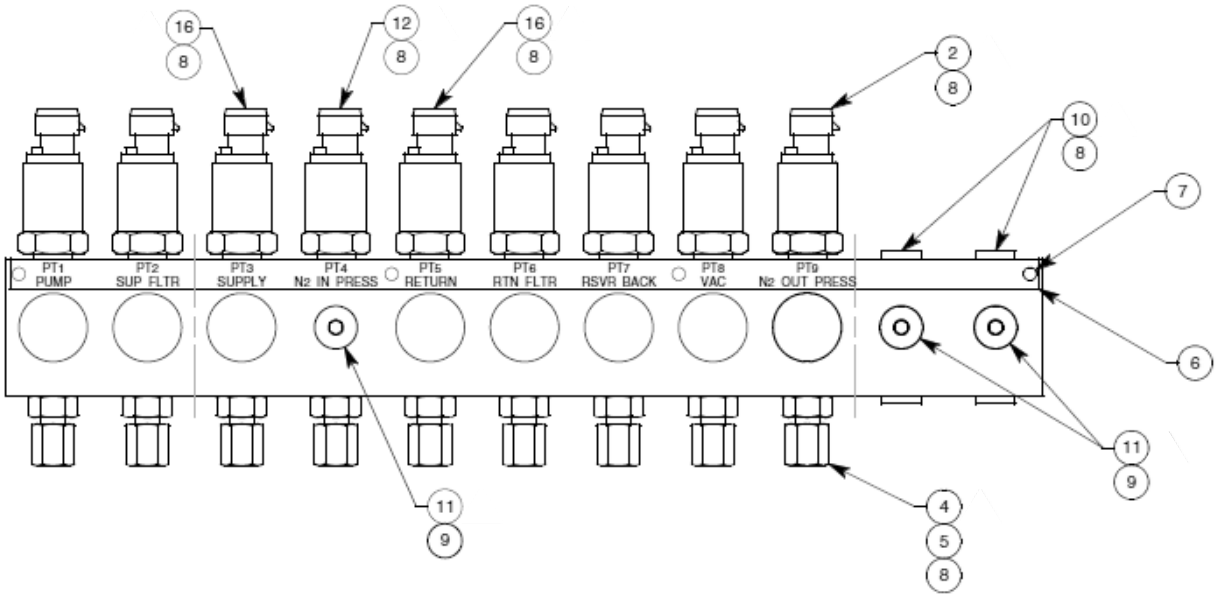
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

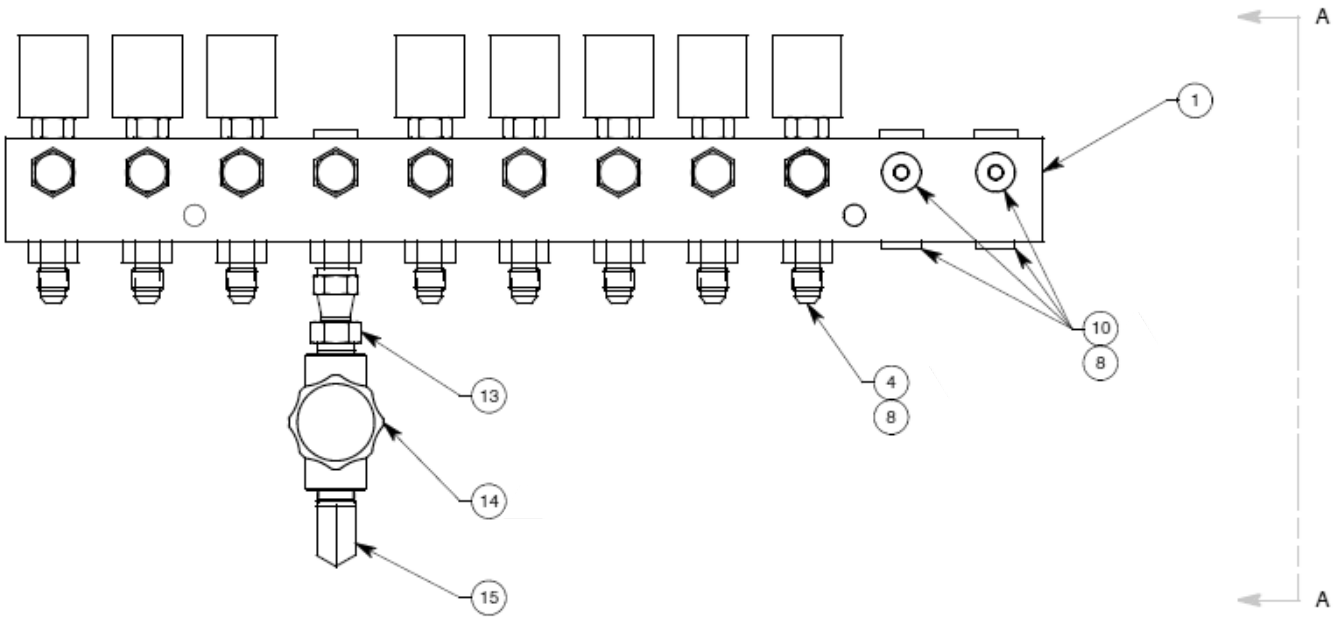


Item	Part Number	Description	Qty
	1006147	**VACUUM PUMP ASSEMBLY**; consist of:	
1	442-063	VACUUM PUMP	1
2	472-007	MUFFLER, 1/4 MPT	1
3	486-034	TRAP, 1/4 FPT	1
4	711-101	NIPPLE, 1/4 MPT X 1/4 MPT	1
5	722-069	ELBOW, 3/8 MALE 37º X 1/4 MPT	1
6	719-055	SEAL NUT, 1/4 FPT	3
7	450-308	MALE CONNECTOR, METRI-PACK 150	1
8	450-328	MALE TERMINAL, 16/18 AWG	2
9	450-327	CABLE SEAL, RED	2
10	450-299	TPA, 2 POSITION	1
11	450-530	CAPACITOR, 0.47 MICROFARAD	1

Parts List– Pressure Transducer Manifold Assembly

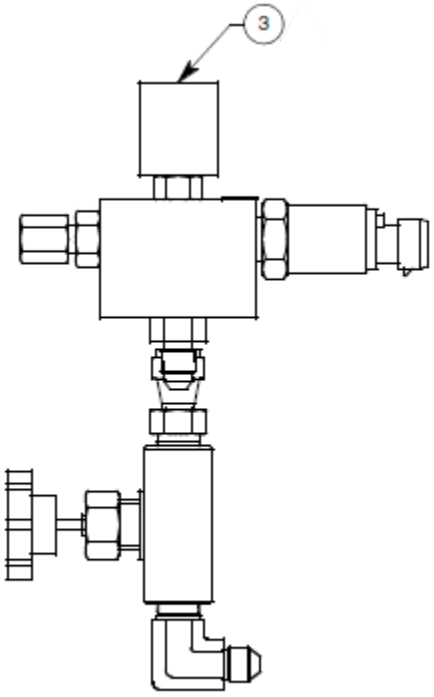
When ordering replacement parts/kits, please specify model, serial number and color of your unit.





Parts List – Pressure Transducer Manifold Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

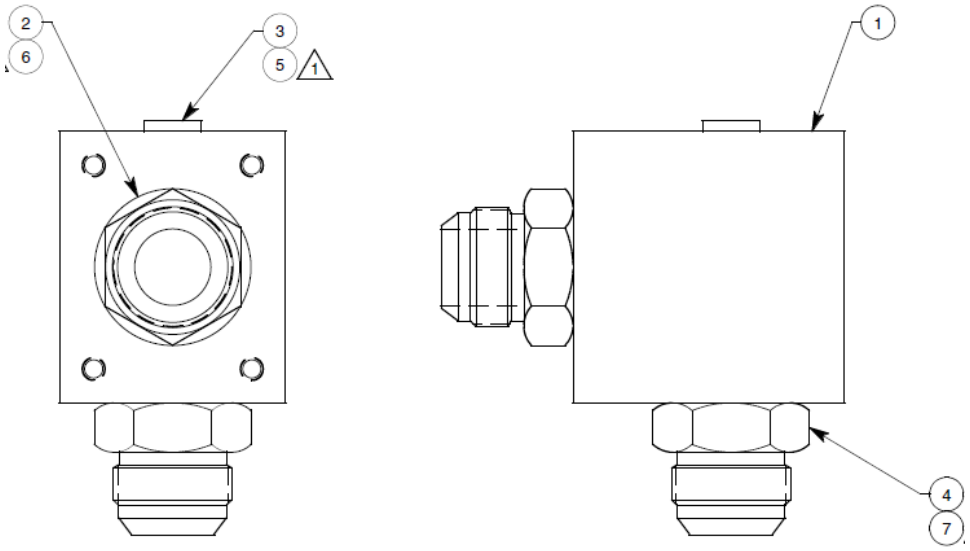


VIEW A-A

Item	Part Number	Description	Qty
	1016030	**PRESSURE TRANSDUCER MANIFOLD ASSEMBLY**; consist of:	
1	1016031	PRESSURE TRANSDUCER MANIFOLD	1
2	482-106	PRESSURE TRANSDUCER	6
3	424-070	SAMPLING VALVE	8
4	721-158	CONNECTOR, 1/4 37º X 1/4 SAE O-RING	18
5	717-081	CAP, 1/4 37º	9
6	106033	PRESSURE TRANSDUCER PLACARD	1
7	393-004	DRIVE SCREW, #2 X 3/16 LG	4
8	55930-904	O-RING, 1/4	33
9	55930-905	O-RING, 5/16	3
10	717-090	PLUG, 1/4 SAE	6
11	717-089	PLUG, 5/16 SAE	3
12	482-107	PRESSURE TRANSDUCER, 0-5000 PSI	1
13	721-224	ADAPTER, 1/4 FEMALE 37º X 1/4 MPT	1
14	424-002	NEEDLE VALVE	1
15	722-148	ELBOW, 1/4 MALE 37º X 1/4 MPT	1
16	482-110	PRESSURE TRANSDUCER, 0-300 PSI	2

Parts List – Outlet Manifold Assembly

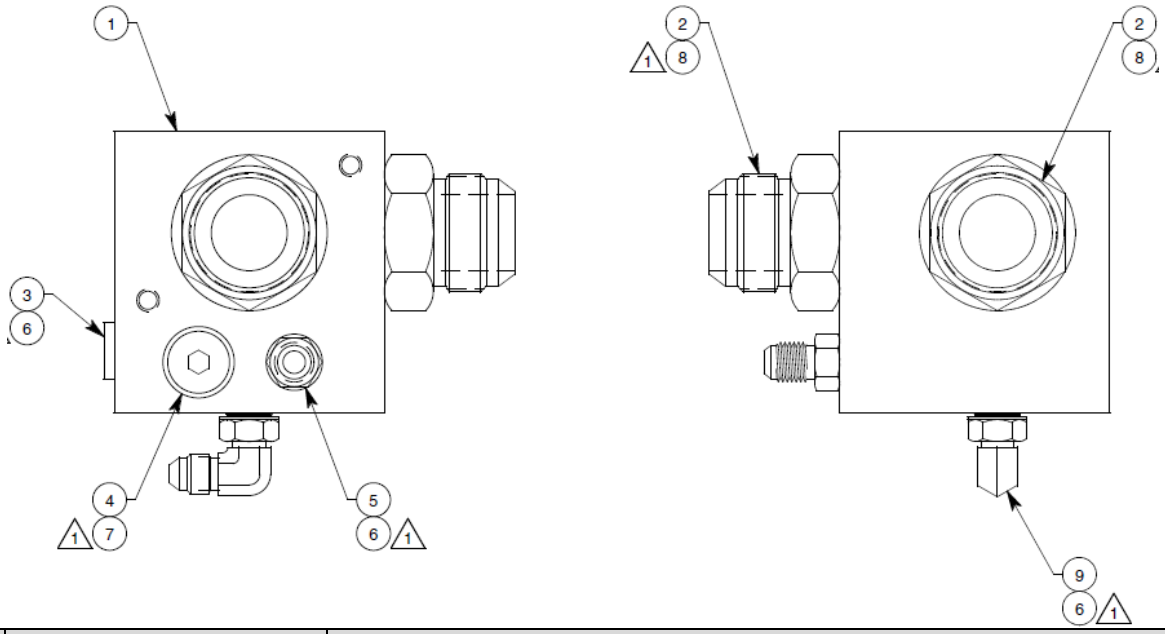
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
	1016128	**OUTLET MANIFOLD ASSEMBLY**; consist of:	
1	1011134A	OUTLET MANIFOLD	1
2	721-159	CONNECTOR, 1 MALE 37º X 1 SAE O-RING	1
3	717-090	SOCKET HEAD PLUG, 1/4 SAE O-RING	1
4	721-226	CONNECTOR, 1 MALE 37º X 1-1/2 SAE O-RING	1
5	55930-904	O-RING	1
6	55930-916	O-RING	1
7	55930-924	O-RING	1

Parts List – Return Manifold Assembly

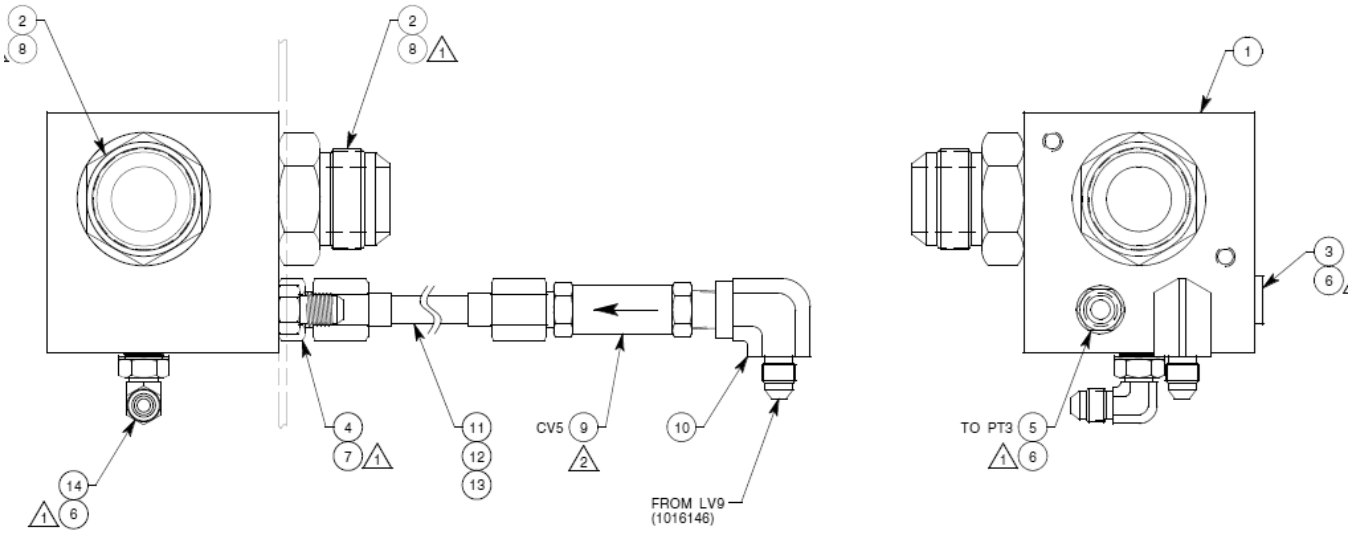
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
	1016129	**RETURN MANIFOLD ASSEMBLY**; consist of:	
1	1011134A	OUTLET MANIFOLD	
2	721-159	CONNECTOR, 1 MALE 37º X 1 SAE O-RING	
3	717-090	SOCKET HEAD PLUG, 1/4 SAE O-RING	
4	717-079	SOCKET HEAD PLUG, 3/8 SAE O-RING	
5	721-158	CONNECTOR, 1/4 MALE 37º X 1/4 SAE O-RING	
6	55930-904	O-RING	
7	55930-906	O-RING	
8	55930-916	O-RING	
9	722-115	ELBOW, 1/4 MALE 37º X 1/4 SAE O-RING	

Parts List – Supply Manifold Assembly

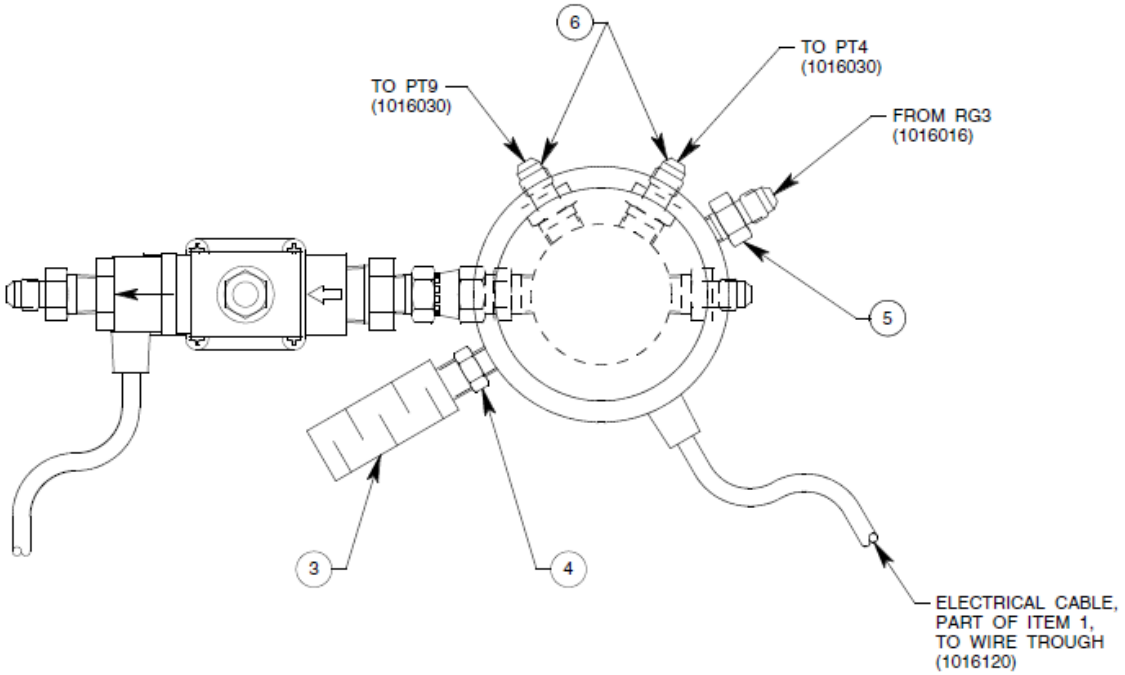
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

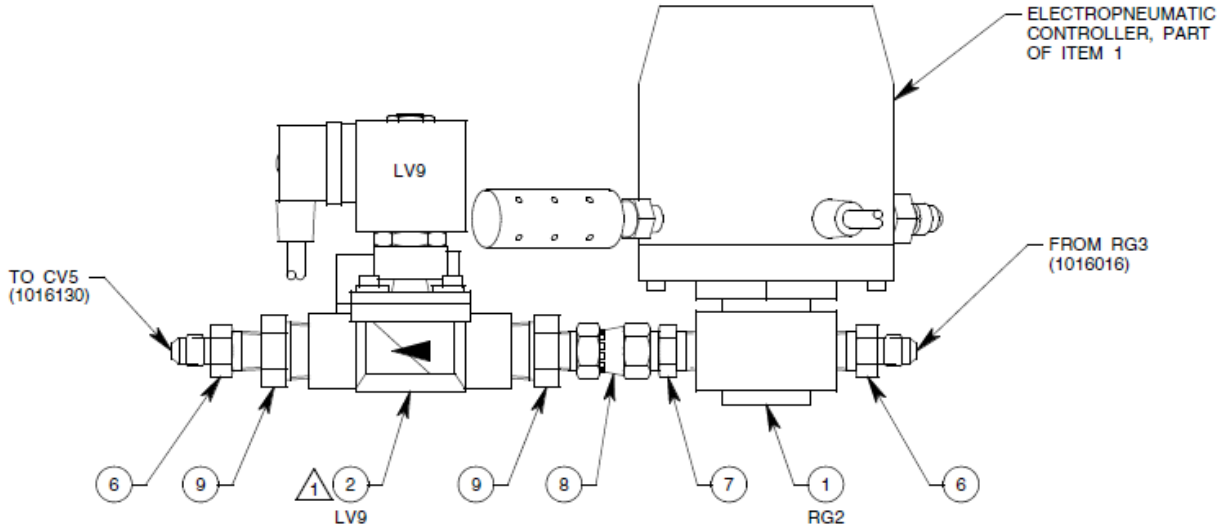


Item	Part Number	Description	Qty
	1016130	**SUPPLY MANIFOLD ASSEMBLY**; consist of:	
1	1011132A	MANIFOLD	1
2	721-159	CONNECTOR, 1 MALE 37º X 1 SAE O-RING	2
3	717-090	SOCKET HEAD PLUG, 1/4 SAE O-RING	1
4	721-108	CONNECTOR, 3/8 MALE 37º X 3/8 SAE O-RING	1
5	721-158	CONNECTOR, 1/4 MALE 37º X 1/4 SAE O-RING	1
6	55930-904	O-RING	3
7	55930-906	O-RING	1
8	55930-916	O-RING	2
9	422-076	CHECK VALVE, 1/4 MPT X 3/8 MALE 37º	1
10	722-111	ELBOW, 1/4 MALE 37º X 1/4 FTP	1
11	732-024	TUBE, 3/8 OD X .035 WALL X 5 LG	AR
12	729-092	NUT, 3/8 37º	2
13	729-091	SLEEVE, 3/8 37º	2
14	722-115	ELBOW, 1/4 MALE 37º X 1/4 SAE O-RING	1

Parts List – N2 Regulator Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

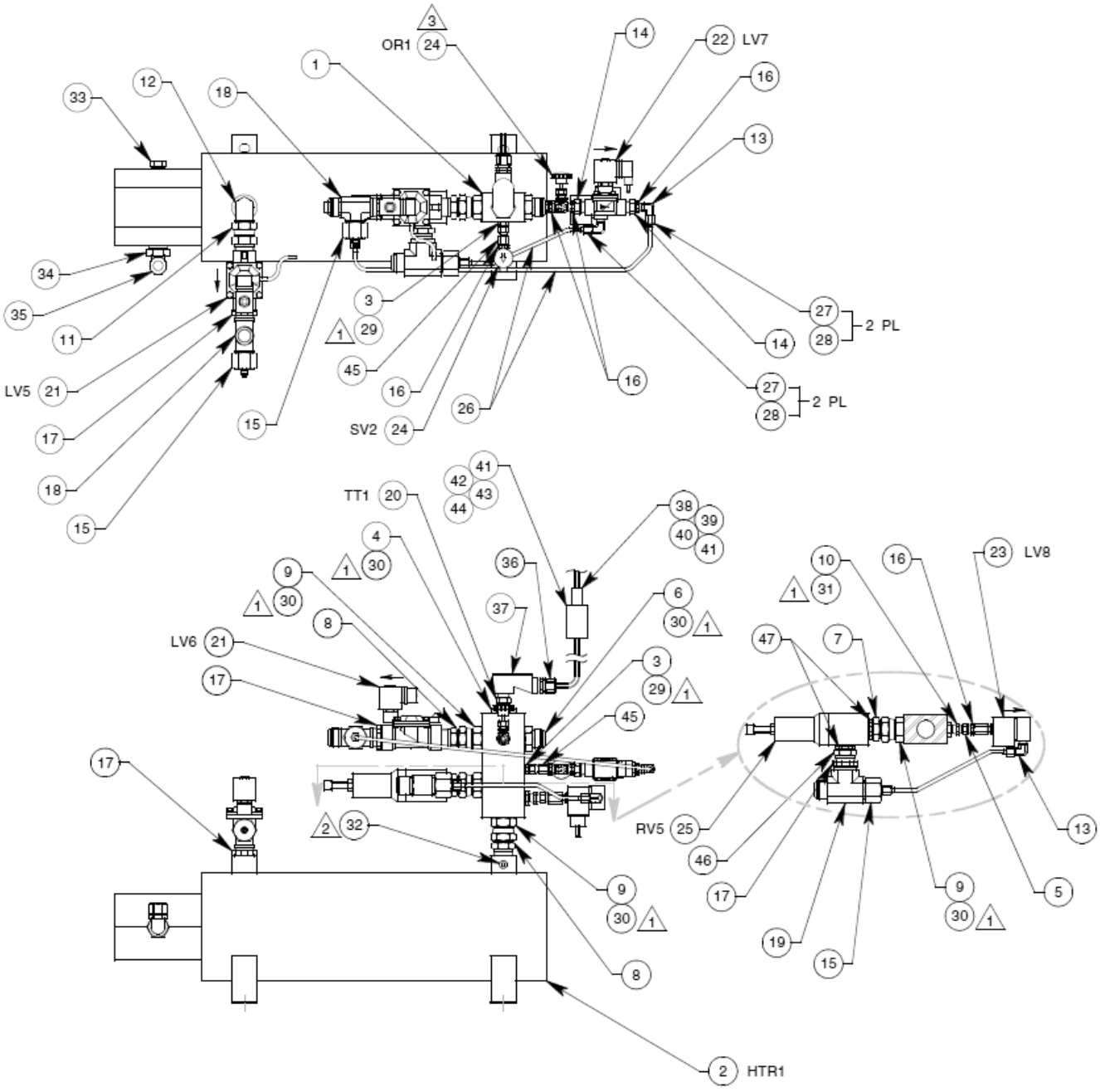




Item	Part Number	Description	Qty
	1016146	**N2 REGULATOR ASSEMBLY**; consist of:	
1	473-015	REGULATOR, VENTED, 5-500 PSIG, 1/4 FPT	1
2	424-063	SHUTOFF VALVE, 1/2 FPT, 300 PSI, SST	1
3	472-003	MUFFLER, 1/4 FPT	1
4	711-127	NIPPLE, 1/4 MPT X 1/8 MPT	1
5	711-073	CONNECTOR, 1/4 MALE 37º X 1/8 MPT	1
6	721-138	CONNECTOR, 1/4 MALE 37º X 1/4 MPT	6
7	721-124	CONNECTOR, 3/8 MALE 37º X 1/4 MPT	1
8	721-173	ADAPTER, 3/8 SWIVEL F 37º X 1/4 MPT	1
9	714-028	REDUCER, 1/2 MPT X 1/4 FPT	2

Parts List– Heater Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



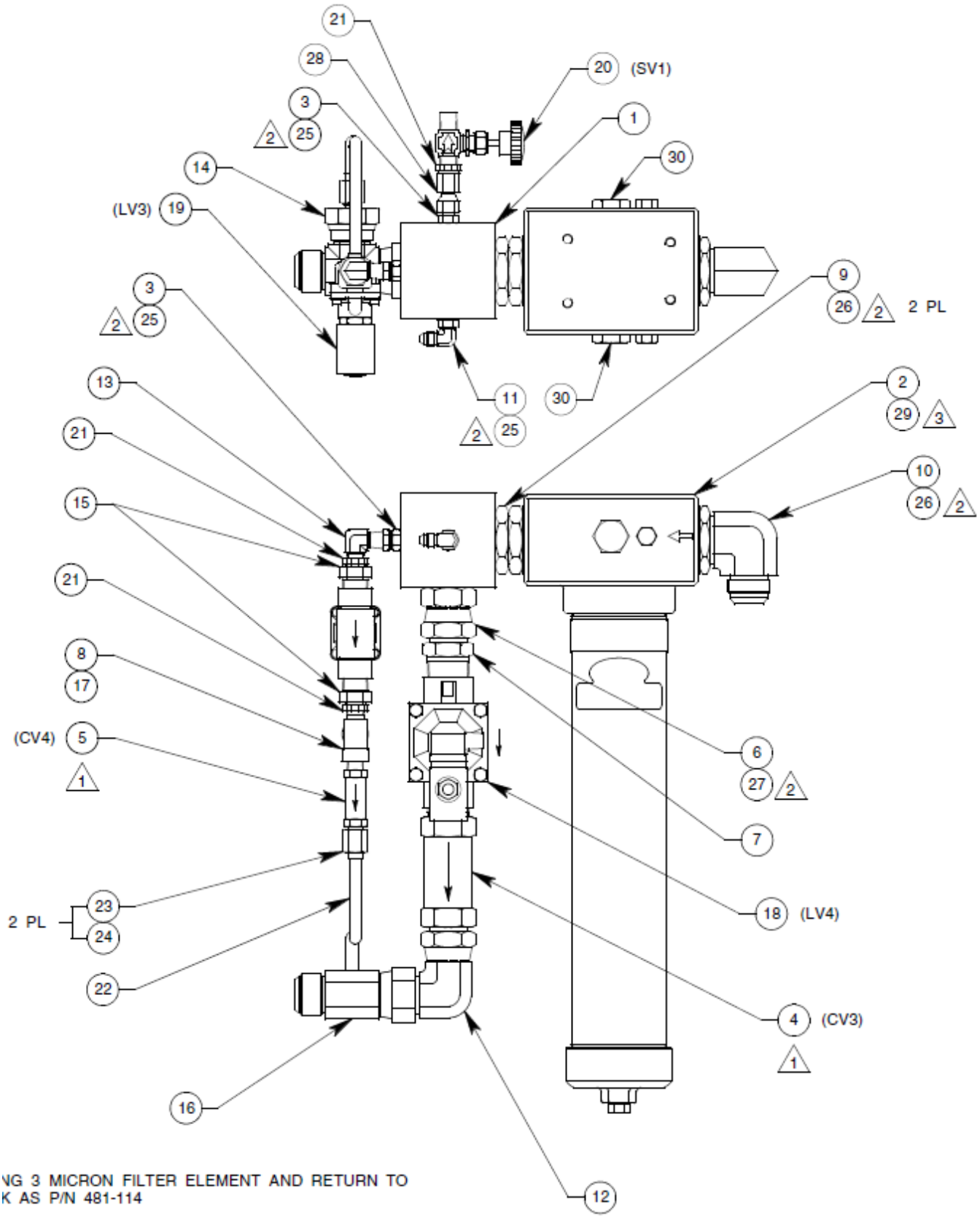
Parts List– Heater Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016127	**HEATER ASSEMBLY**; consist of:	
1	1016132	MANIFOLD	1
2	450-779	HEATER	1
3	721-158	CONNECTOR, 1/4 M 37º X 1/4 SAE	2
4	714-052	ADAPTER, 1/2 FPT X 1 SAE	1
5	721-124	CONNECTOR, 3/8 MALE 37º X 1/4 MPT	1
6	721-159	CONNECTOR, 1 MALE 37º X 3/4 MPT	1
7	721-162	CONNECTOR, 1 MALE 37º X 3/4 MPT	1
8	721-163	CONNECTOR, 1 M 37º X 1 MPT	2
9	721-165	CONNECTOR, 1 F 37º X 1 SAE	3
10	721-174	CONNECTOR, 3/8 37º X 3/8 M SAE	1
11	721-225	CONNECTOR, 1 F 37º X 1 MPT	1
12	722-139	ELBOW, 1 M 37º X 1 MPT	1
13	722-148	ELBOW, 1/4 M 37º X 1/4 MPT	2
14	714-028	REDUCER, 1/2 MPT X 1/4 FPT	2
15	729-149	REDUCER, 1 F 37º X 1/4 M 37º	3
16	719-055	SEAL NUT, 1/4 FPT	5
17	719-059	SEAL NUT, 1 FPT	4
18	723-077	TEE, 1 MPT X 1 M 37º 1 M 37º	2
19	723-077	TEE, 1 M 37º X 1 M FPT 1 M 37º	1
20	1016024	TEMPERATURE TRANSMITTER	1
21	424-061	SHUTOFF VLAVE, 1 FTP, 230 PSI, SST	2
22	424-063	SHUTOFF VLAVE, 1/2 FTP, 300 PSI, SST	1
23	424-068	SHUTOFF VLAVE, 1/4 FTP, 250 PSI, SST	1
24	424-003	NEEDLE VALVE, 1/4 MTP, SST	2
25	423-086	RELIEF VALVE, 3/4 FTP, 85 PSIG, SST	1
26	732-003	TUBE, 1/4 OD X .035 WALL, X 40 LG SST	AR
27	729-107	SLEEVE, 1/4 37º, SST	4
28	729-106	NUT, 1/4 37º, SST	4
29	55930-904	O-RING	2
30	55930-916	O-RING	5
31	55930-906	O-RING	1
32	717-064	PLUG, 1/4 MPT, SST	1
33	717-077	PLUG, 1/2 MPT, SST	1
34	714-058	REDUCER, 1 MPT X 1/4 FPT, SST	1
35	450-542	CONDUIT FITTING ELBOW, 17MM X 1/2 NPT	1
36	450-669	CORD GRIP, 1/2 NPT X .17-.45	1
37	450-704	CONDUIT BODY, 1/2 SLB, ALUMINUM	1
38	450-308	MALE CONNECTOR, METRI-PACK 2 PIN	1
39	450-307	MALE TERMINAL, 22/20 AWG	2
40	450-303	CABLE SEAL, TAN	2
41	450-299	TPA 2 POSITION	2
42	450-296	FEMALE CONNECTOR, METRI-PACK 2 PIN	1
43	450-298	FEMALE TERMINAL, 18 AWG	2
44	450-327	CABLE SEAL, RED	2
45	721-191	CONNECTOR, 1/4 F SWIVEL 37º X 1/4 FPT	2
46	711-132	NIPPLE, 1 MPT X 3/4 MPT	1
47	719-058	SEAL NUT, 3/4 FPT	2

Parts List – Supply Filter Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



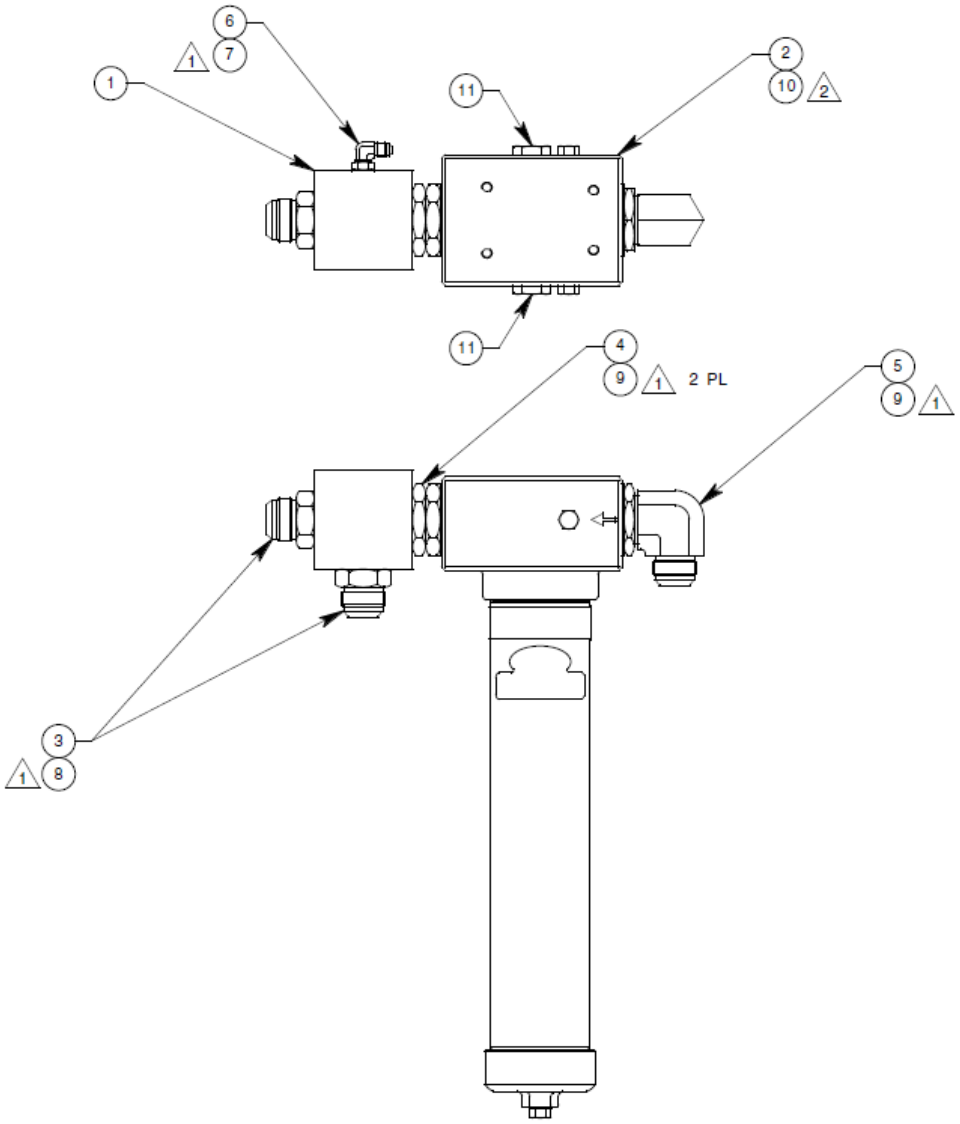
Parts List– Supply Filter Assembly

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
	1016125	**SUPPLY FILTER ASSEMBLY**; consist of:	
1	1016131	SUPPLY MANIFOLD BLOCK	1
2	481-125	FILTER ASSEMBLY, 3 MICRON ABSOLUTE	1
3	721-158	CONNECTOR, 1/4 MALE 37° x 1/4 SAE	2
4	422-087	CHECK VALVE, 1 MPT x 1 37° FLARE	1
5	422-076	CHECK VALVE, 1/4 MPT IN x 3/8 37° M OUT	1
6	721-165	CONNECTOR, 1" MALE 37° x 1 SAE	1
7	721-163	CONNECTOR, 1" FEMALE 37° x 1 MPT	1
8	721-124	CONNECTOR, 3/8 MALE 37° x 1/4 MPT	1
9	721-180	CONNECTOR, 1-1/4 SAE	1
10	722-152	ELBOW, 1 MALE 37º X 1-1/4 SAE	1
11	722-115	ELBOW, 1/4 MALE 37º X 1/4 SAE	1
12	722-178	ELBOW, 1 FEMALE 37º X 1 MALE 37º	1
13	722-141	ELBOW, 1/4 FEMALE SWIVEL 37° x 1/4 FPT	1
14	729-126	REDUCER, 1 FEMALE 37º X 3/8 MALE 37º	1
15	714-028	REDUCER, 1/2 MPT X 1/4 FPT	2
16	723-061	TEE, 1 F 37º X 1 M 37º X 1 M 37º	1
17	713-026	TEE, 1/4 MPT X 1/4 FPT X 1/4 FPT	1
18	424-061	SHUTOFF VALVE, 1 FPT	1
19	424-063	SHUTOFF VALVE, 1/2 FPT	1
20	424-003	NEEDLE VALVE, 1/4 MPT	1
21	719-055	SEAL NUT, 1/4 FPT	3
22	732-024	TUBE, 3/8 X .035 WALL X 10 LG, SST	AR
23	729-091	SLEEVE, 3/8 37º, SST	2
24	729-092	NUT, 3/8 37º, SST	2
25	55930-904	O-RING	3
26	55930-920	O-RING	3
27	55930-916	O-RING	1
28	721-191	CONNECTOR, 1/4 FEMALE SWIVEL 37° x 1/4 FPT	1
29	481-113	FILTER ELEMENT, 12 MICRON	1
30	481-145	FILTER BLANKING PLUG	2

Parts List– Return Filter Assembly

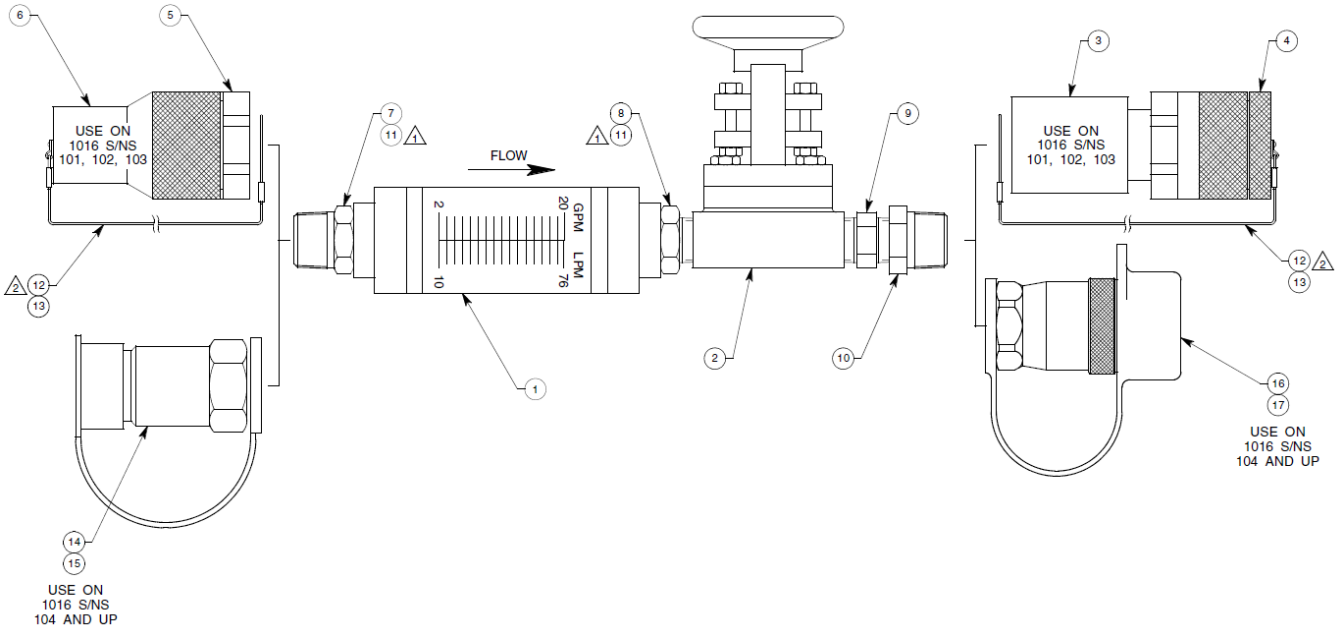
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	
	1016126	**RETURN FILTER ASSEMBLY**; consist of:	
1	1016133	RETURN MANIFOLD BLOCK	1
2	481-125	FILTER ASSEMBLY	1
3	721-159	CONNECTOR, 1 M 37º x 1 SAE	2
4	721-180	CONNECTOR, 1-1/4 MALE SAE	1
5	722-152	ELBOW, 1 MALE 37° x 1-1/4 SAE	1
6	722-115	ELBOW, 1/4 MALE 37° x 1/4 SAE	1
7	55930-904	O-RING	1
8	55930-916	O-RING	2
9	55930-920	O-RING	3
10	481-113	FILTER ELEMENT, 12 MICRON	1
11	481-145	FILTER BLANKING PLUG	2

Parts List– Flow Meter Test Tool

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	
	1016201	**FLOW METER TEST TOOL**; consist of:	
1	486-055	FLOWMETER, 1 FEMALE SAE	1
2	424-086	GATE VALVE, 3/4 FPT	1
3	736-181	QD COUPLER, 1 FPT	1
4	736-182	DUST PLUG	1
5	735-091	QD NIPPLE, 1 FPT	1
6	735-092	DUST CAP	1
7	721-167	ADAPTER, 1 MPT X 1 MALE SAE	1
8	721-185	ADAPTER, 3/4 MPT X 1 MALE SAE	1
9	711-091	NIPPLE, 3/4 MPT	1
10	714-054	REDUCER, 3/4 FPT X 1 MPT	1
11	55930-916	O-RING	2
12	491-027	CABLE, 16 LG	AR
13	491-028	SLEEVE, KRIMP	4
14	735-068	QD NIPPLE, 1 FPT, SST	1
15	735-069	DUST CAP	1
16	736-133	QD COUPLER, 1 FPT SST	1
17	736-134	DUST PLUG	1

MALABAR™
INTERNATIONAL
A TRONAIR COMPANY

APPENDIX I

Hydraulic Schematic
1016002

DWG. NO.	1016012	SH. 1	REV. J

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	BY	APPROVED
		NEW RELEASE	1/21/14	JW	BW
	A	SEE ECN 6009	8/15/14	JW	BW
	B	SEE ECN 6065	1/15/15	KG	BW
	C	SEE ECN 6166	9/10/15	JW	BW
	D	SEE ECN 6209	11/19/15	JW	BW
	E	SEE ECN 6290	3/28/16	BA	BW
	F	SEE ECN 6291	4/1/16	BA	BW
	G	SEE ECN 6350	7/21/16	JW	BW
	H	SEE ECN 6582	6/1/18	BW	BW
	J	SEE ECN 6616	1/24/19	BW	BW

(1) #12 BLU, 12350
(1) #12 BLU/WHT, 12371
(1) #12 GND

PLC (9) #18 BLU, 14080, 14380, 15220, 15240, 15260, 15280, 15440, 15581

LV'S (9) #18 BLU, 16160, 16180, 16200, 16220, 16240, 16260, 16280, 16501, 16521

PT'S (9) #18 BLU, 17100, 17180, 17260, 17340, 18100, 18180, 18260, 18340, 19100
SIGNAL

RG2 (1) #18 BLU, 485+ ; (1) #18 BLU/WHT, 485-

ALL 3 CURRENT INPUT MODULES 1 (9) #18 BLU/WHT, IN0- IN1- IN2- IN3-

RTD INPUT MODULE (2) #18 BLU, 20040, 20110

CONDUIT 2 → TO SHEET 2

(2) #16 BLU, 12520
(2) #16 BLU/WHT, 12371

(1) #12 BLU, 12350
(1) #12 BLU/WHT, 12371
(1) #14 GND
(13) #16 BLU, 11310, 11311, 11531, 11532, 15120, 15180, 15181, 15221, 15261, 15361, 15461, 15501, 15561
(3) #14 BLK, 12040, 12041, 12081

CONTROL ENCLOSURE (1016017)

CONDUIT 1
CONDUIT 3
CONDUIT 4

STACK HORN
FSLT3
FSLT2
FSLT1

57, 58, 59, 60, 61, 62, 63

1, 36, 40 — 16 PL

(2) #16 BLU, 15321
(2) #16 BLU/WHT, 12371

30, 37, 39 — 2 PL; 35 — 4 PL

50, 23

14

27

LINE CORD & PLUG - SEE TOP ASSY DWG (REF)

3, 42, 43, 44, 45 — 2 PL; 29 — 3 PL; 46, 47 — 4 PL — -1, -3

M1
3 HP
(1016121)

28, 29, 48 — 4 PL

M2
1/3 HP
(1016122)

11

MOTOR CONDUIT
MOTOR CONDUIT

24, 49

10

VAC PUMP & 0.1 MFD CAP (1006147)

C545

ELECTRICAL ENCLOSURE POWER DISTRIBUTION BOX (1016020)

#10 GND

HEATER CONDUIT

FRAME GROUND STUD

15, 16

20 — -1, -2 → TO SHEET 2

28, 48 — -1, -3

24, 49 — -1, -3

TR1

TR2

-1, -3 CONDUIT 5

-1, -3 CONDUIT 6

11 — -1, -3

10 — -1, -3

(3) #10 BLK, 2L1, 2L2, 2L3
(3) #12 BLK, 12L1, 12L2, 12L3
(1) #12 GND

(2) #10 BLK, 2L2, 2L3
(2) #12 BLK, 12L2, 12L3
(1) #12 GND

51 -1
52 -2
53 -3
54 -4
31 △3
32
33
34 — 10 PL

VACUUM PUMP CABLE ASSEMBLY (1011170)

10 → CIRCULATION HEATER (450-779)

-1: 380/480V w/ GENSET
-2: 200/240V w/ GENSET
-3: 380/480V w/o GENSET
-4: 200/240V w/o GENSET

△7 PULL WIRE THROUGH FEMALE CONNECTOR BODY. STRIP WIRE .19 AND USE CRIMP TOOL P/N 1V6F3-12039500

△6 WIRE PER DETAIL A

△5 ADD SHRINK TUBE FOR CORD CONNECTOR PASSTHROUGH

△4 TERMINATE WIRES/CABLES INDICATED USING CRIMP-ON WIRE JOINTS (450-544)

△3 AFFIX NEOPRENE STRIP ALONG INSIDE EDGES OF ENLCOSURE MOUNTING FLANGE

△2 CABLES AND/OR CONNECTORS INCLUDED WITH FT1. RUN CABLE THRU WIRE TROUGH AND INTO CONTROL ENCLOSURE W/O CUTTING DUE TO NOISE PROBLEM

1. ELECTRICAL SYSTEM SCHEMATIC 1016001 (REF)

NOTES : UNLESS OTHERWISE SPECIFIED

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

1016000	1016
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES 125
TOLERANCES ARE :
FRACTIONS ± 1/32 DECIMALS ± .03 ± .010 ANGLES ± 1°
MATERIAL SEE SHEET 3
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

	APPROVAL	DATE
DRAWN	JOHN W.	1/14
CHECKED	BILL W.	1/14
ISSUED		

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

ELECTRICAL INTERCONNECT ASSEMBLY

SIZE	FSCM NO.	DWG. NO.	REV.
D	94861	1016012	J

SCALE 1/1 SHEET 1 OF 3

DWG. NO.	1016012	SH.	2	REV.	J

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

(REF) 9

FROM SHEET 1

CONDUIT 2

WIRE TROUGH (1016120)

5 22 10 25 -3, -4 4

2
38
41
36
4 PL
8 PL

12 21 13

C506 C507 C508 C509 C* C** CONDUIT 7 C510 450-814 C505 C504 C503 C501 C502

12

26 55 56 6 2 4

4 4 4 4 4 26

LT1 (1016176) | LT2 (1016176) | FT1 (1016023) | TT1 (1016024) | PT* (1016030) | LV** SOLENOID VALVE | LV8 (424-068) | RG2 (473-105)

LSL1 (484-038) | LSL2 (484-038) | LSH1 (484-038) | LSH2 (484-038)

5
18
6
7
19
8
2 PL
4 PL
-1, -2

-1, -2 17

(1011114)

LSL2

20 (REF)

FROM SHEET 1

GENSET (1011057)

#10 GND

15
16

FRAME GROUND STUD

-1, -2 27

CORD GRIP (PART OF GENSET)

CABLE TO SOLENOID VALVE TABLE

C**	- LV**
C511	- LV1
C512	- LV2
C513	- LV3
C514	- LV4
C515	- LV5
C516	- LV6
C517	- LV7
C519	- LV9

CABLE TO PRESSURE TRANSDUCER TABLE 6

C*	- PT*
PT1	- PT1
PT2	- PT2
PT3	- PT3
PT4	- PT4
PT5	- PT5
PT6	- PT6
PT7	- PT7
PT8	- PT8
PT9	- PT9

A B C

BLK WHT RED

VIEW A-A
SCALE: 2/1

1.75
JACKET STRIP LENGTH

A A

56 55 3 PL 7

DETAIL A

SEE SHEET 1

NOTES : UNLESS OTHERWISE SPECIFIED

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

1016000	1016
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES 125 TOLERANCES ARE :
FRACTIONS ± 1/32 DECIMALS ± .03 ± .010 ANGLES ± 1°

MATERIAL SEE SHEET 3

FINISH —

DO NOT SCALE DRAWING

CONTRACT NO.

	APPROVAL	DATE
DRAWN	JOHN W.	1/14
CHECKED	BILL W.	1/14
ISSUED		

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

ELECTRICAL INTERCONNECT ASSEMBLY

SIZE	FSCM NO.	DWG. NO.	REV.
D	94861	1016012	J

SCALE 1/1 SHEET 2 OF 3

DWG. NO. 1016012	SH. 3	REV. J

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

-4	-3	-2	-1	ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
1	1	1	1	63			353-027	HEX LOCKNUT, SST, 6-32	
1	1	1	1	62			362-063	FLAT WASHER, SST, #6 SAE	
1	1	1	1	61			324-064	PHMS, SST, 6-32 x 1/2 LG	
8	8	8	8	60			362-037	FLAT WASHER, SST, #4 SAE	
4	4	4	4	59			353-026	HEX LOCKNUT, SST, #4-40	
4	4	4	4	58			326-018	BHCS, SST, #4-40 x 1/2 LG	
1	1	1	1	57			1016054	SIGNAL CABLE	
9	9	9	9	56			450-437	FEMALE CONN., METRIPACK 150, 3 PIN	
27	27	27	27	55			450-438	FEMALE TERMINAL, 20/22 AWG	
1	–	–	–	54			1016020-4	ELECTRICAL ENCLOSURE	
–	1	–	–	53			1016020-3	ELECTRICAL ENCLOSURE	
–	–	1	–	52			1016020-2	ELECTRICAL ENCLOSURE	
–	–	–	1	51			1016020-1	ELECTRICAL ENCLOSURE	

PARTS LIST

-4	-3	-2	-1	ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
5	5	5	5	50			450-462	LOCKNUT, PF7/1/4 FPT, NYLON	
1	3	1	3	49			450-581	LOCKNUT, 1/2 FPT, NYLON	
1	2	1	2	48			450-580	LOCKNUT, 3/4 FPT, NYLON	
–	8	–	8	47			362-055	FLAT WASHER, SST, #10 SAE	
–	8	–	8	46			362-048	FLAT WASHER, SST, 5/16 SAE	
–	4	–	4	45			353-019	HEX LOCKNUT, SST, 10-32	
–	4	–	4	44			324-027	HHCS, SST, 10-32 x 3/4 LG	
–	4	–	4	43			353-021	HEX LOCKNUT, SST, 5/16-18	
–	4	–	4	42			324-010	HHCS, SST, 5/16-18 x 1" LG	
4	4	4	4	41			324-012	HHCS, SST, 1/4-20 x 1" LG	
16	16	16	16	40			326-033	BHCS, SST, 1/4-20 x 3/4 LG	
2	2	2	2	39			326-030	BHCS, SST, 8-32 x 1-3/4 LG	
4	4	4	4	38			353-020	HEX LOCKNUT, SST, 1/4-20	
2	2	2	2	37			353-025	HEX LOCKNUT, SST, 8-32	
24	24	24	24	36			362-038	FLAT WASHER, SST, 1/4 SAE,	
4	4	4	4	35			362-051	FLAT WASHER, SST, #8 SAE	
10	10	10	10	34			369-006	RETAINER	
10	10	10	10	33			390-102	CLIP-ON RECEPTACLE	
10	10	10	10	32			390-106	SLOTTED SCREW WITH WEAR WASHER	
AR	AR	AR	AR	31			999-051	NEOPRENE STRIP, 130" LG	
1	1	1	1	30			450-790	STACK HORN	
4	7	4	7	29			450-838	WALL NUT	
1	2	1	2	28			450-670	CONDUIT FTG, 90°, 23mm x 3/4 MPT	
1	1	2	2	27			390-087	GROMMET, 1-1/4 ID	
5	5	5	5	26			450-669	CORD GRIP, 1/2 NPT x .17-.45 GRIP	
1	1	–	–	25			450-701	PLUG	
1	3	1	3	24			450-542	CONDUIT FITTING, 90°, 17mm x 1/2 MPT	
5	5	5	5	23			450-743	CONDUIT FITTING, STR, 8mm, PG7	
2	2	2	2	22			450-543	CONDUIT FITTING, 17mm x 1/2 MPT, STR	
AR	AR	AR	AR	21			450-423	CABLE, 3 COND, DRN, 22 AWG x 700" LG	
–	–	AR	AR	20			450-714	CABLE, TYPE W, 4 COND, 8 AWG x 180" LG	
–	–	2	2	19			450-328	MALE TERMINAL, 16/18 AWG	
–	–	1	1	18			450-308	MALE CONN., METRIPACK 150, 2 PIN	
–	–	1	1	17			482-097	CONNECTOR & PIGTAIL	
2	2	2	2	16			351-035	HEX NUT, 3/8-16, BRASS	
2	2	2	2	15			329-015	STUD, 3/8-16 x 1-1/4 LG, BRASS	
AR	AR	AR	AR	14			450-748	CONDUIT, FLEX, 8mm, x 96" LG	
8	8	8	8	13			450-721	CABLE & CONN. DIN 43650 FORM A, 3M	
AR	AR	AR	AR	12			EC-1170-06	CABLE, 3 COND 18 AWG, x 630" LG	
AR	AR	AR	AR	11			450-665	CONDUIT, FLEX, 23mm, x 115" LG	
AR	AR	AR	AR	10			450-541	CONDUIT, FLEX, 17mm, x 155" LG	
AR	AR	AR	AR	9			450-776	CONDUIT, FLEX, 29mm, x 30" LG	
–	–	4	4	8			450-301	CABLE SEAL, BLUE	
–	–	2	2	7			450-298	FEMALE TERMINAL, 16/18 AWG	
–	–	2	2	6			450-299	TPA, 2 POSITION	
–	–	1	1	5			450-296	FEMALE CONN., METRIPACK 150, 2 PIN	
AR	AR	AR	AR	4			450-526	CABLE, 2 COND., DRN., 18 AWG, 240" LG	
–	2	–	2	3			450-676	TRANSFORMER	
1	1	1	1	2			1016120	WIRING TROUGH	
1	1	1	1	1			1016017	CONTROL ENCLOSURE	

PARTS LIST

SEE SHEET 1

NOTES : UNLESS OTHERWISE SPECIFIED

1016000	1016
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES 125 TOLERANCES ARE :

FRACTIONS ± 1/32 DECIMALS ± .03 ± .010 ANGLES ± 1°

MATERIAL SEE PARTS LIST

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVAL	DATE
DRAWN JOHN W.	1/14
CHECKED BILL W.	1/14
ISSUED	

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

ELECTRICAL INTERCONNECT ASSEMBLY

SIZE	FSCM NO.	DWG. NO.	REV.
D	94861	1016012	J

SCALE 1/1 SHEET 3 OF 3

MALABAR™ INTERNATIONAL
A TRONAIR COMPANY

APPENDIX II

Electrical Schematic
1016001-1

DWG NO.	1016001-1	SH	1	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		NEW RELEASE	7/17/14	TT	BW
	A	SEE ECN 6582	6/1/18	BW	BW

Construction Notes:

1. All wire & cord is stranded copper conductor. Solid conductor shall not be used.
   a.) Individual hook up wire, unspecified:
   18 awg & smaller - type MTW (600V) / H05V-K (300/500V)
   16 awg & larger - type MTW (600V) / H07V-K (450/750V)

   b.) Individual hook up wire, specified:
   TFE - teflon hook up wire, NEMA HP-3 Type E (Mil-W-16878/4), 600V nom., 2 kV dielectric withstand voltage, NPC, -65 to 200°C

   c.) Multi-Conductor Power Cords over 50 V, specified:
   Utility Power Cord - type W (UL), 2000V, 90°C
   Generator Power Cord - type W (UL), 2000V, 90°C

   d.) Multi-Conductor Control & Actuator Cordage, less than 50V, unspecified:
   Type SJOOW or H05VVF or SOOW

2. Shielded instrument cable within enclosures (except flowmeter cable) is UL type TC, Belden 9341 or equal, (1) pair, 18 awg, 600V, 90°C

3. Minimum wire size, unless otherwise noted, shall be:
   18 AWG for individule conductors
   22 AWG for multiconductor jacketed cable

4. Wire sizes indicated are minimum. Larger sizes may be substituted.

5. Wire color for individual wires shall be:
   (Colored shrink-tube at wire termination may be used to designate wire color)
   BLACK - Ungrounded conductors at line voltage (greater than 150 volts).
   BLUE - Ungrounded DC control conductors. (DC+)
   WHITE w/ BLUE Stripe - Grounded DC control conductors (DC-)
   GREEN w/ YELLOW Stripe - Equipment ground conductor.

6. Each wire shall be clearly marked at each termination with commercial wire markers, with the wire number or cable number shown on this schematic diagram.

7. Grounding: All metal enclosures and panels exposed to electrical wiring shall be grounded. Use internal toothed star washer under ground lug on painted surfaces.

8. Grounding conductors shall be copper. Conduit and enclosures shall not be used as a grounding conductor. Grounding conductors shall be sized per NFPA-70(NEC), Art. 250-95.

△9 Wrap exposed terminals w/ glass tape: LT18.

△10 Verify P2 for proper flow direction (motor rotates clockwise when viewed from motor end). Move wire to 2 (DIR/RUN FWD) if pump rotation needs to be changed.

General Notes:

11. △11 = Located in Electrical Enclosure Assembly power panel.
12. See dwg 1016012 for Cord/Cable specifications.
13. All 18 awg stranded wire may be terminated using non-insulated crimp-on ferrules for strand containment, unless otherwise specified. Panduit F77-7-M or equal (0.28 in. lg).
14. To restart after an EMERGENCY STOP, push Power On/Off Button OFF and reset (twist-pull) E-Stop mushroom button. Then push Power On/Off Button ON.

NEXT ASSEMBLY	USED ON
	1016

APPLICATION

DO NOT SCALE DRAWING

ITEM NO.	QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES 125
TOLERANCES ARE :
FRACTIONS ± 1/32 DECIMALS .xx ± .03 .xxx ± .010 ANGLES ± 1°

MATERIAL

FINISH

CONTRACT NO.

	APPROVAL	DATE
DRAWN	MIKE M.	7/14
CHECKED	TEAGUE	7/14
ISSUED	BILL W.	7/14

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

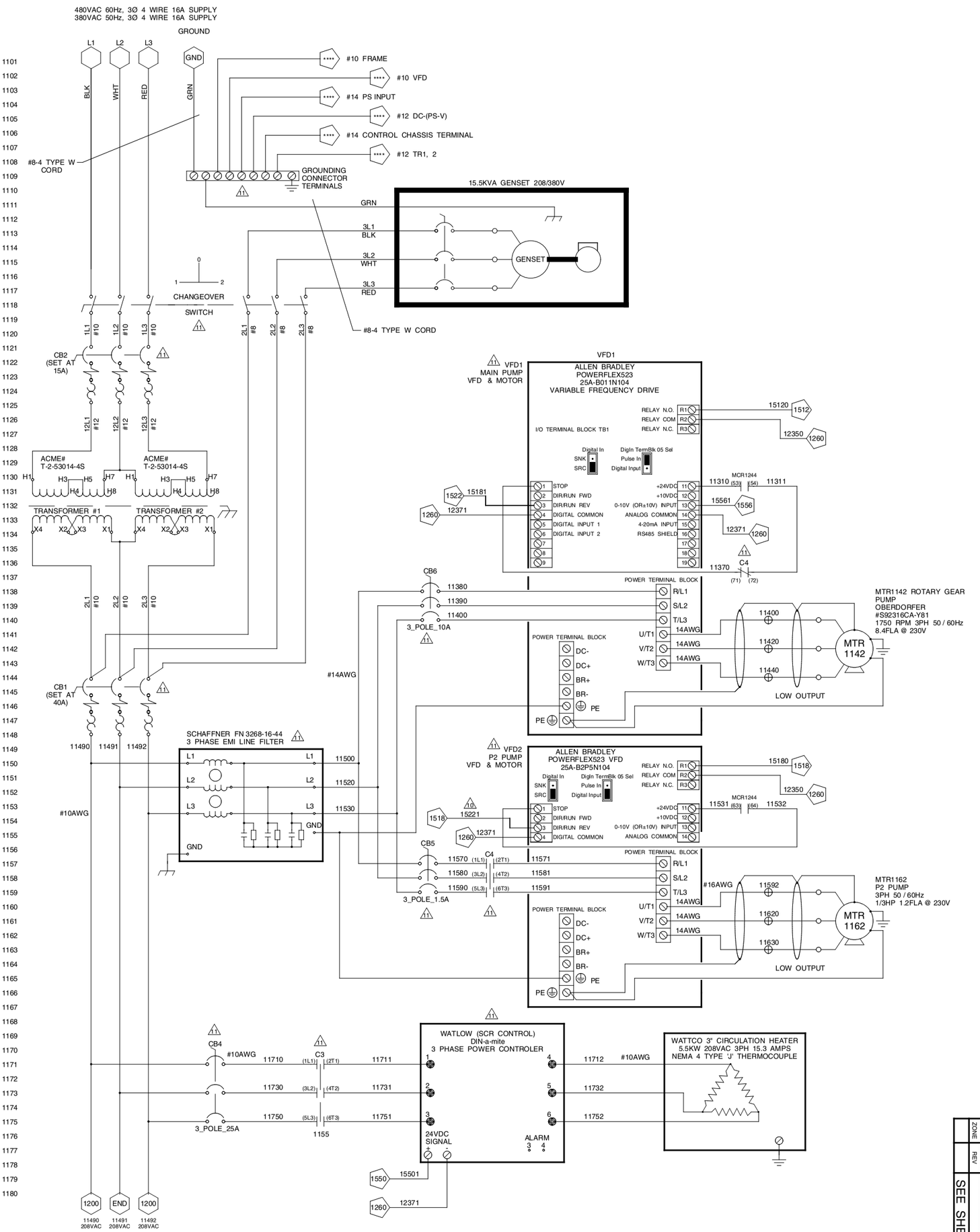
ELECTRICAL SCHEMATIC

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A

SCALE 1/1 SHEET 1 OF 12

NOTES : UNLESS OTHERWISE SPECIFIED

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A

SCALE 1/1 SHEET 2 OF 12

DWG NO.	SH	REV
1016001-1	2	A

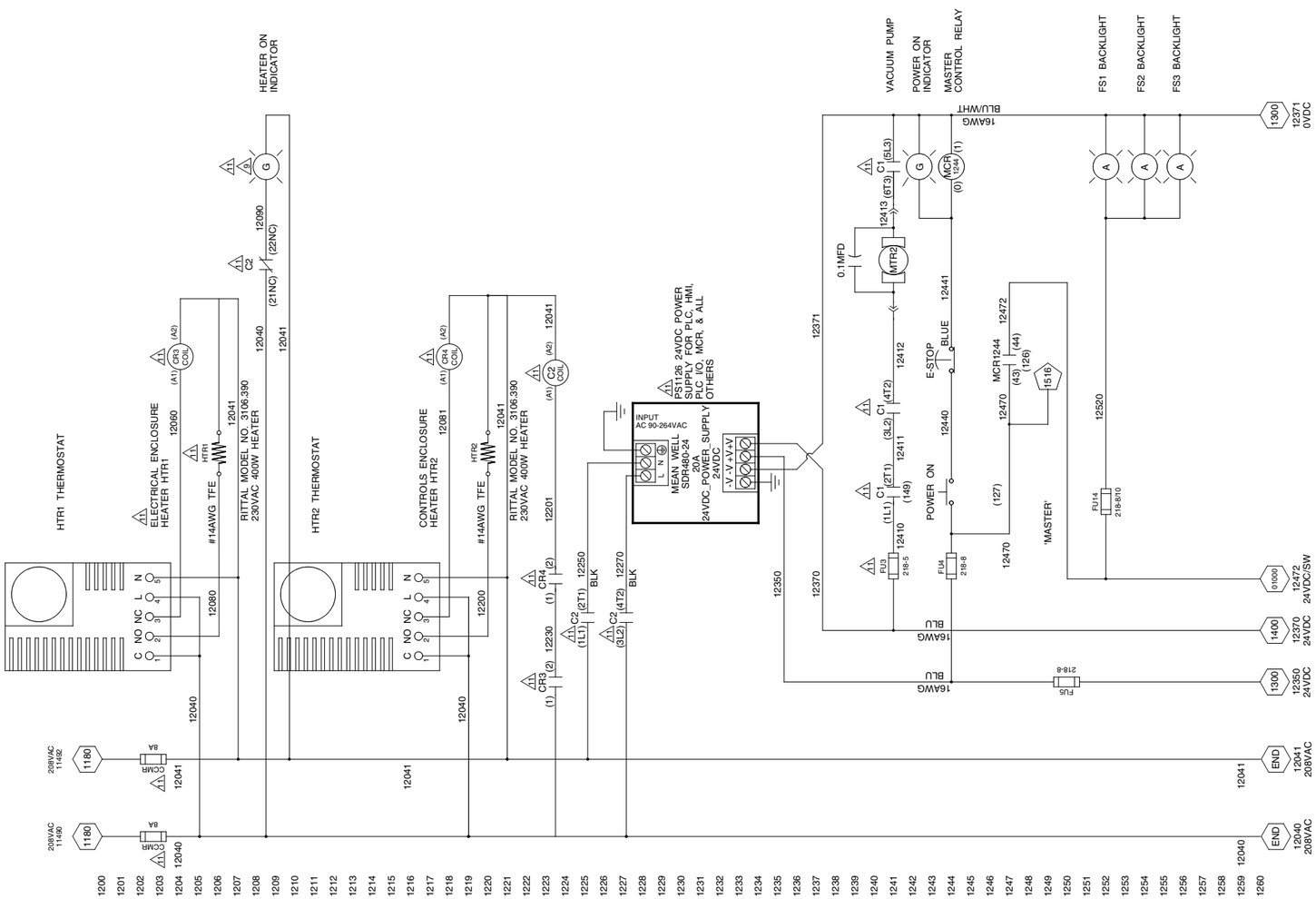
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
SEE SHEET 1					

DWG NO.	1016001-1	SH	3	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



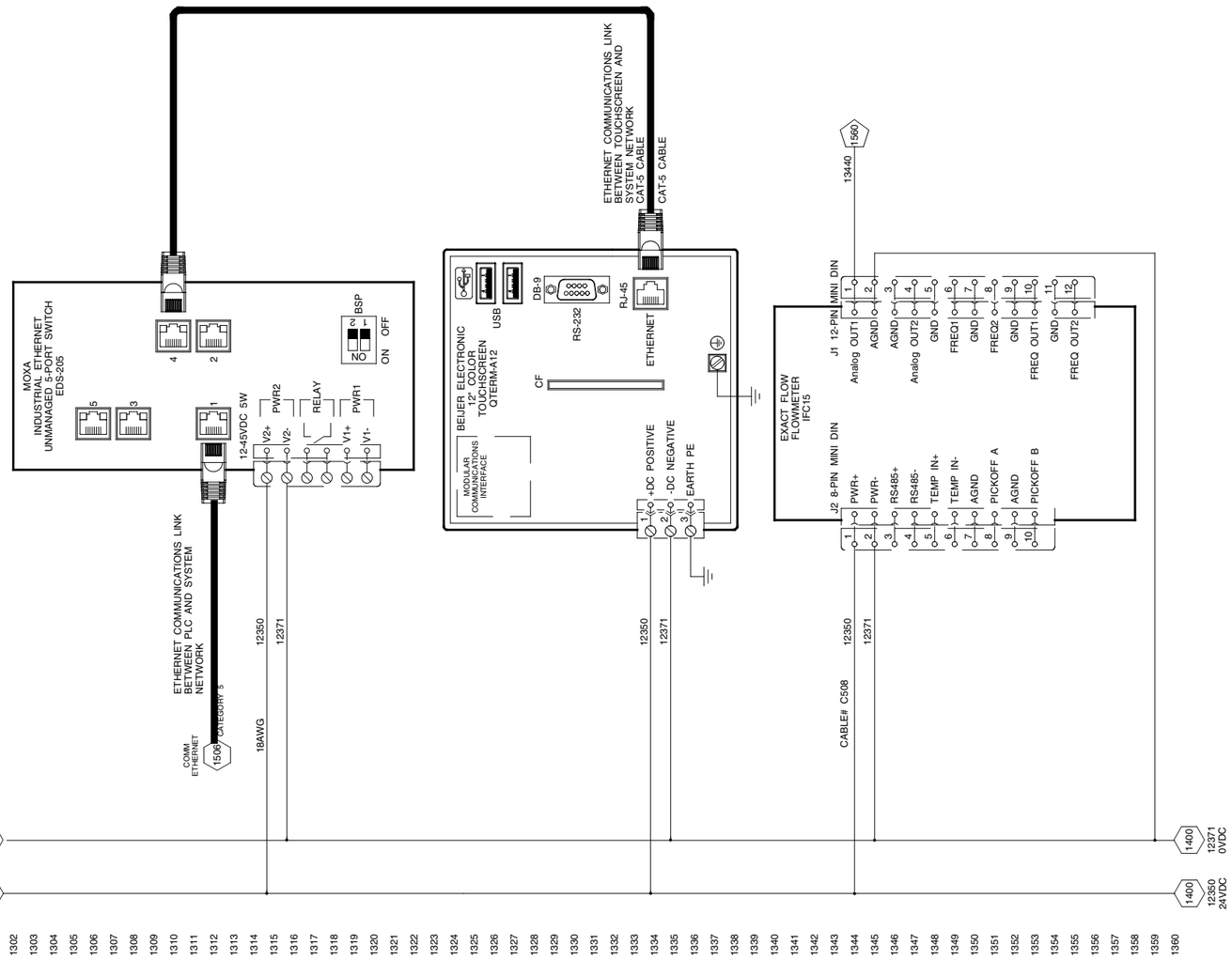
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 3 OF 12	

DWG NO.	1016001-1	SH	4	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



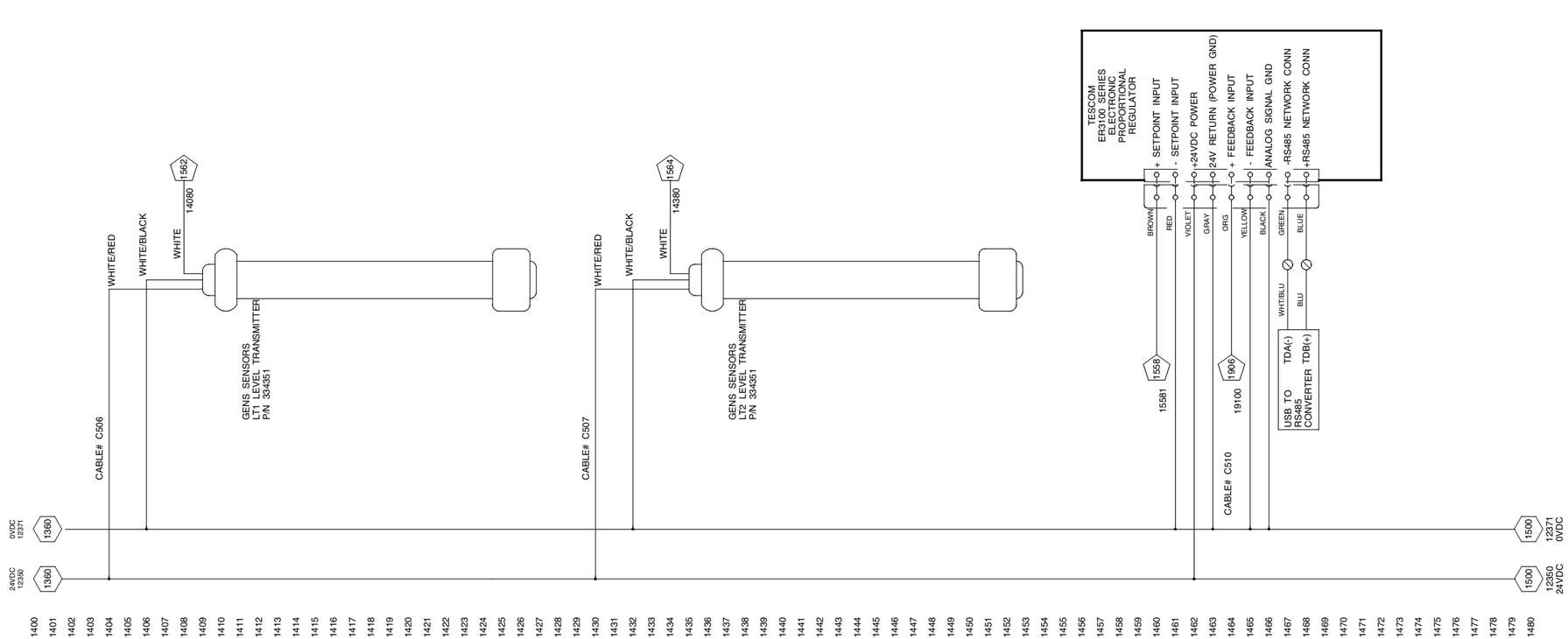
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 4 OF 12	

DWG NO.	1016001-1	SH	5	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



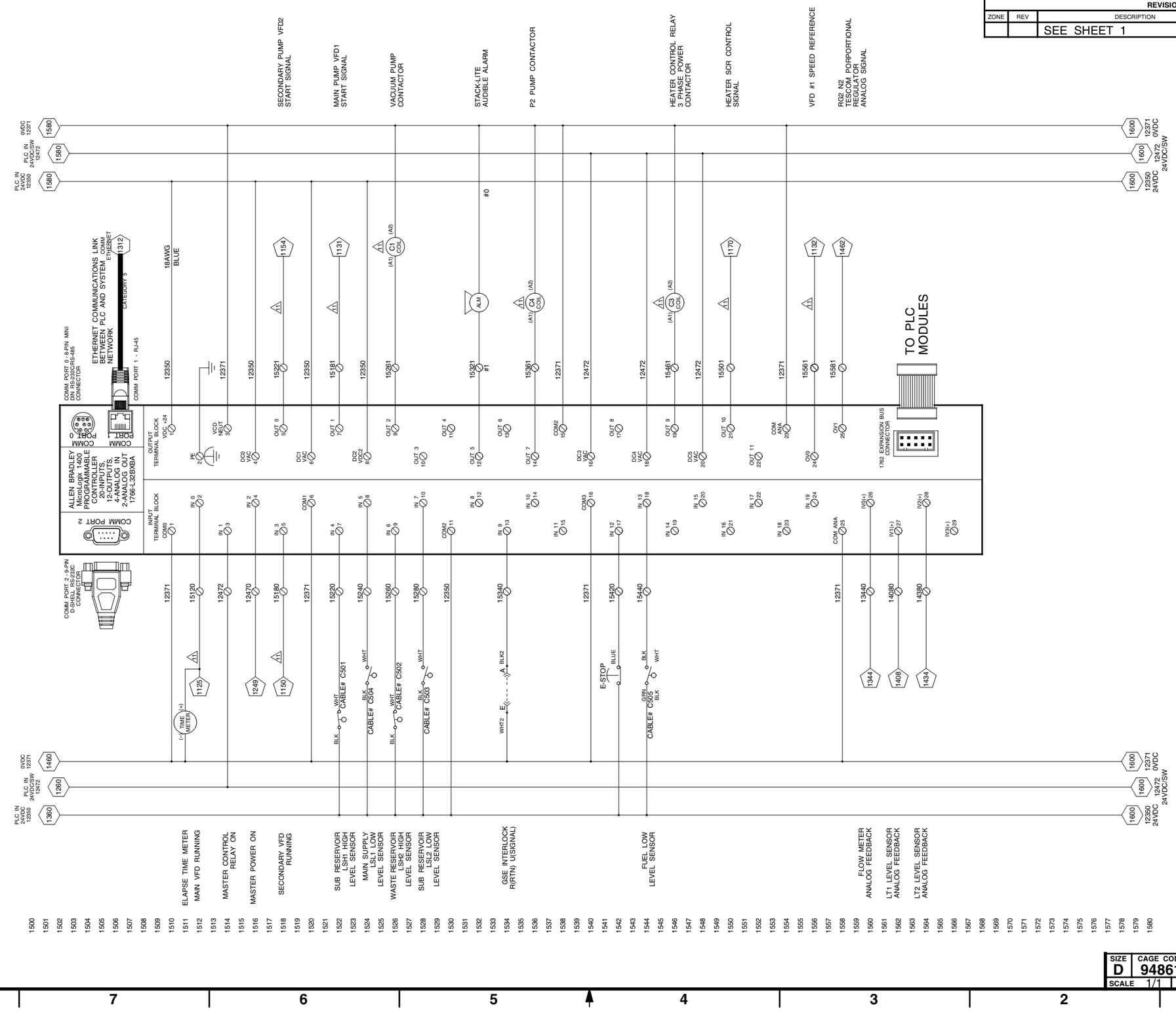
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
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SCALE 1/1		SHEET 5 OF 12	

DWG NO.	1016001-1	SH	6	REV	A

REVISIONS

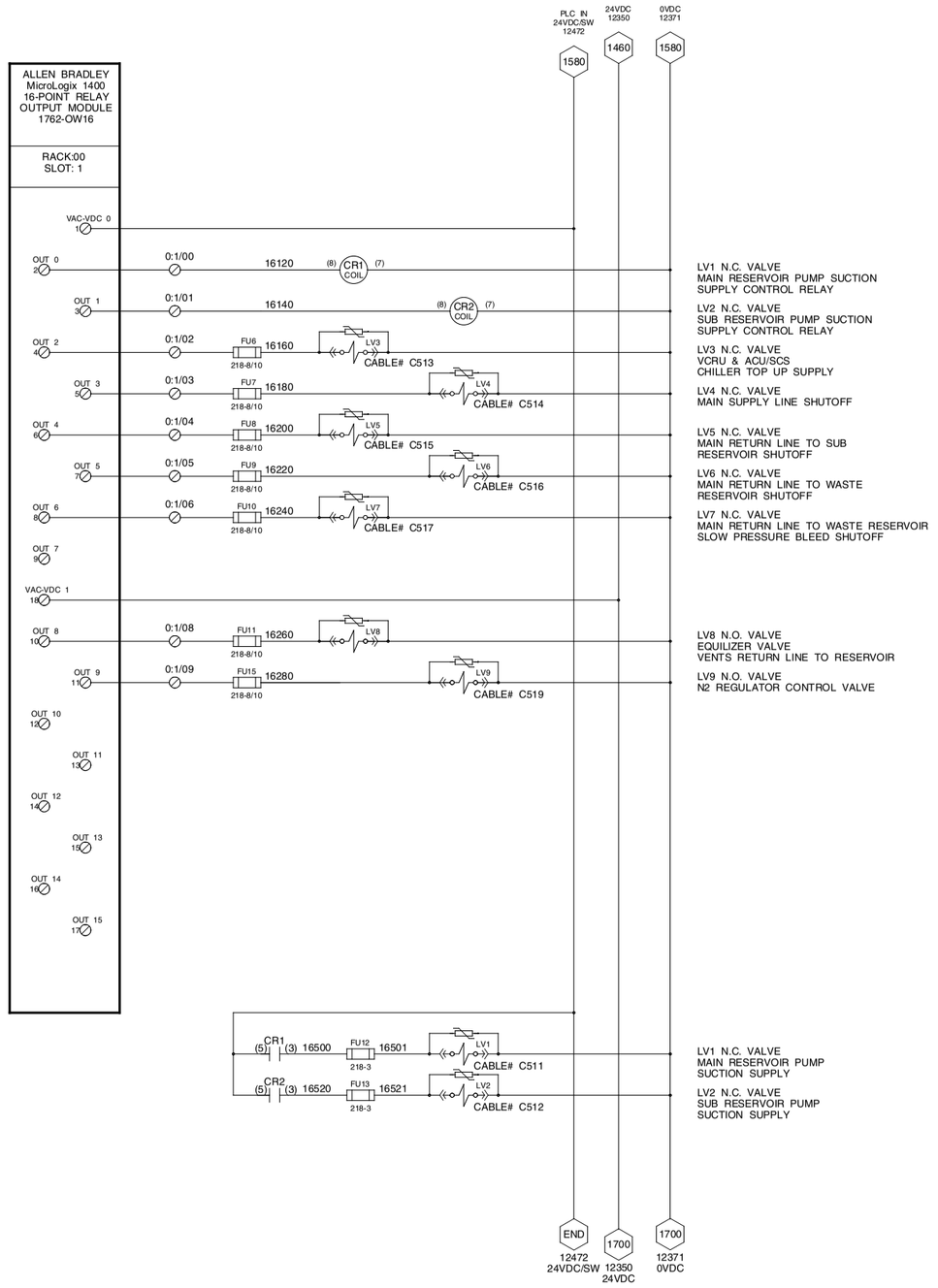
ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 6 OF 12	

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 7 OF 12	

DWG NO. 1016001-1	SH 7	REV A

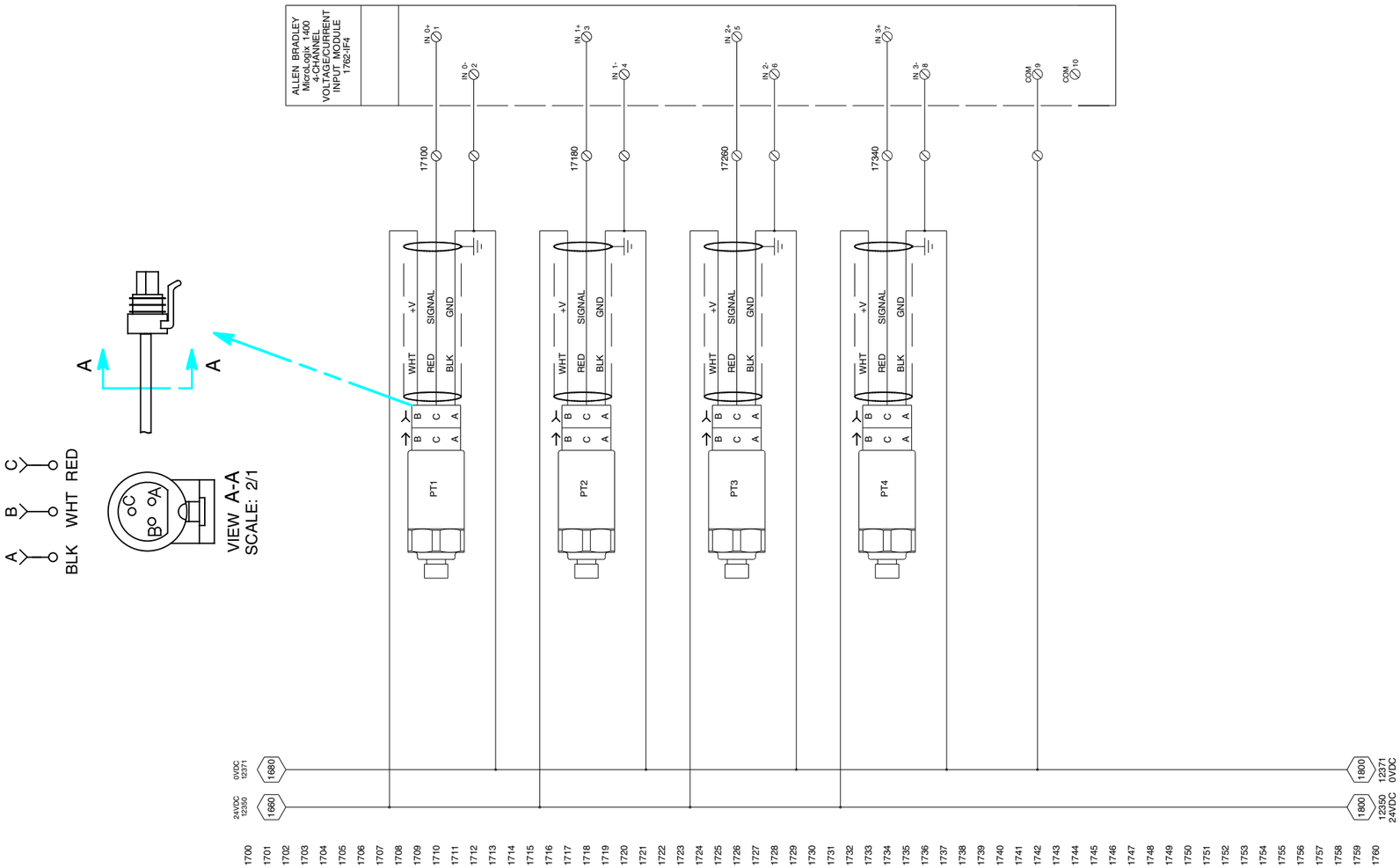
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

DWG NO.	1016001-1	SH	8	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



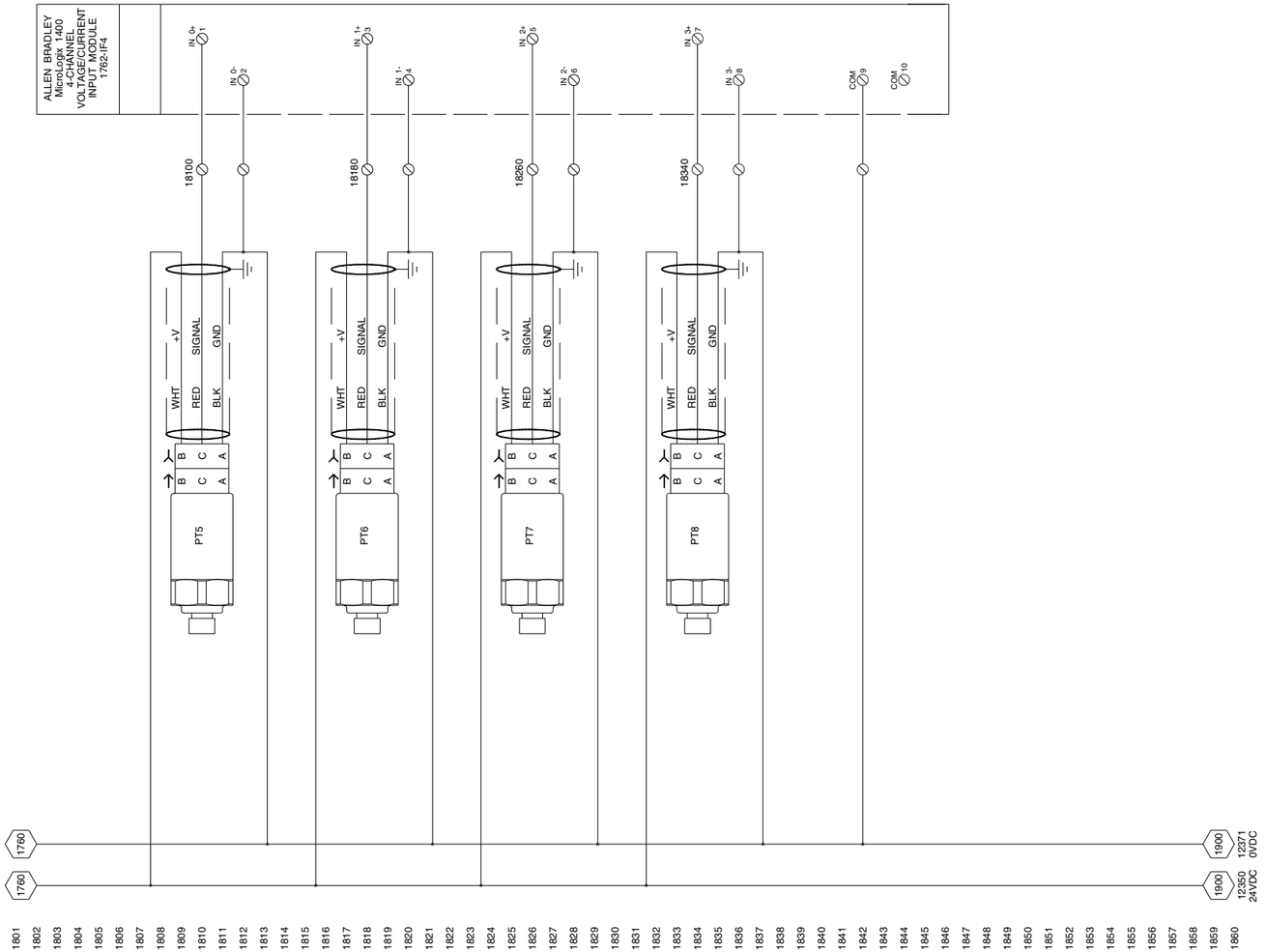
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
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SCALE 1/1		SHEET 8 OF 12	

DWG NO.	1016001-1	SH	9	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



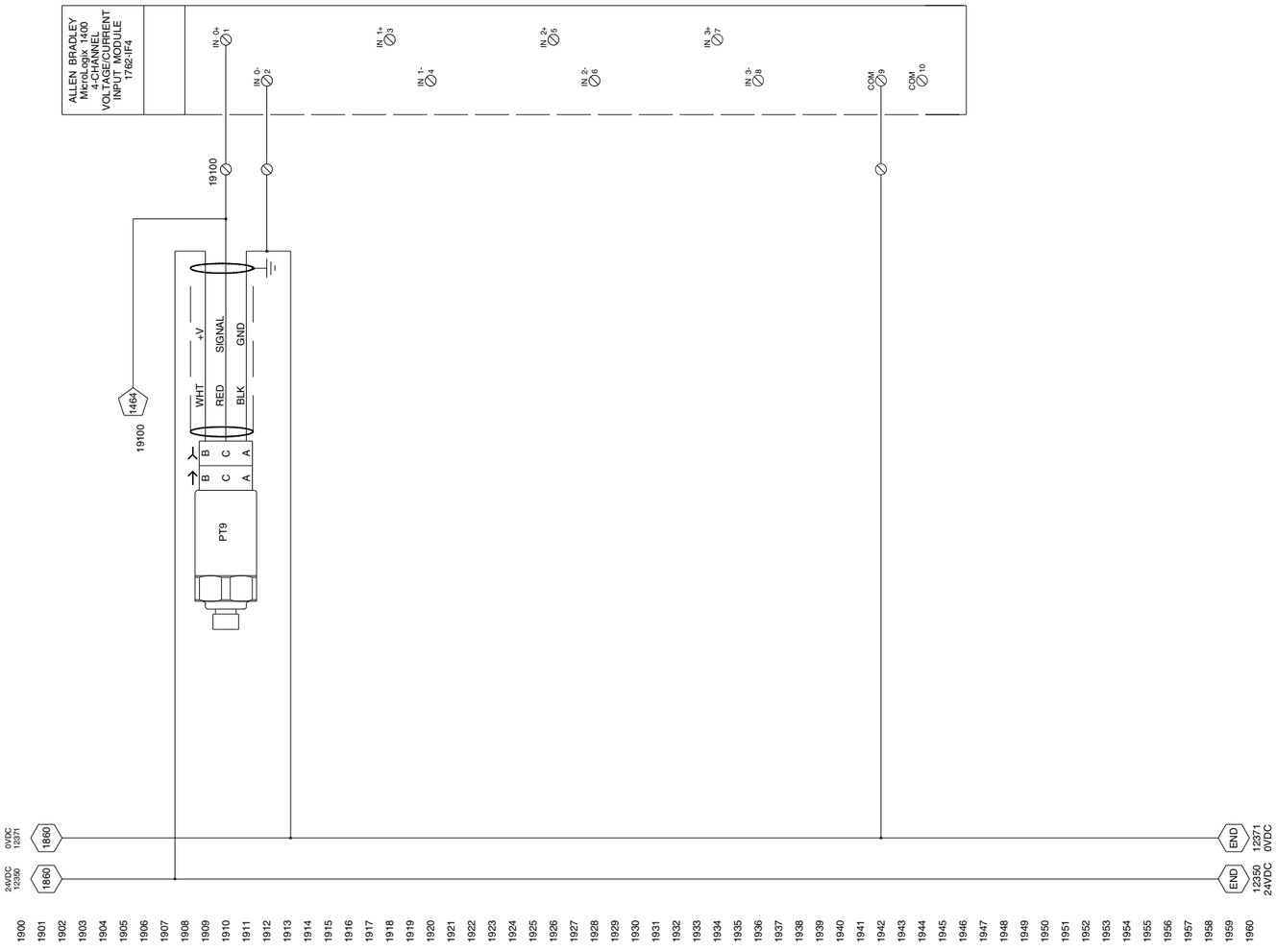
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
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SCALE 1/1		SHEET 9 OF 12	

DWG NO.	1016001-1	SH	10	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



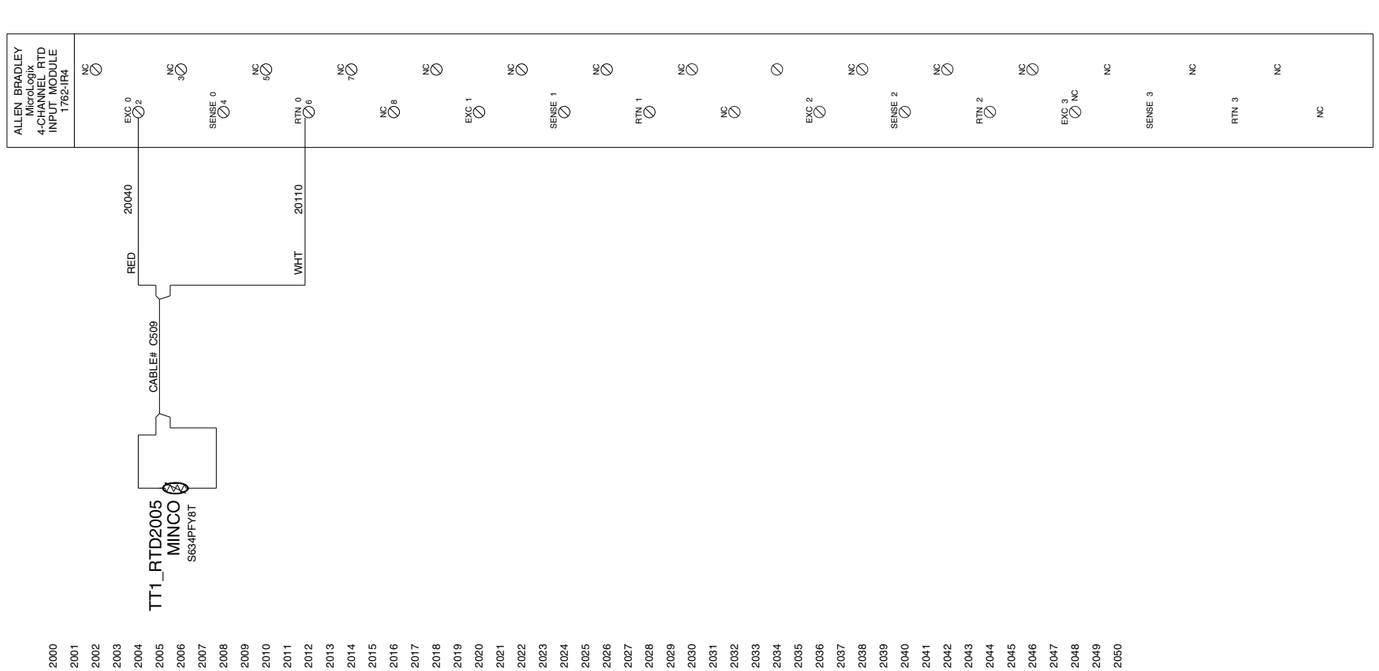
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 10 OF 12	

DWG NO.	1016001-1	SH	11	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES : UNLESS OTHERWISE SPECIFIED

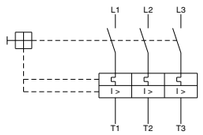
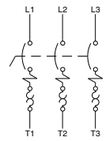
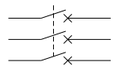
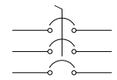
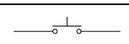
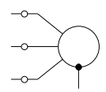
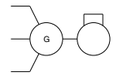
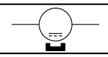
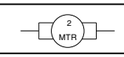
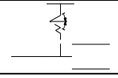
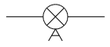
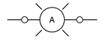
SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 11 OF 12	

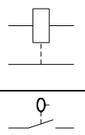
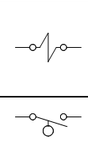
DWG NO.	1016001-1	SH	12	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

IEC CROSS REFERENCE LEGEND

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		RELAY OR CONTACTOR, NORMALLY OPEN CONTACT
		RELAY OR CONTACTOR, NORMALLY CLOSED CONTACT
		CAPACITOR
		RELAY OR CONTACTOR COIL
		CIRCUIT BREAKER THERMAL & MAGNETIC TRIP
		CIRCUIT BREAKER, 3 POLE
		PUSH BUTTON, NO - MAINTAINED
		RESISTOR, VARIABLE
		MOTOR, 3-PHASE INDUCTION
		GENERATOR, 3-PHASE
		MOTOR, DC PERMANENT MAGNET
		LINE FILTER / REACTOR / TRANSFORMER
		MUSHROOM PUSHBUTTON, TWIST-LATCH
		FUSE
		MANUAL SWITCH, SPDT, CENTER-OFF
		INDICATOR LAMP, SWITCH LAMP, PANEL LAMP, STACK LIGHT (LETTER INDICATES COLOR)
		CABLE MARKERS
		TERMINALS
		SHIELD + DRAIN WIRE

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		EARTH (GROUND)
		NOISELESS (CLEAN) EARTH (GROUND)
		PROTECTIVE EARTH (GROUND)
		EQUIPOTENTIAL BOND (FRAME GROUND)
		SOLENOID VALVE
		LEVEL SWITCH, CLOSE ON RISE
		LEVEL SWITCH, OPEN ON RISE
		RESISTANCE HEATER ELEMENT
		BUZZER, AUDIBLE ALARM
		VARISTOR
		PLUG / JACK

NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-1	A
SCALE 1/1		SHEET 12 OF 12	

DWG NO.	1016001-2	SH	1	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		NEW RELEASE	11/19/15	JW	BW
	A	SEE ECN 6582	6/1/18	BW	BW

Construction Notes:

1. All wire & cord is stranded copper conductor. Solid conductor shall not be used.
   a.) Individual hook up wire, unspecified:
   18 awg & smaller - type MTW (600V) / H05V-K (300/500V)
   16 awg & larger - type MTW (600V) / H07V-K (450/750V)

   b.) Individual hook up wire, specified:
   TFE - teflon hook up wire, NEMA HP-3 Type E (Mil-W-16878/4), 600V nom., 2 kV dielectric withstand voltage, NPC, -65 to 200°C

   c.) Multi-Conductor Power Cords over 50 V, specified:
   Utility Power Cord - type W (UL), 2000V, 90°C
   Generator Power Cord - type W (UL), 2000V, 90°C

   d.) Multi-Conductor Control & Actuator Cordage, less than 50V, unspecified:
   Type SJOOW or H05VVF or SOOW

2. Shielded instrument cable within enclosures (except flowmeter cable) is UL type TC, Belden 9341 or equal, (1) pair, 18 awg, 600V, 90°C

3. Minimum wire size, unless otherwise noted, shall be:
   18 AWG for individule conductors
   22 AWG for multiconductor jacketed cable

4. Wire sizes indicated are minimum. Larger sizes may be substituted.

5. Wire color for individual wires shall be:
   (Colored shrink-tube at wire termination may be used to designate wire color)
   BLACK - Ungrounded conductors at line voltage (greater than 150 volts).
   BLUE - Ungrounded DC control conductors. (DC+)
   WHITE w/ BLUE Stripe - Grounded DC control conductors (DC-)
   GREEN w/ YELLOW Stripe - Equipment ground conductor.

6. Each wire shall be clearly marked at each termination with commercial wire markers, with the wire number or cable number shown on this schematic diagram.

7. Grounding: All metal enclosures and panels exposed to electrical wiring shall be grounded. Use internal toothed star washer under ground lug on painted surfaces.

8. Grounding conductors shall be copper. Conduit and enclosures shall not be used as a grounding conductor. Grounding conductors shall be sized per NFPA-70(NEC), Art. 250-95.

△9 Wrap exposed terminals w/ glass tape: LT18.

△10 Verify P2 for proper flow direction (motor rotates clockwise when viewed from motor end). Move wire to 2 (DIR/RUN FWD) if pump rotation needs to be changed.

General Notes:

11. △11 = Located in Electrical Enclosure Assembly power panel.
12. See dwg 1016012 for Cord/Cable specifications.
13. All 18 awg stranded wire may be terminated using non-insulated crimp-on ferrules for strand containment, unless otherwise specified. Panduit F77-7-M or equal (0.28 in. lg).
14. To restart after an EMERGENCY STOP, push Power On/Off Button OFF and reset (twist-pull) E-Stop mushroom button. Then push Power On/Off Button ON.

NEXT ASSEMBLY	USED ON
	1016
APPLICATION	

ITEM NO.	QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: 125
FRACTIONS ± 1/32 DECIMALS .xx ± .03 .xxx ± .010 ANGLES ± 1°

MATERIAL _____

FINISH _____

DO NOT SCALE DRAWING

CONTRACT NO.

	APPROVAL	DATE
DRAWN	JOHN W.	11/15
CHECKED	BILL W.	11/15
ISSUED		

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

ELECTRICAL SCHEMATIC

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A

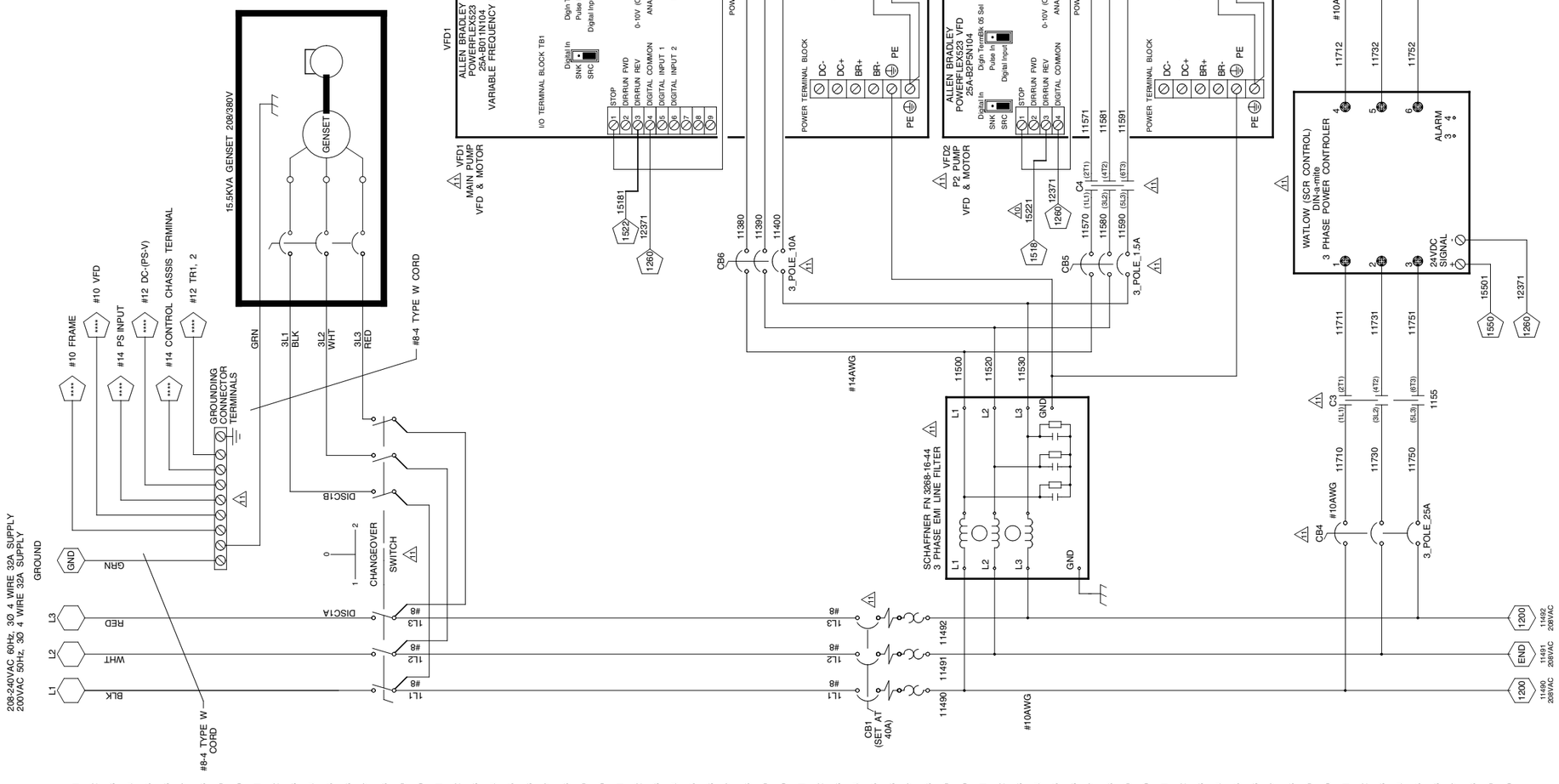
SCALE 1/1 SHEET 1 OF 12

NOTES: UNLESS OTHERWISE SPECIFIED

DWG NO.	1016001-2	SH 2	REV A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



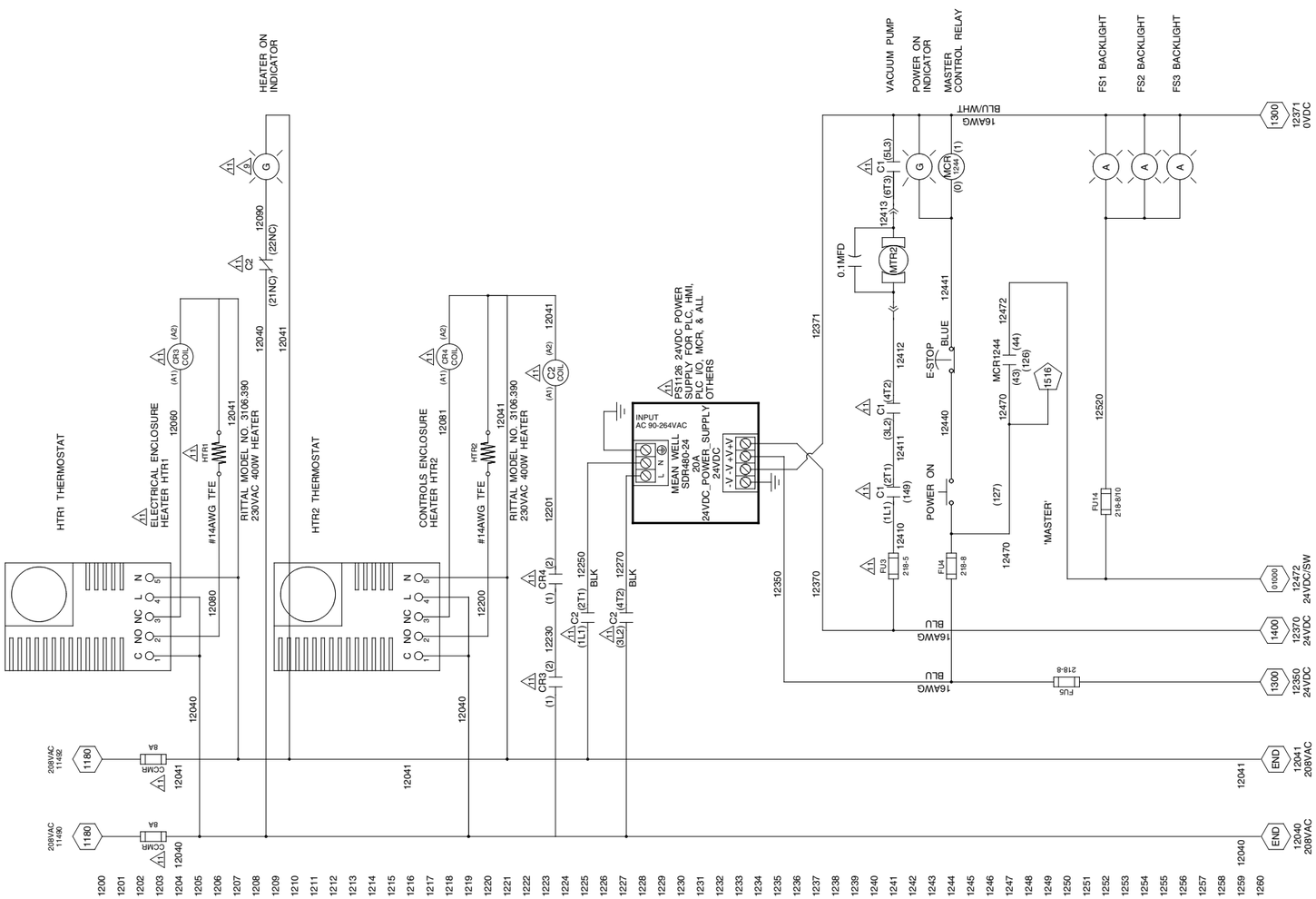
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 2 OF 12	

DWG NO.	1016001-2	SH	3	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



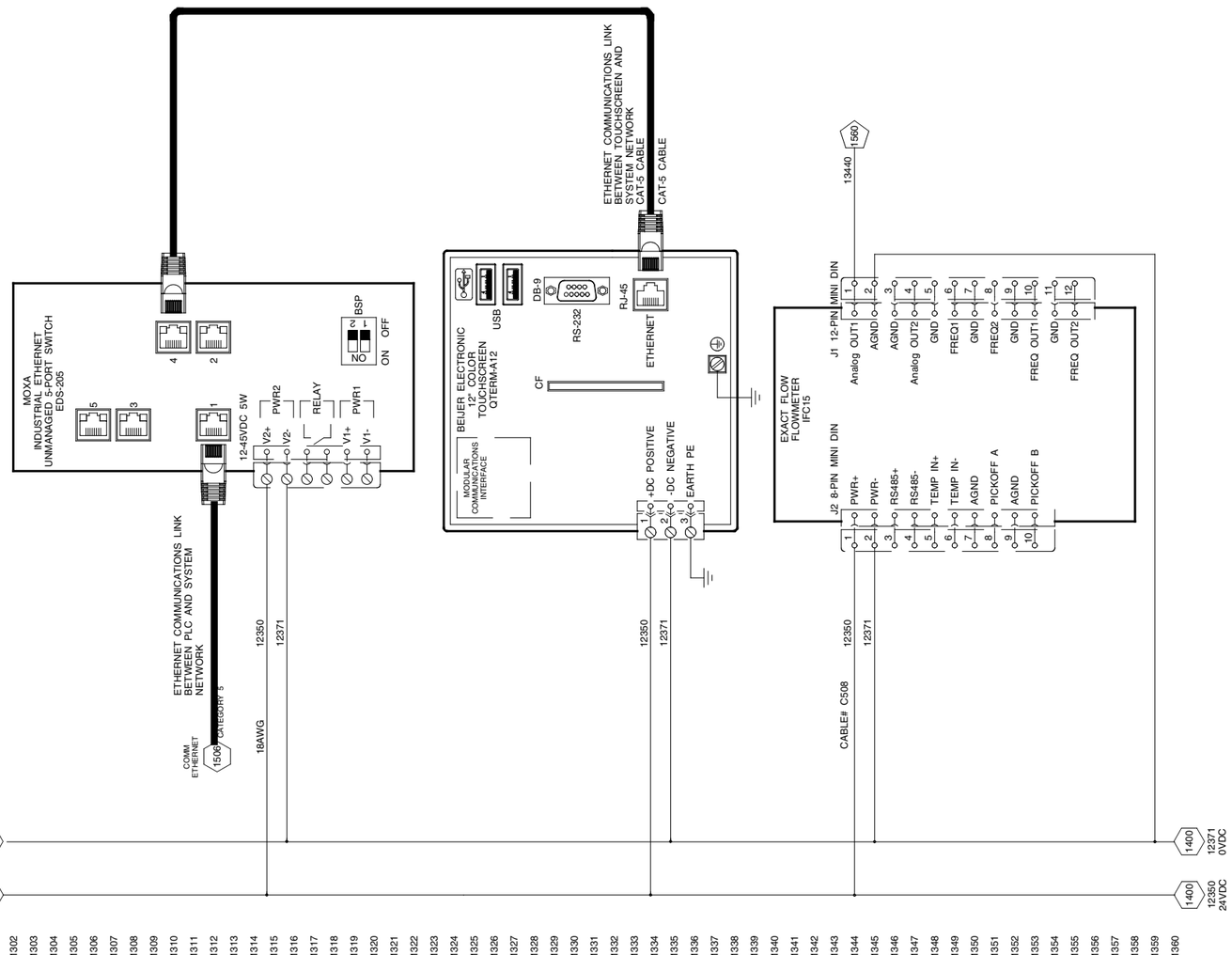
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 3 OF 12	

DWG NO.	1016001-2	SH 4	REV A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



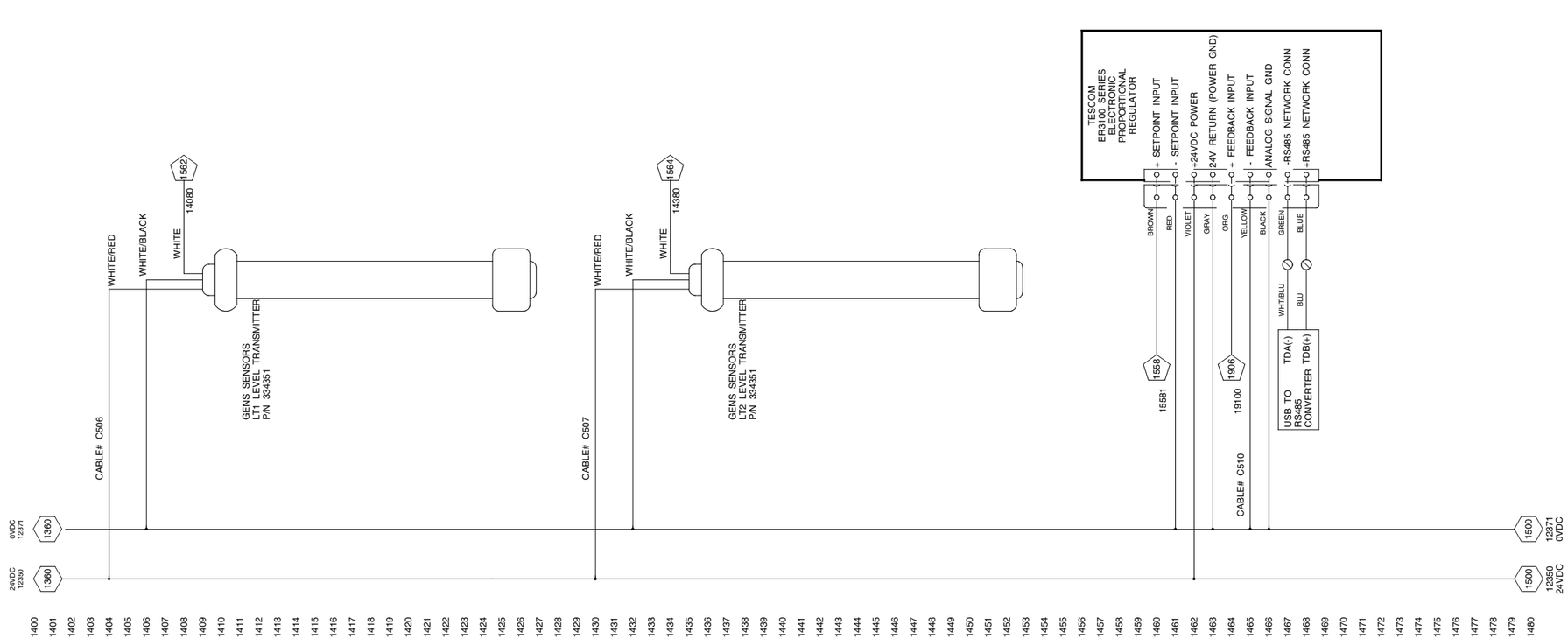
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 4 OF 12	

DWG NO.	1016001-2	SH	5	REV	A

REVISIONS

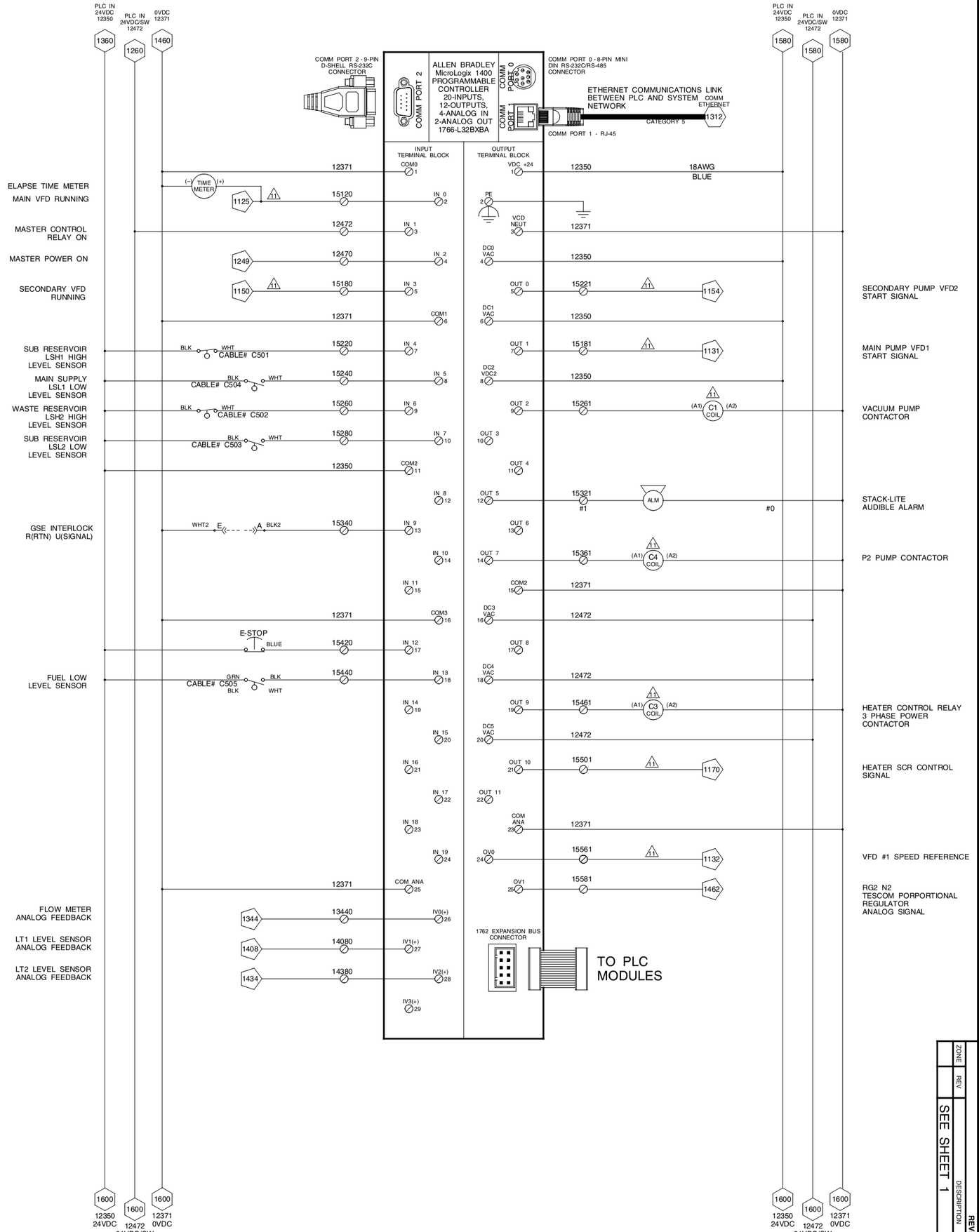
ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 5 OF 12	

NOTES: UNLESS OTHERWISE SPECIFIED



ZONE	REV.	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

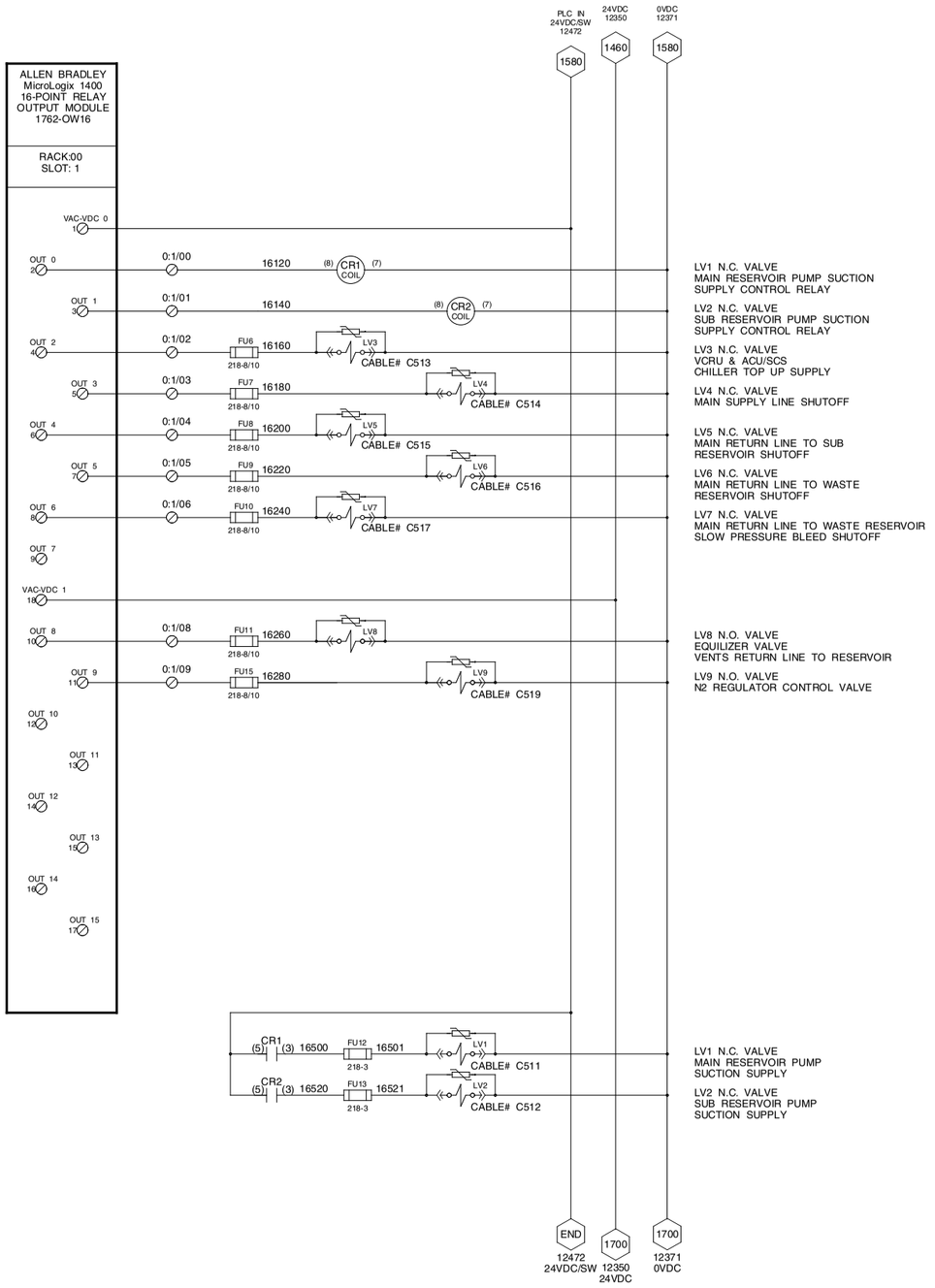
REVISIONS

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A

SCALE 1/1 SHEET 6 OF 12

DWG NO. 1016001-2 SH 6 REV A

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 7 OF 12	

DWG NO.	1016001-2	SH 7	REV A

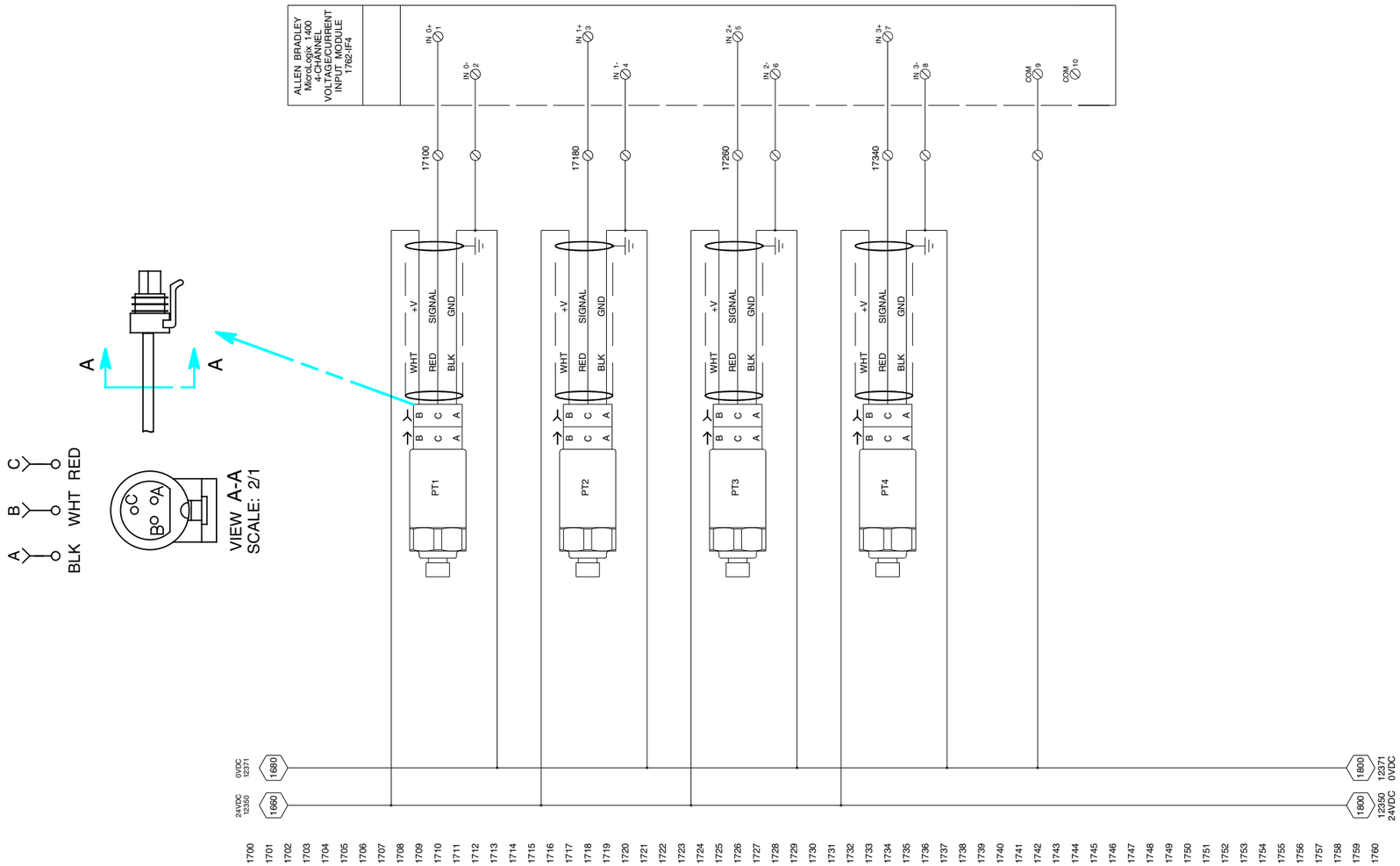
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

DWG NO.	1016001-2	SH	8	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



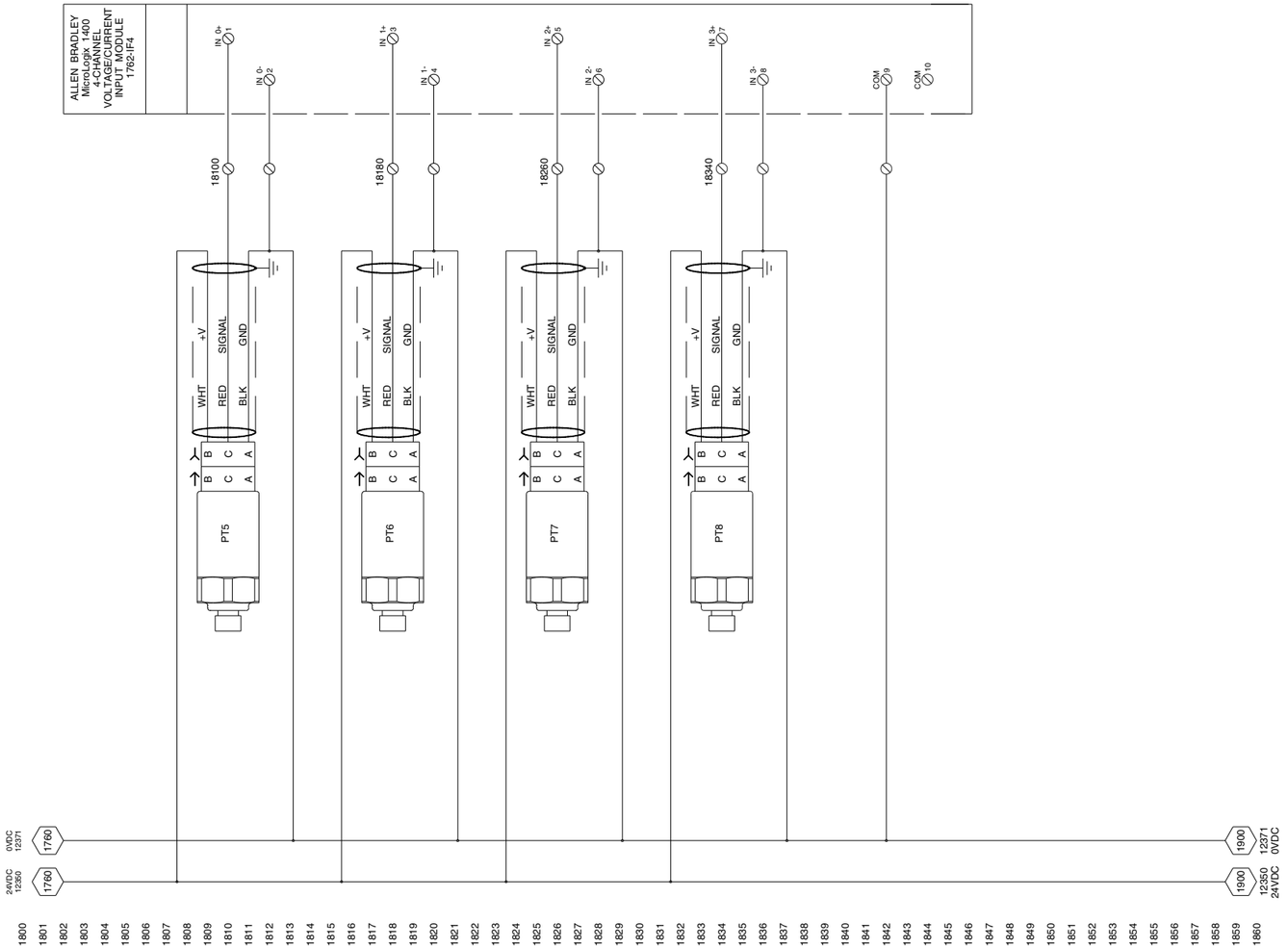
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 8 OF 12	

DWG NO.	1016001-2	SH	9	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



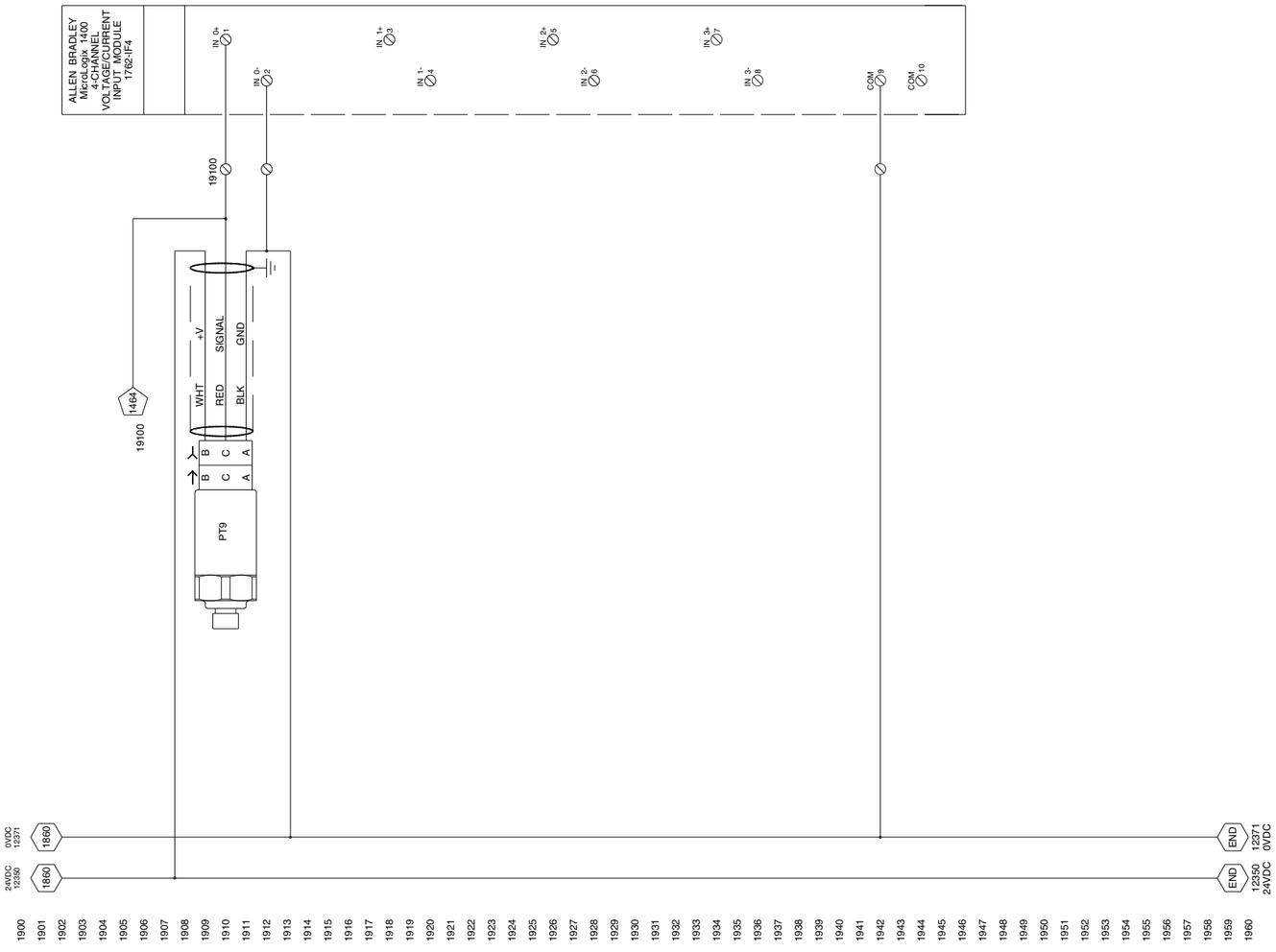
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 9 OF 12	

DWG NO.	1016001-2	SH	10	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



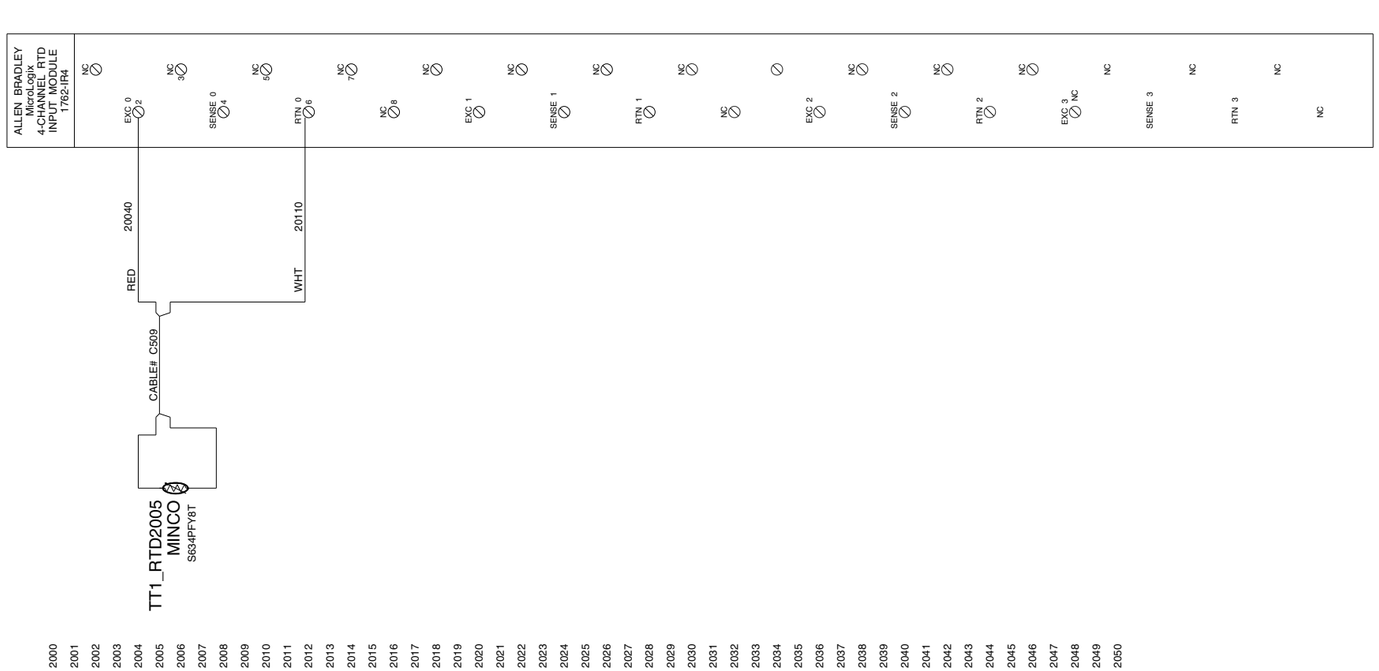
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 10 OF 12	

DWG NO.	SH	REV
1016001-2	11	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES : UNLESS OTHERWISE SPECIFIED

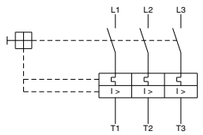
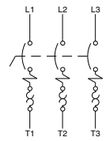
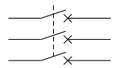
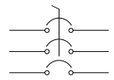
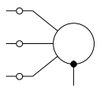
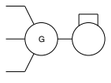
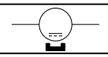
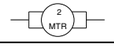
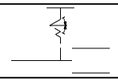
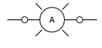
SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 11 OF 12	

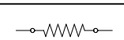
DWG NO.	1016001-2	SH	12	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

IEC CROSS REFERENCE LEGEND

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		RELAY OR CONTACTOR, NORMALLY OPEN CONTACT
		RELAY OR CONTACTOR, NORMALLY CLOSED CONTACT
		CAPACITOR
		RELAY OR CONTACTOR COIL
		CIRCUIT BREAKER THERMAL & MAGNETIC TRIP
		CIRCUIT BREAKER, 3 POLE
		PUSH BUTTON, NO - MAINTAINED
		RESISTOR, VARIABLE
		MOTOR, 3-PHASE INDUCTION
		GENERATOR, 3-PHASE
		MOTOR, DC PERMANENT MAGNET
		LINE FILTER / REACTOR / TRANSFORMER
		MUSHROOM PUSHBUTTON, TWIST-LATCH
		FUSE
		MANUAL SWITCH, SPDT, CENTER-OFF
		INDICATOR LAMP, SWITCH LAMP, PANEL LAMP, STACK LIGHT (LETTER INDICATES COLOR)
		CABLE MARKERS
		TERMINALS
		SHIELD + DRAIN WIRE

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
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		NOISELESS (CLEAN) EARTH (GROUND)
		PROTECTIVE EARTH (GROUND)
		EQUIPOTENTIAL BOND (FRAME GROUND)
		SOLENOID VALVE
		LEVEL SWITCH, CLOSE ON RISE
		LEVEL SWITCH, OPEN ON RISE
		RESISTANCE HEATER ELEMENT
		BUZZER, AUDIBLE ALARM
		VARISTOR
		PLUG / JACK

NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-2	A
SCALE 1/1		SHEET 12 OF 12	

DWG NO.	1016001-3	SH	1	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		NEW RELEASE	11/19/15	JW	BW
	A	SEE ECN 6582	6/1/18	BW	BW

Construction Notes:

1. All wire & cord is stranded copper conductor. Solid conductor shall not be used.
   a.) Individual hook up wire, unspecified:
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   16 awg & larger - type MTW (600V) / H07V-K (450/750V)

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   Generator Power Cord - type W (UL), 2000V, 90°C

   d.) Multi-Conductor Control & Actuator Cordage, less than 50V, unspecified:
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   22 AWG for multiconductor jacketed cable

4. Wire sizes indicated are minimum. Larger sizes may be substituted.

5. Wire color for individual wires shall be:
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   BLACK - Ungrounded conductors at line voltage (greater than 150 volts).
   BLUE - Ungrounded DC control conductors. (DC+)
   WHITE w/ BLUE Stripe - Grounded DC control conductors (DC-)
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△9 Wrap exposed terminals w/ glass tape: LT18.

△10 Verify P2 for proper flow direction (motor rotates clockwise when viewed from motor end). Move wire to 2 (DIR/RUN FWD) if pump rotation needs to be changed.

General Notes:

11. △11 = Located in Electrical Enclosure Assembly power panel.
12. See dwg 1016012 for Cord/Cable specifications.
13. All 18 awg stranded wire may be terminated using non-insulated crimp-on ferrules for strand containment, unless otherwise specified. Panduit F77-7-M or equal (0.28 in. lg).
14. To restart after an EMERGENCY STOP, push Power On/Off Button OFF and reset (twist-pull) E-Stop mushroom button. Then push Power On/Off Button ON.

NEXT ASSEMBLY	USED ON
	1016
APPLICATION	

ITEM NO.	QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: 125
FRACTIONS ± 1/32 DECIMALS .xx ± .03 .xxx ± .010 ANGLES ± 1°

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

	APPROVAL	DATE
DRAWN	JOHN W.	11/15
CHECKED	BILL W.	11/15
ISSUED		

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

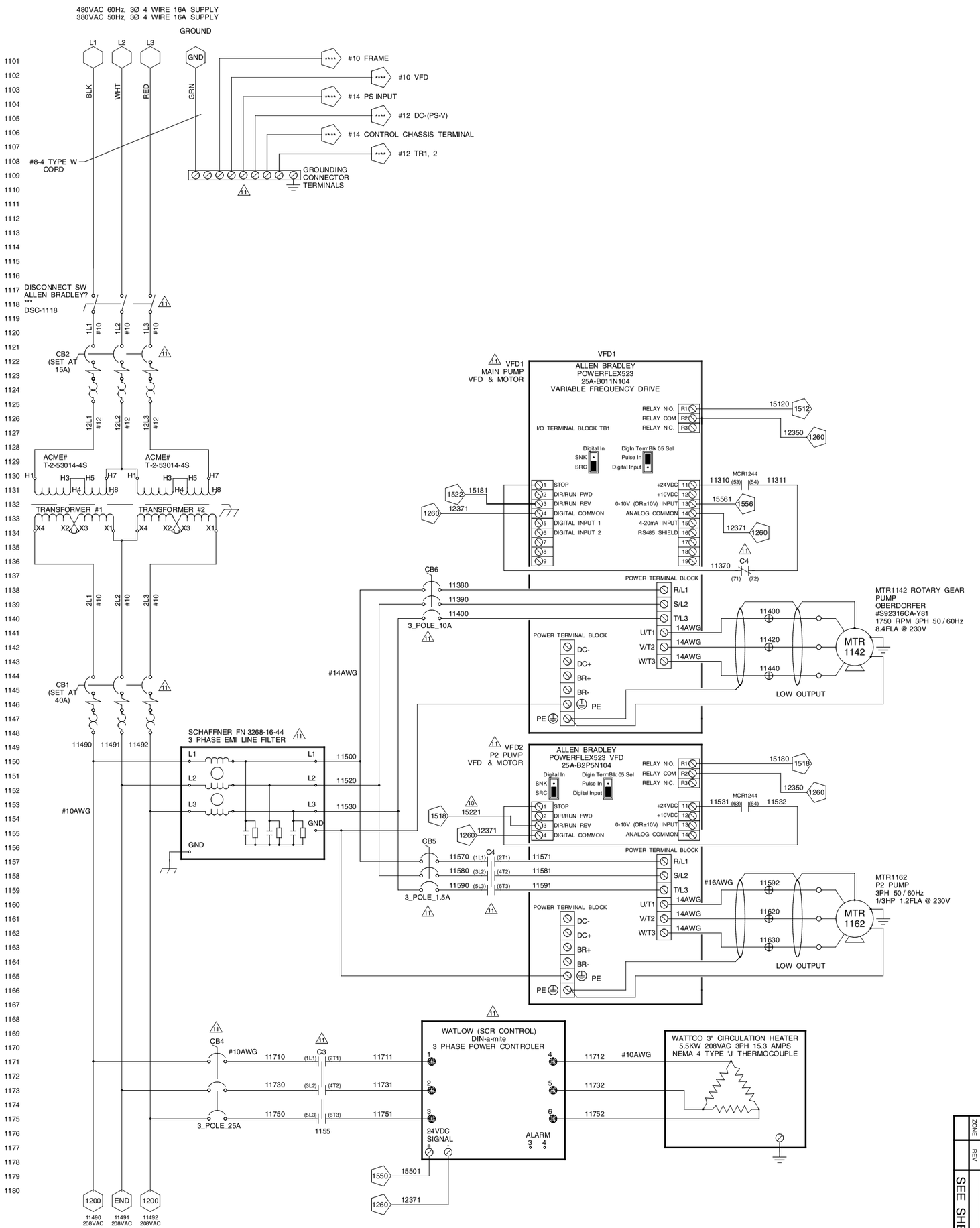
ELECTRICAL SCHEMATIC

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A

SCALE 1/1 SHEET 1 OF 12

NOTES: UNLESS OTHERWISE SPECIFIED

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 2 OF 12	

DWG NO.	1016001-3	SH	2	REV	A

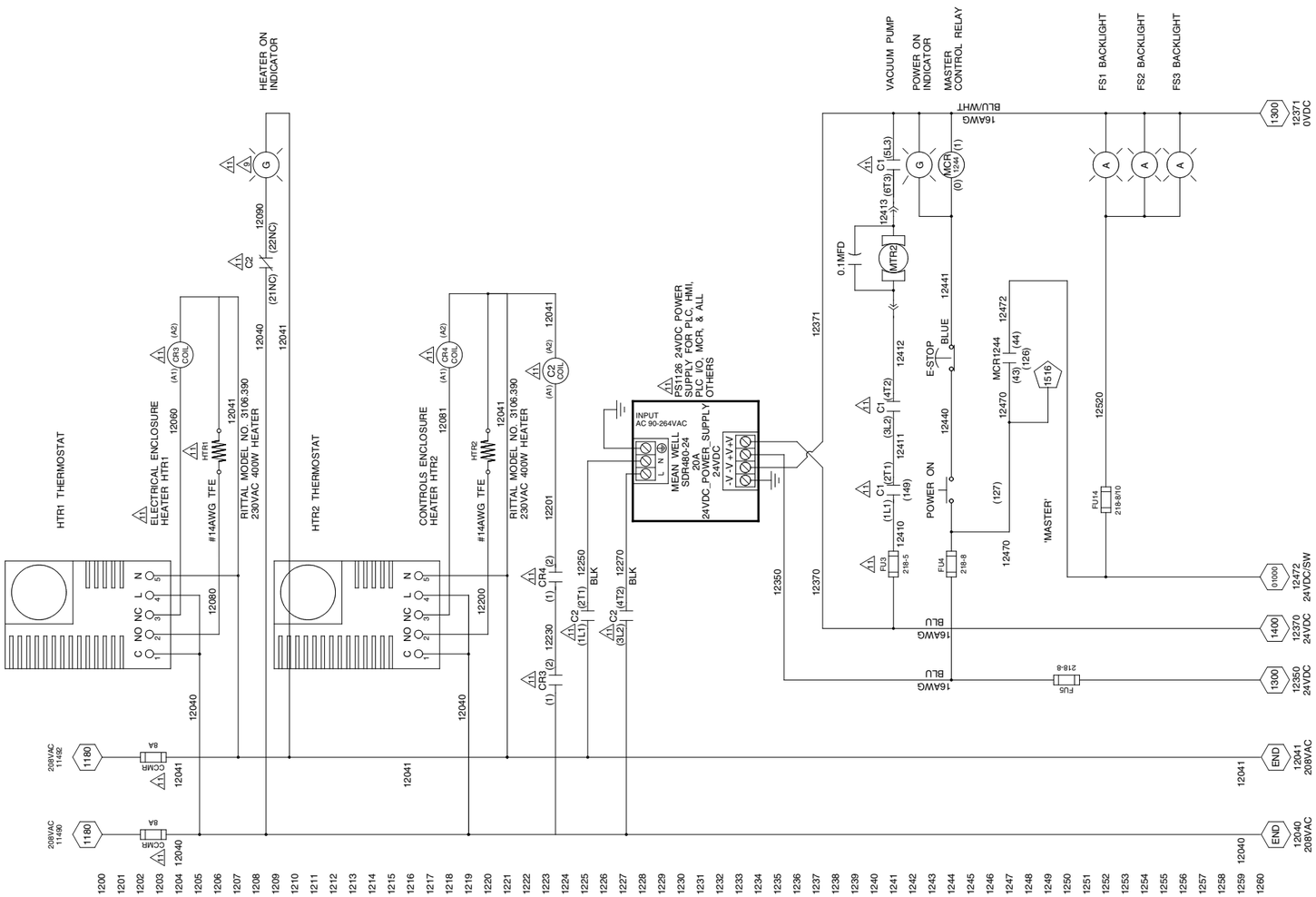
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
SEE SHEET 1					

DWG NO.	1016001-3	SH	3	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



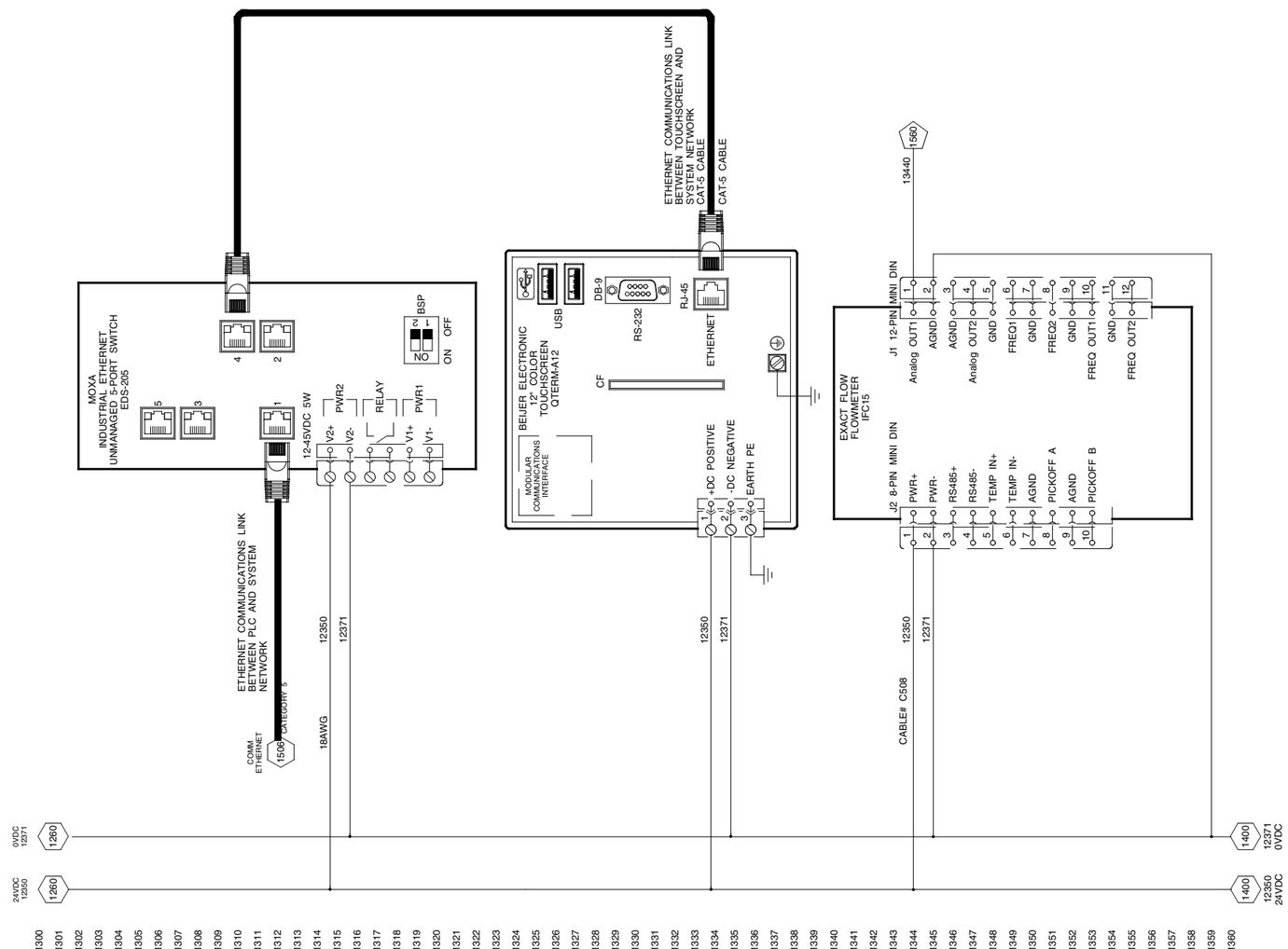
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 3 OF 12	

DWG NO.	1016001-3	SH 4	REV A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



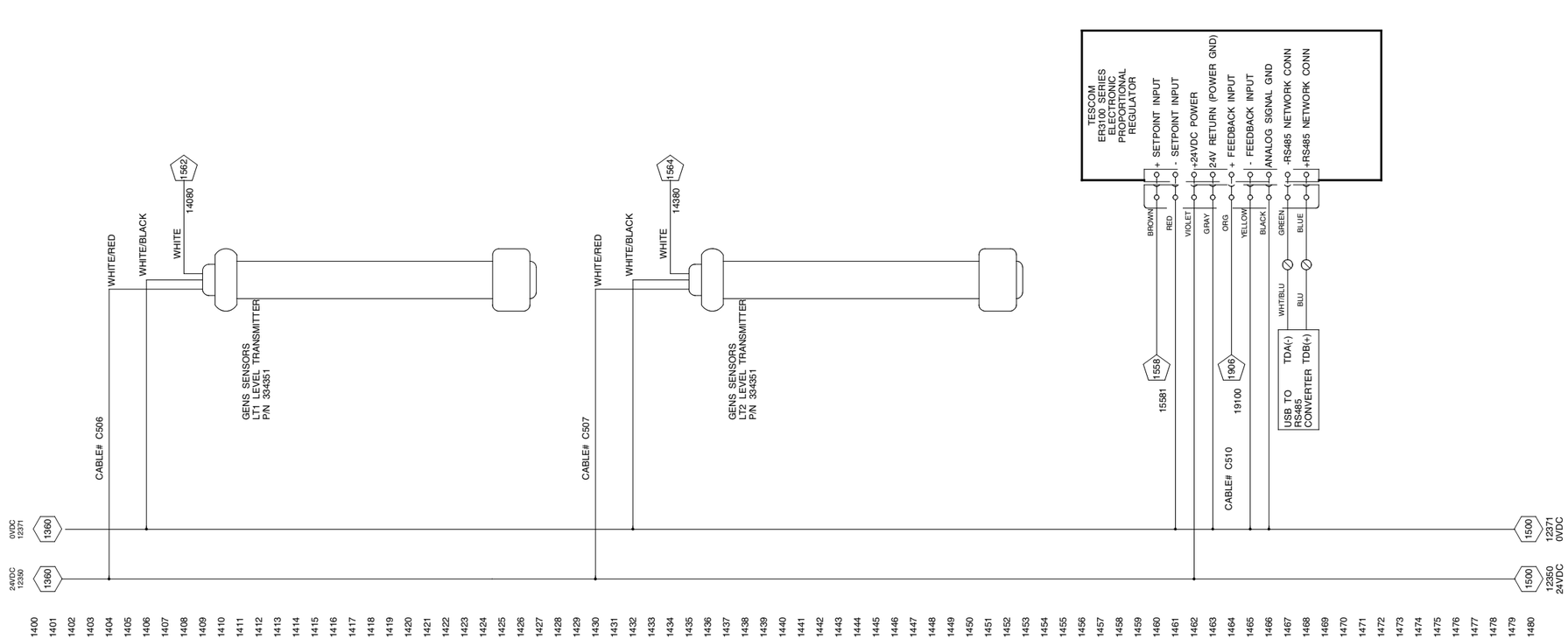
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 4 OF 12	

DWG NO.	1016001-3	SH	5	REV	A

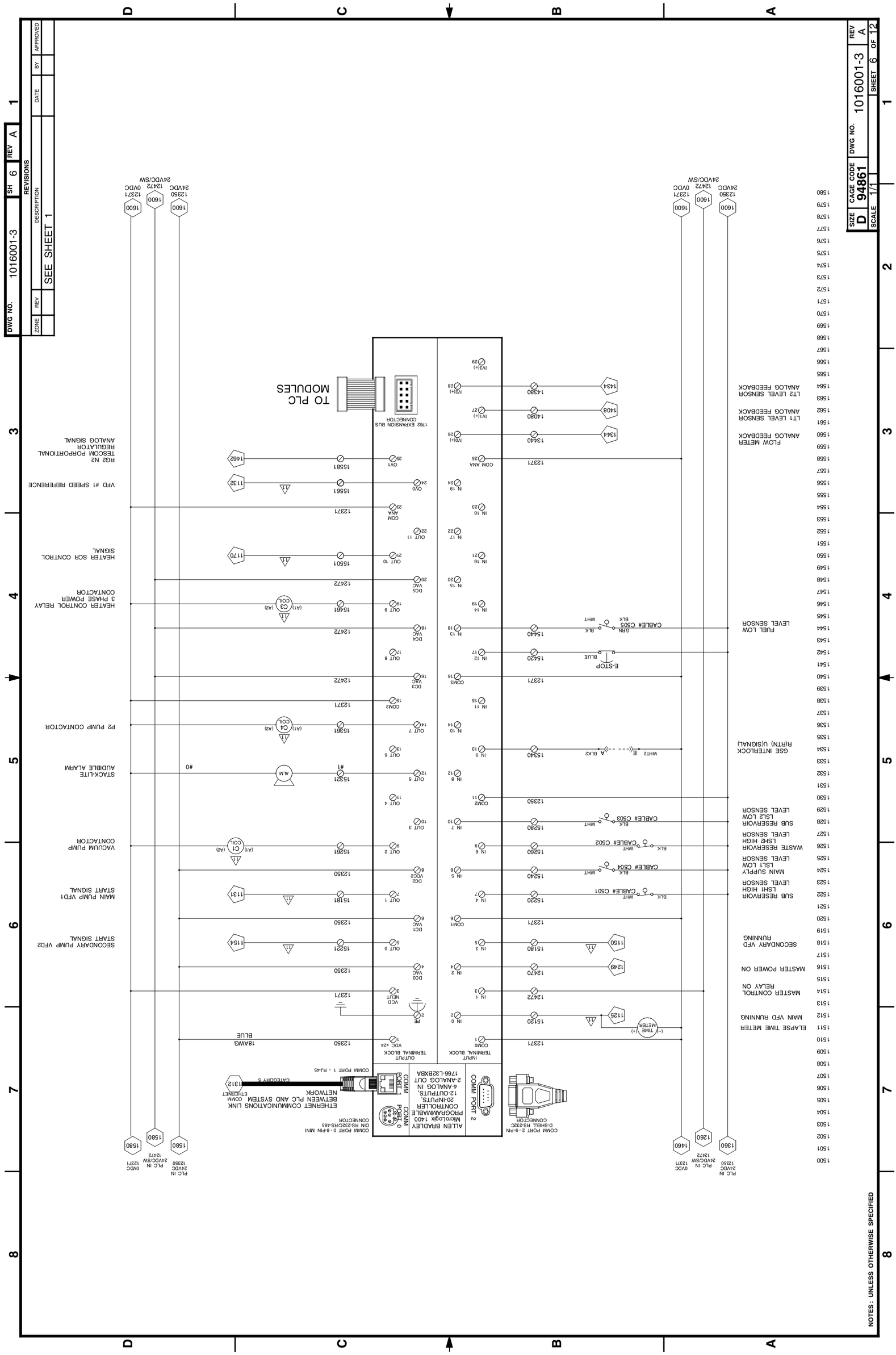
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

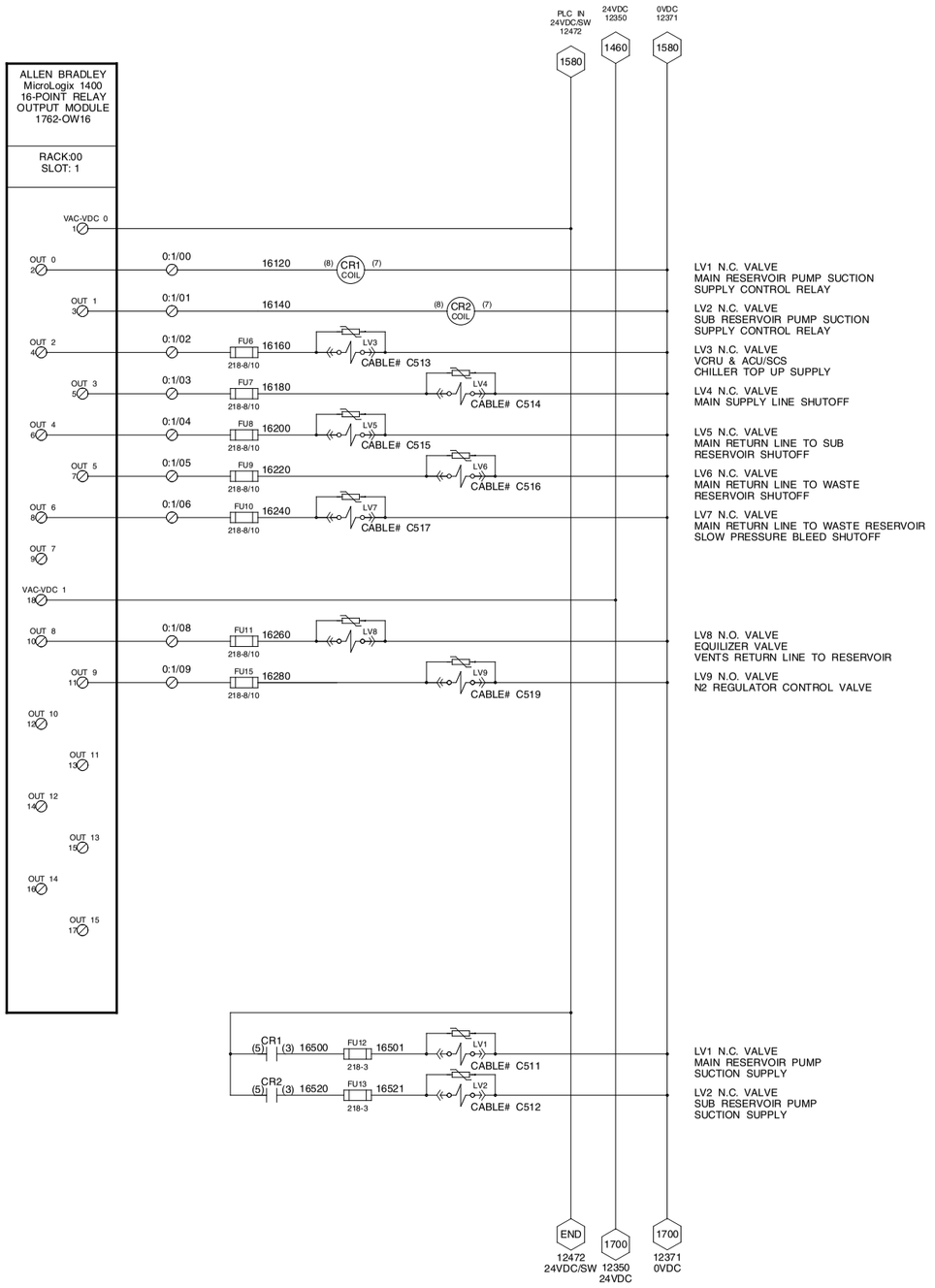


NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 5 OF 12	


DWG NO. 1016001-3 SH 6 REV A
REVISIONS
ZONE REV DESCRIPTION DATE BY APPROVED
SEE SHEET 1
SIZE D CAGE CODE 94861 DWG NO. 1016001-3 REV A
SCALE 1/1 SHEET 6 OF 12
NOTES: UNLESS OTHERWISE SPECIFIED
TO PLC MODULES
ALLEN BRADLEY Micrologix 1400 PROGRAMMABLE CONTROLLER 20-INPUTS, 12-OUTPUTS, 4-ANALOG IN 2-ANALOG OUT 1766-L32BXBA
COMM PORT 0
COMM PORT 1
COMM PORT 2
INPUT TERMINAL BLOCK
OUTPUT TERMINAL BLOCK
1762 EXPANSION BUS CONNECTOR
COMM PORT 0 - 8-PIN MINI DIN RS-232/RS-485 CONNECTOR
COMM PORT 1 - RJ-45
COMM PORT 2 - 9-PIN D-SHELL RS-232C CONNECTOR
ETHERNET COMMUNICATIONS LINK BETWEEN PLC AND SYSTEM COMM NETWORK
CAT5E/CAT6 S
ETHERNET
1312
18AWG BLUE
FUEL LOW LEVEL SENSOR
CABLE# C505
E-STOP
GSE INTERLOCK R(RTN) U(SIGNAL)
WHT2
MAIN SUPPLY LSL1 LOW LEVEL SENSOR
CABLE# C504
SUB RESERVOIR LSH1 HIGH LEVEL SENSOR
CABLE# C501
WASTE RESERVOIR LSH2 HIGH LEVEL SENSOR
CABLE# C502
SUB RESERVOIR LSL2 LOW LEVEL SENSOR
CABLE# C503
FLOW METER ANALOG FEEDBACK
LT2 LEVEL SENSOR ANALOG FEEDBACK
LT1 LEVEL SENSOR ANALOG FEEDBACK
ELAPSE TIME METER
MAIN VFD RUNNING
SECONDARY VFD RUNNING
MASTER CONTROL RELAY ON
MASTER POWER ON
P2 PUMP CONTACTOR
VACUUM PUMP CONTACTOR
HEATER CONTROL RELAY 3 PHASE POWER CONTACTOR
HEATER SCR CONTROL SIGNAL
VFD #1 SPEED REFERENCE
RG2 N2 TESCOM PORPORTIONAL REGULATOR ANALOG SIGNAL
STACKLITE AUDIBLE ALARM
MAIN PUMP VFD1 START SIGNAL
SECONDARY PUMP VFD2 START SIGNAL
24VDC/SW
0VDC
PLC IN
ALM
TIME METER

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 7 OF 12	

DWG NO. 1016001-3	SH 7	REV A

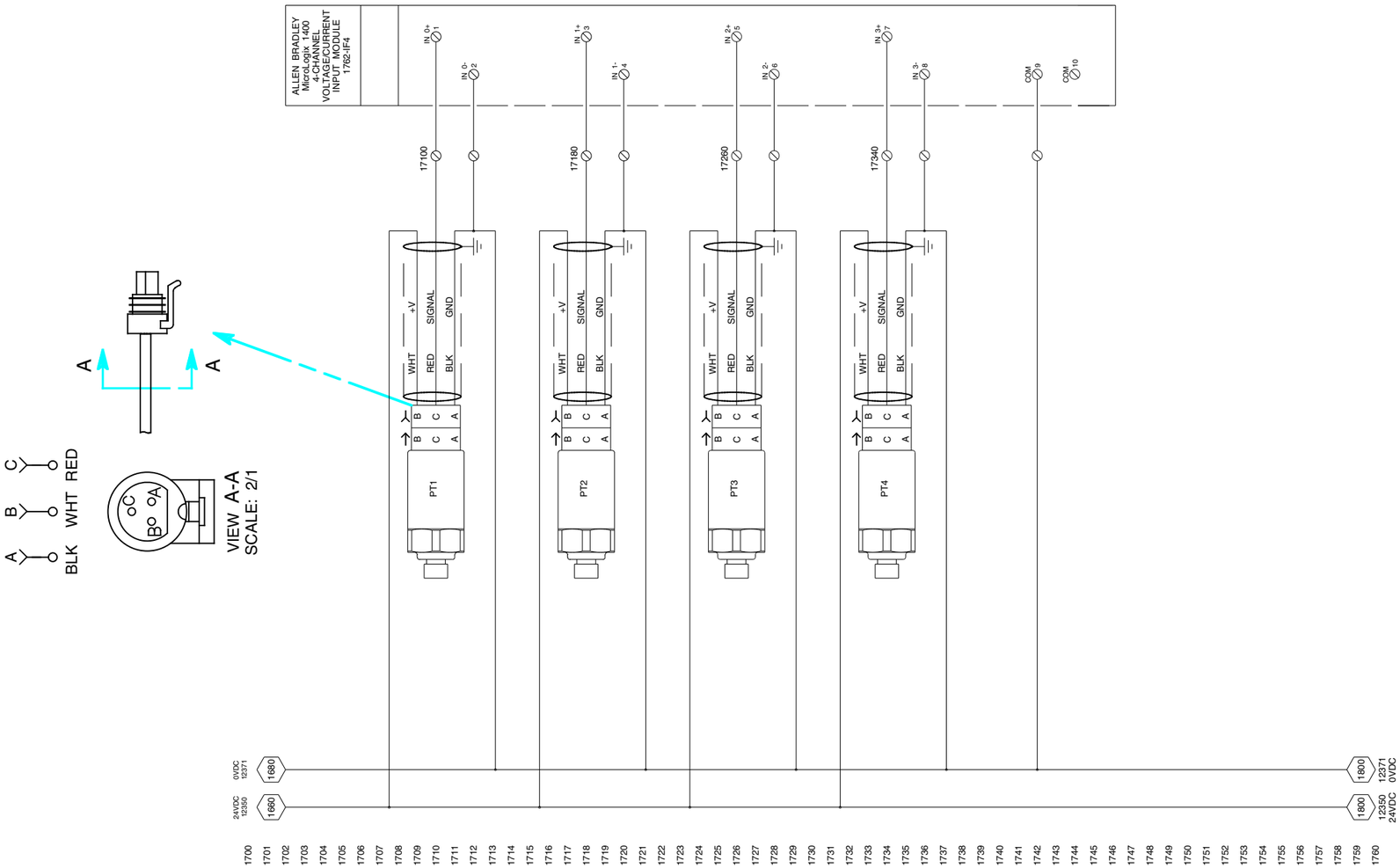
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

DWG NO.	1016001-3	SH	8	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



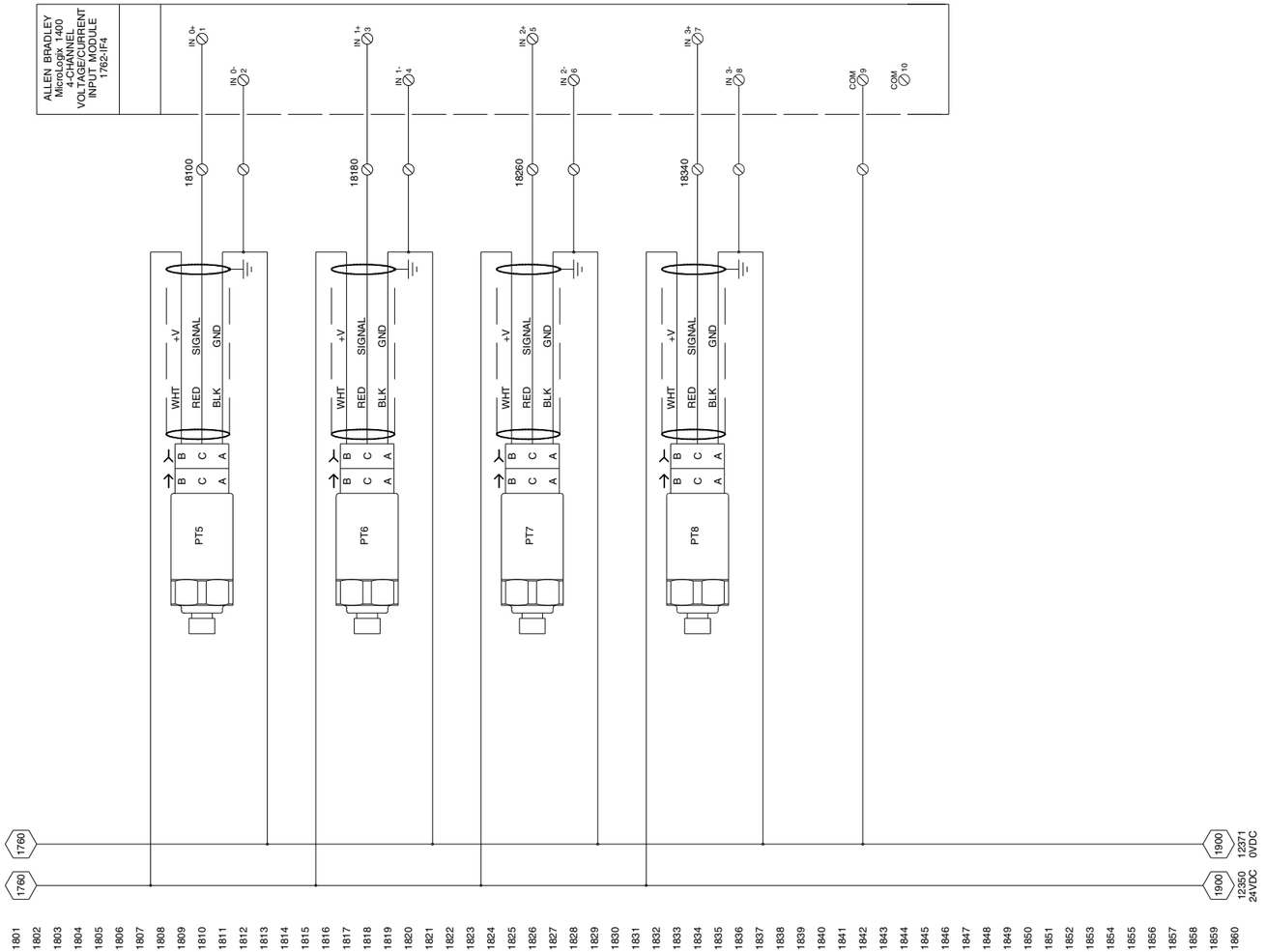
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 8 OF 12	

DWG NO.	1016001-3	SH	9	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



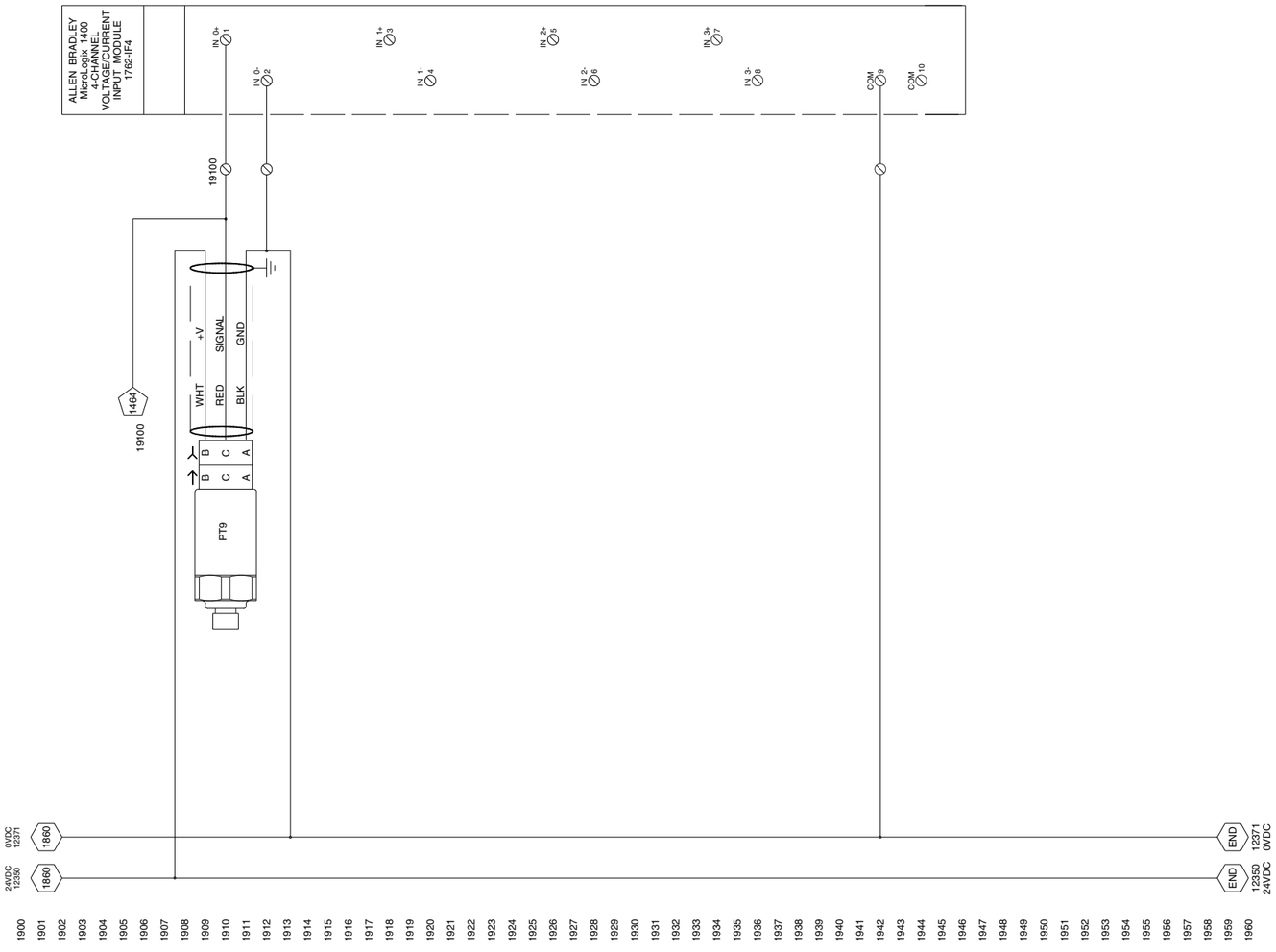
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 9 OF 12	

DWG NO.	1016001-3	SH	10	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



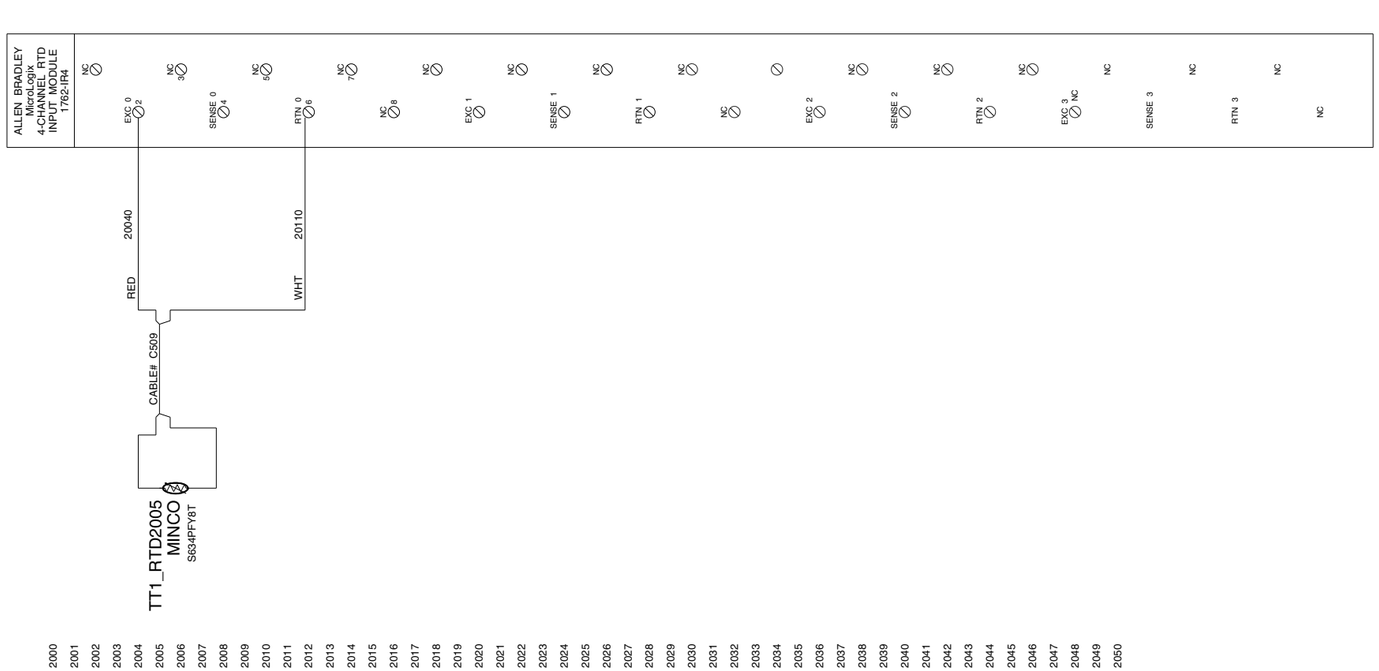
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 10 OF 12	

DWG NO.	1016001-3	SH	11	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES : UNLESS OTHERWISE SPECIFIED

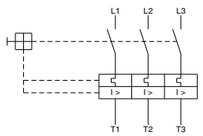
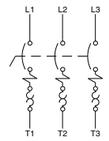
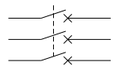
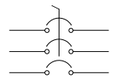
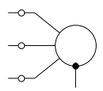
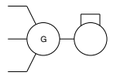
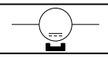
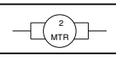
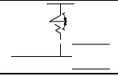
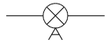
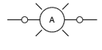
SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 11 OF 12	

DWG NO.	1016001-3	SH	12	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

IEC CROSS REFERENCE LEGEND

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		RELAY OR CONTACTOR, NORMALLY OPEN CONTACT
		RELAY OR CONTACTOR, NORMALLY CLOSED CONTACT
		CAPACITOR
		RELAY OR CONTACTOR COIL
		CIRCUIT BREAKER THERMAL & MAGNETIC TRIP
		CIRCUIT BREAKER, 3 POLE
		PUSH BUTTON, NO - MAINTAINED
		RESISTOR, VARIABLE
		MOTOR, 3-PHASE INDUCTION
		GENERATOR, 3-PHASE
		MOTOR, DC PERMANENT MAGNET
		LINE FILTER / REACTOR / TRANSFORMER
		MUSHROOM PUSHBUTTON, TWIST-LATCH
		FUSE
		MANUAL SWITCH, SPDT, CENTER-OFF
		INDICATOR LAMP, SWITCH LAMP, PANEL LAMP, STACK LIGHT (LETTER INDICATES COLOR)
		CABLE MARKERS
		TERMINALS
		SHIELD + DRAIN WIRE

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		EARTH (GROUND)
		NOISELESS (CLEAN) EARTH (GROUND)
		PROTECTIVE EARTH (GROUND)
		EQUIPOTENTIAL BOND (FRAME GROUND)
		SOLENOID VALVE
		LEVEL SWITCH, CLOSE ON RISE
		LEVEL SWITCH, OPEN ON RISE
		RESISTANCE HEATER ELEMENT
		BUZZER, AUDIBLE ALARM
		VARISTOR
		PLUG / JACK

NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-3	A
SCALE 1/1		SHEET 12 OF 12	

DWG NO.	1016001-4	SH	1	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		NEW RELEASE	11/19/15	JW	BW
	A	SEE ECN 6582	6/1/18	BW	BW

Construction Notes:

1. All wire & cord is stranded copper conductor. Solid conductor shall not be used.
   a.) Individual hook up wire, unspecified:
   18 awg & smaller - type MTW (600V) / H05V-K (300/500V)
   16 awg & larger - type MTW (600V) / H07V-K (450/750V)

   b.) Individual hook up wire, specified:
   TFE - teflon hook up wire, NEMA HP-3 Type E (Mil-W-16878/4), 600V nom., 2 kV dielectric withstand voltage, NPC, -65 to 200°C

   c.) Multi-Conductor Power Cords over 50 V, specified:
   Utility Power Cord - type W (UL), 2000V, 90°C
   Generator Power Cord - type W (UL), 2000V, 90°C

   d.) Multi-Conductor Control & Actuator Cordage, less than 50V, unspecified:
   Type SJOOW or H05VVF or SOOW

2. Shielded instrument cable within enclosures (except flowmeter cable) is UL type TC, Belden 9341 or equal, (1) pair, 18 awg, 600V, 90°C

3. Minimum wire size, unless otherwise noted, shall be:
   18 AWG for individule conductors
   22 AWG for multiconductor jacketed cable

4. Wire sizes indicated are minimum. Larger sizes may be substituted.

5. Wire color for individual wires shall be:
   (Colored shrink-tube at wire termination may be used to designate wire color)
   BLACK - Ungrounded conductors at line voltage (greater than 150 volts).
   BLUE - Ungrounded DC control conductors. (DC+)
   WHITE w/ BLUE Stripe - Grounded DC control conductors (DC-)
   GREEN w/ YELLOW Stripe - Equipment ground conductor.

6. Each wire shall be clearly marked at each termination with commercial wire markers, with the wire number or cable number shown on this schematic diagram.

7. Grounding: All metal enclosures and panels exposed to electrical wiring shall be grounded. Use internal toothed star washer under ground lug on painted surfaces.

8. Grounding conductors shall be copper. Conduit and enclosures shall not be used as a grounding conductor. Grounding conductors shall be sized per NFPA-70(NEC), Art. 250-95.

△9 Wrap exposed terminals w/ glass tape: LT18.

△10 Verify P2 for proper flow direction (motor rotates clockwise when viewed from motor end). Move wire to 2 (DIR/RUN FWD) if pump rotation needs to be changed.

General Notes:

11. △11 = Located in Electrical Enclosure Assembly power panel.
12. See dwg 1016012 for Cord/Cable specifications.
13. All 18 awg stranded wire may be terminated using non-insulated crimp-on ferrules for strand containment, unless otherwise specified. Panduit F77-7-M or equal (0.28 in. lg).
14. To restart after an EMERGENCY STOP, push Power On/Off Button OFF and reset (twist-pull) E-Stop mushroom button. Then push Power On/Off Button ON.

NEXT ASSEMBLY	USED ON
	1016
APPLICATION	

ITEM NO.	QTY REQD	CAGE CODE	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: 125
FRACTIONS ± 1/32 DECIMALS .xx ± .03 .xxx ± .010 ANGLES ± 1°

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

	APPROVAL	DATE
DRAWN	JOHN W.	11/15
CHECKED	BILL W.	11/15
ISSUED		

MALABAR INTERNATIONAL
SIMI VALLEY, CALIFORNIA

ELECTRICAL SCHEMATIC

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A

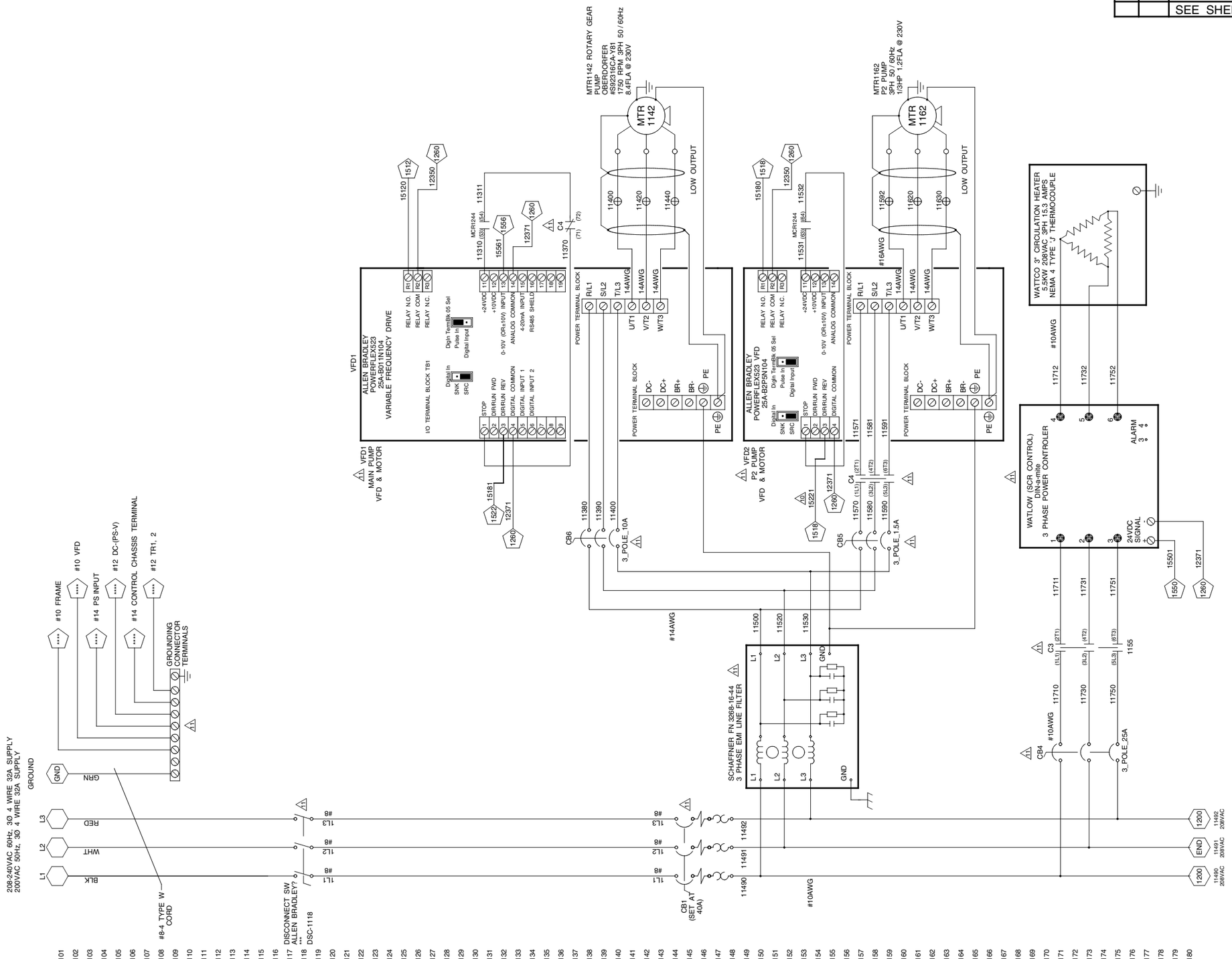
SCALE 1/1 SHEET 1 OF 12

NOTES: UNLESS OTHERWISE SPECIFIED

DWG NO.	1016001-4	SH 2	REV A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



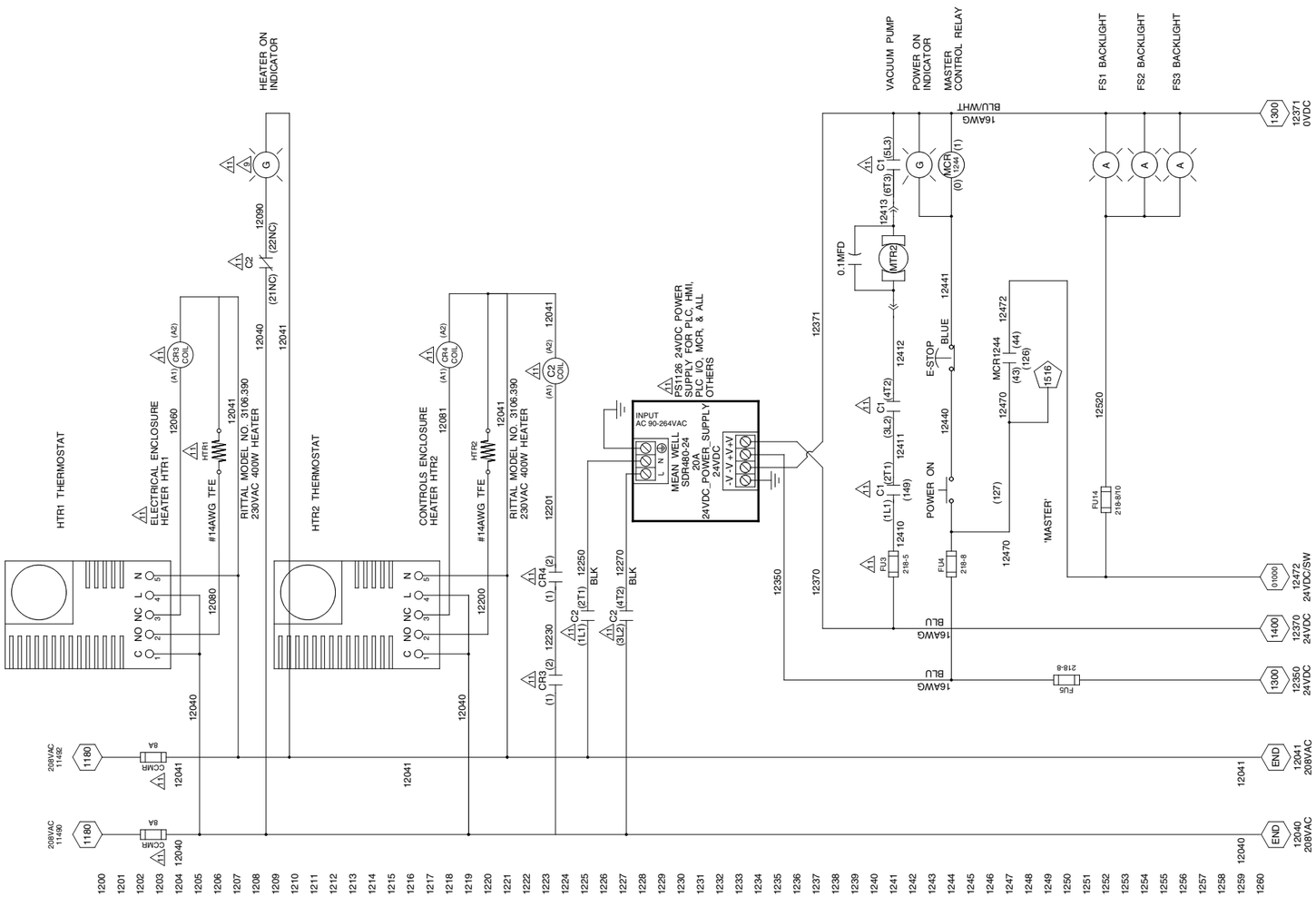
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 2 OF 12	

DWG NO.	1016001-4	SH	3	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



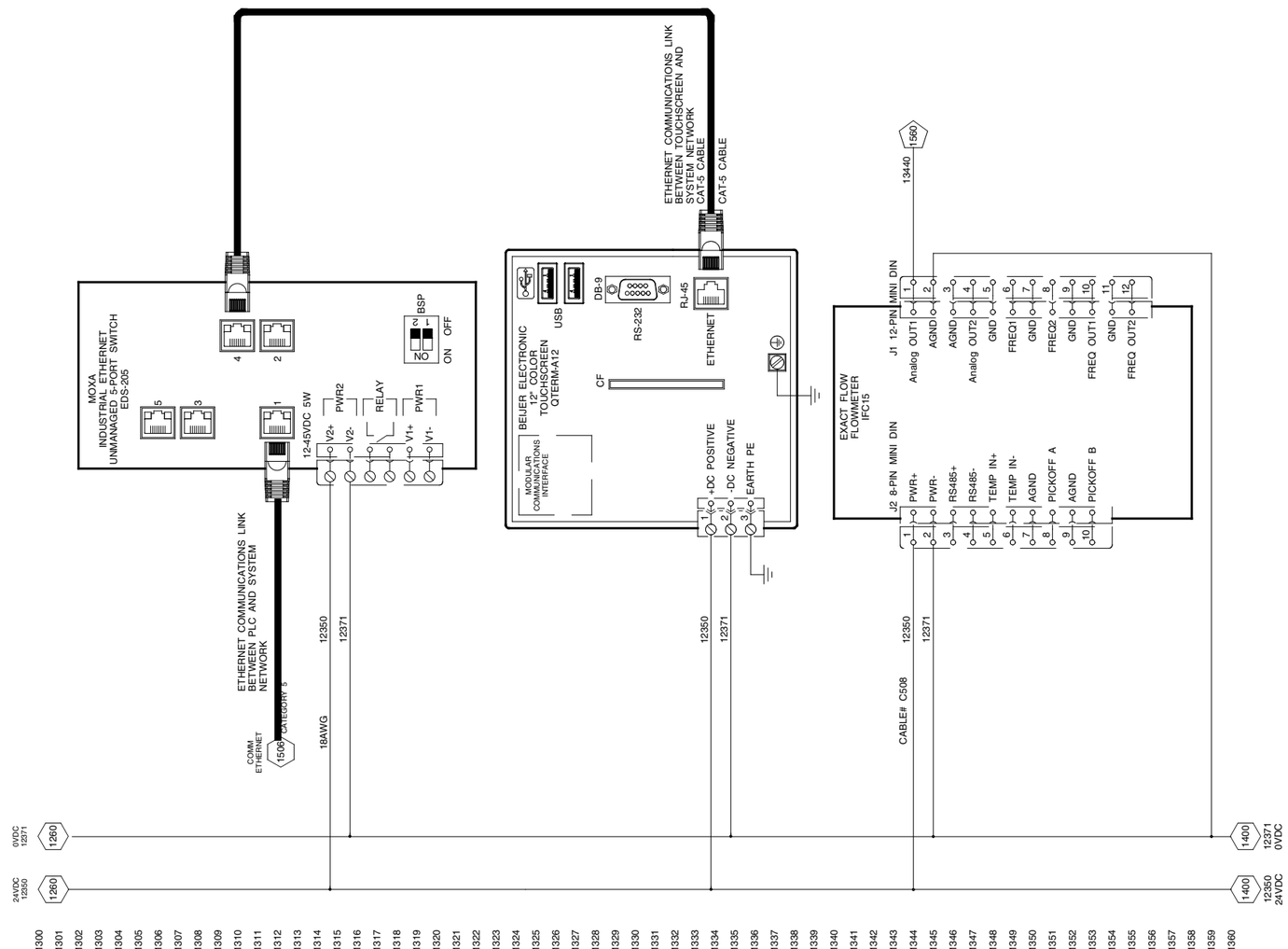
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 3 OF 12	

DWG NO.	1016001-4	SH	4	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



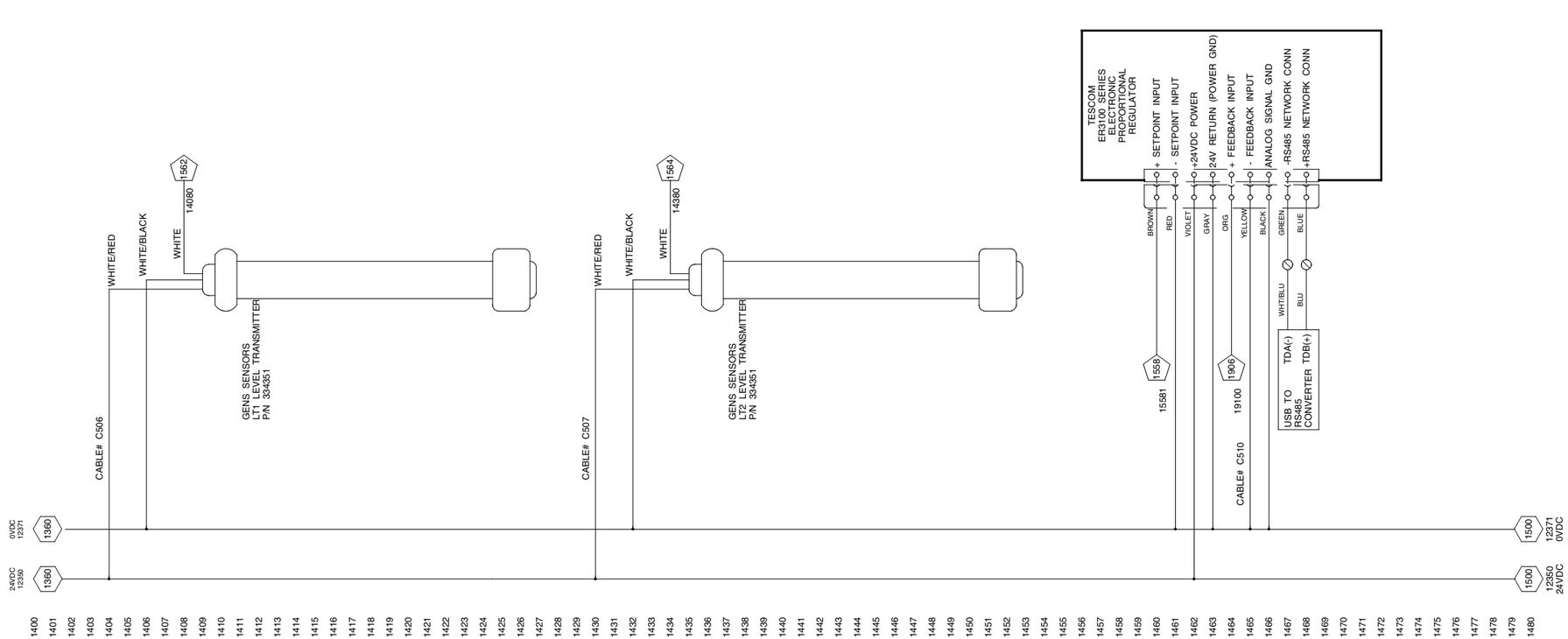
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 4 OF 12	

DWG NO.	1016001-4	SH	5	REV	A

REVISIONS

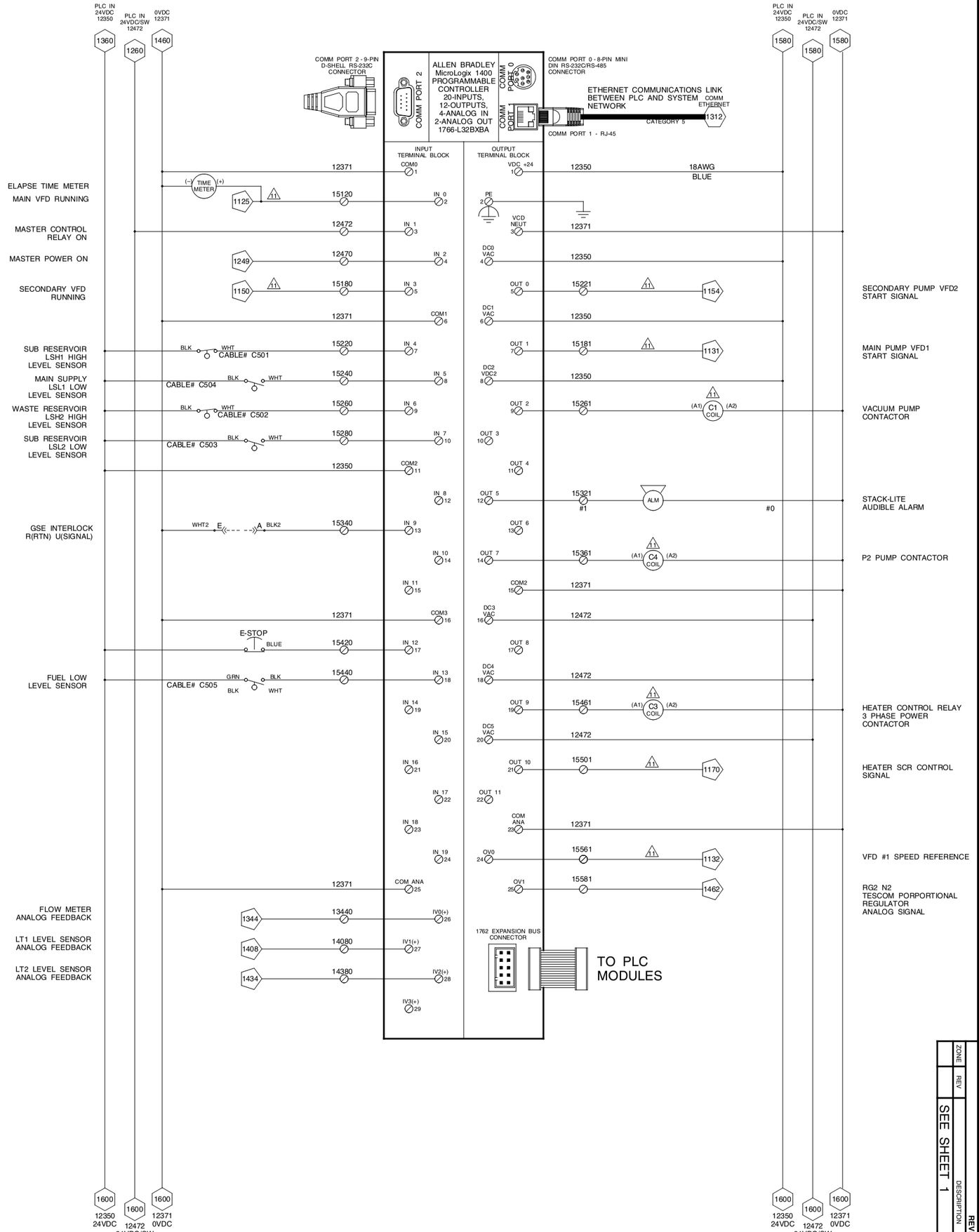
ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 5 OF 12	

NOTES: UNLESS OTHERWISE SPECIFIED



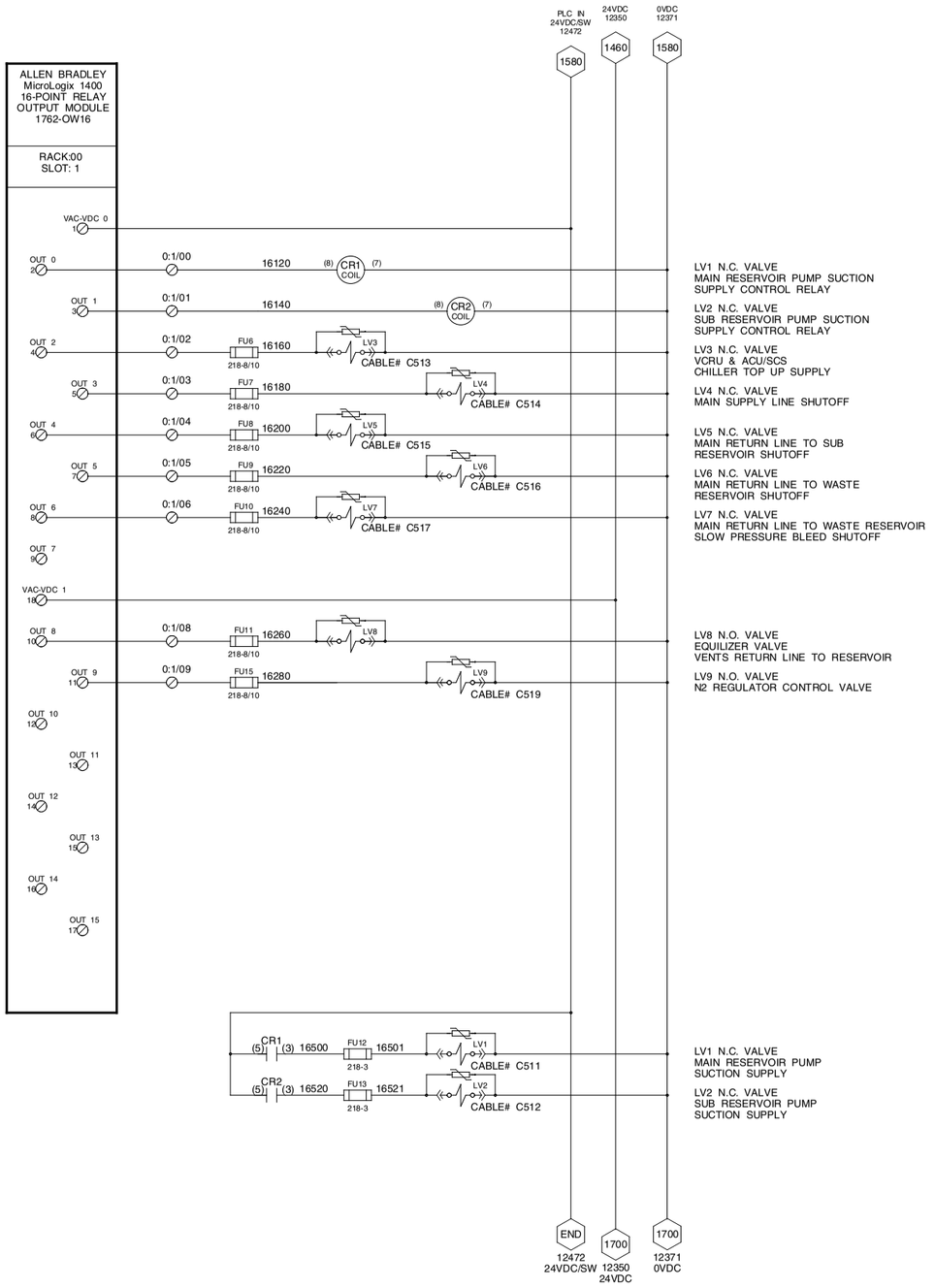
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D	94861	1016001-4	A
SCALE 1/1		SHEET 6 OF 12	

DWG NO.	1016001-4	SH 6	REV A

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

NOTES : UNLESS OTHERWISE SPECIFIED



SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 7 OF 12	

DWG NO. 1016001-4	SH 7	REV A

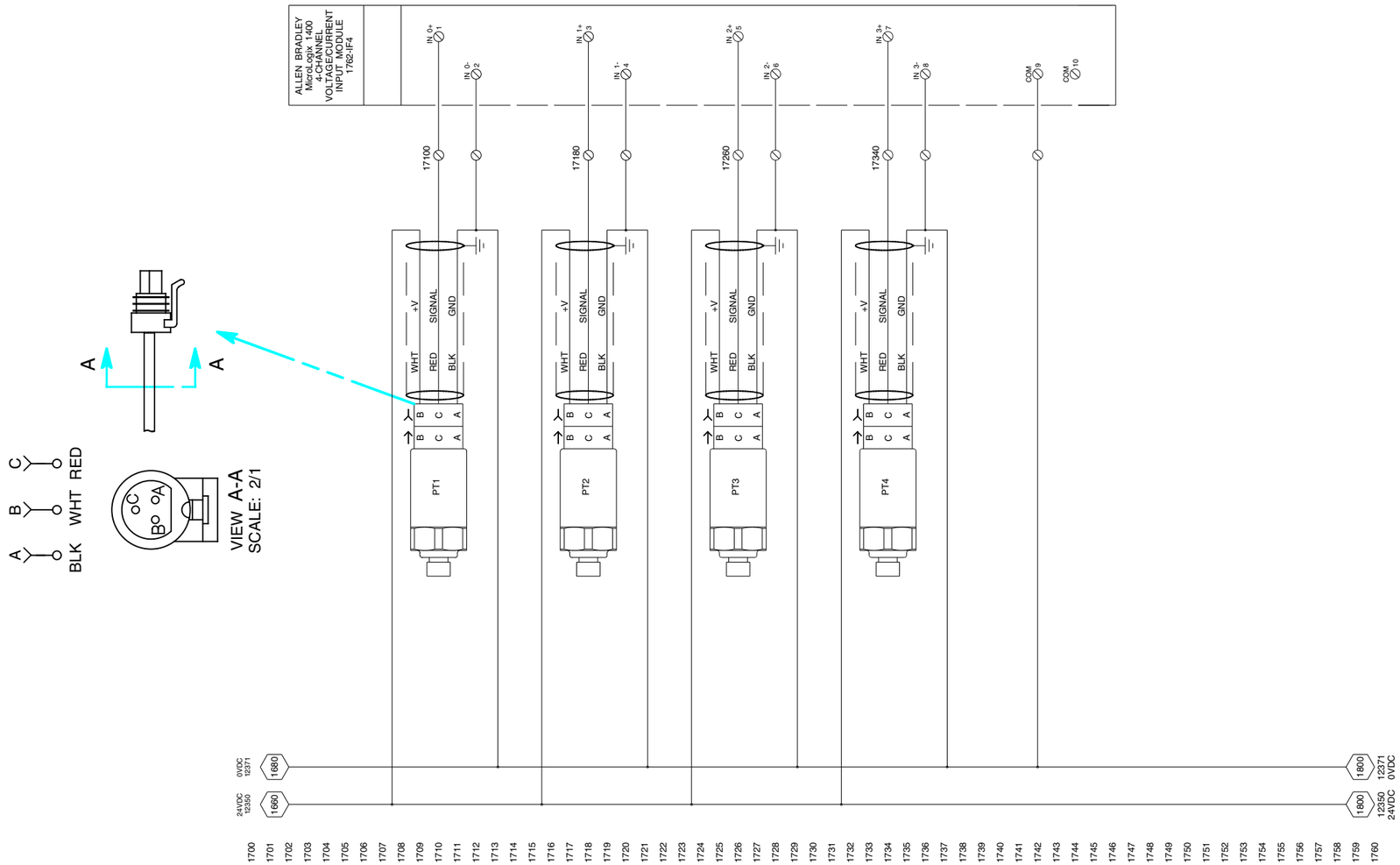
REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

DWG NO.	1016001-4	SH	8	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



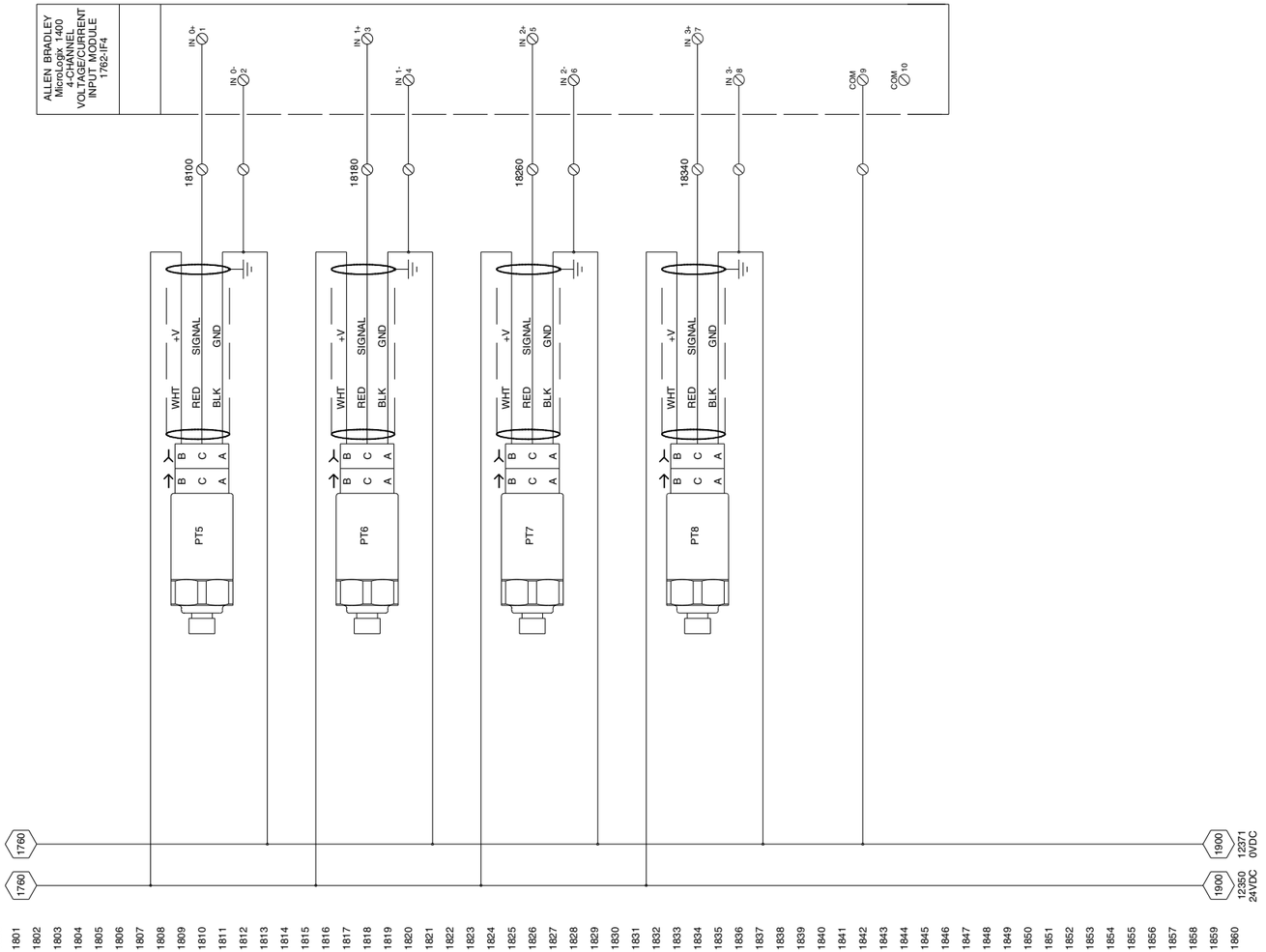
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 8 OF 12	

DWG NO.	1016001-4	SH 9	REV A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



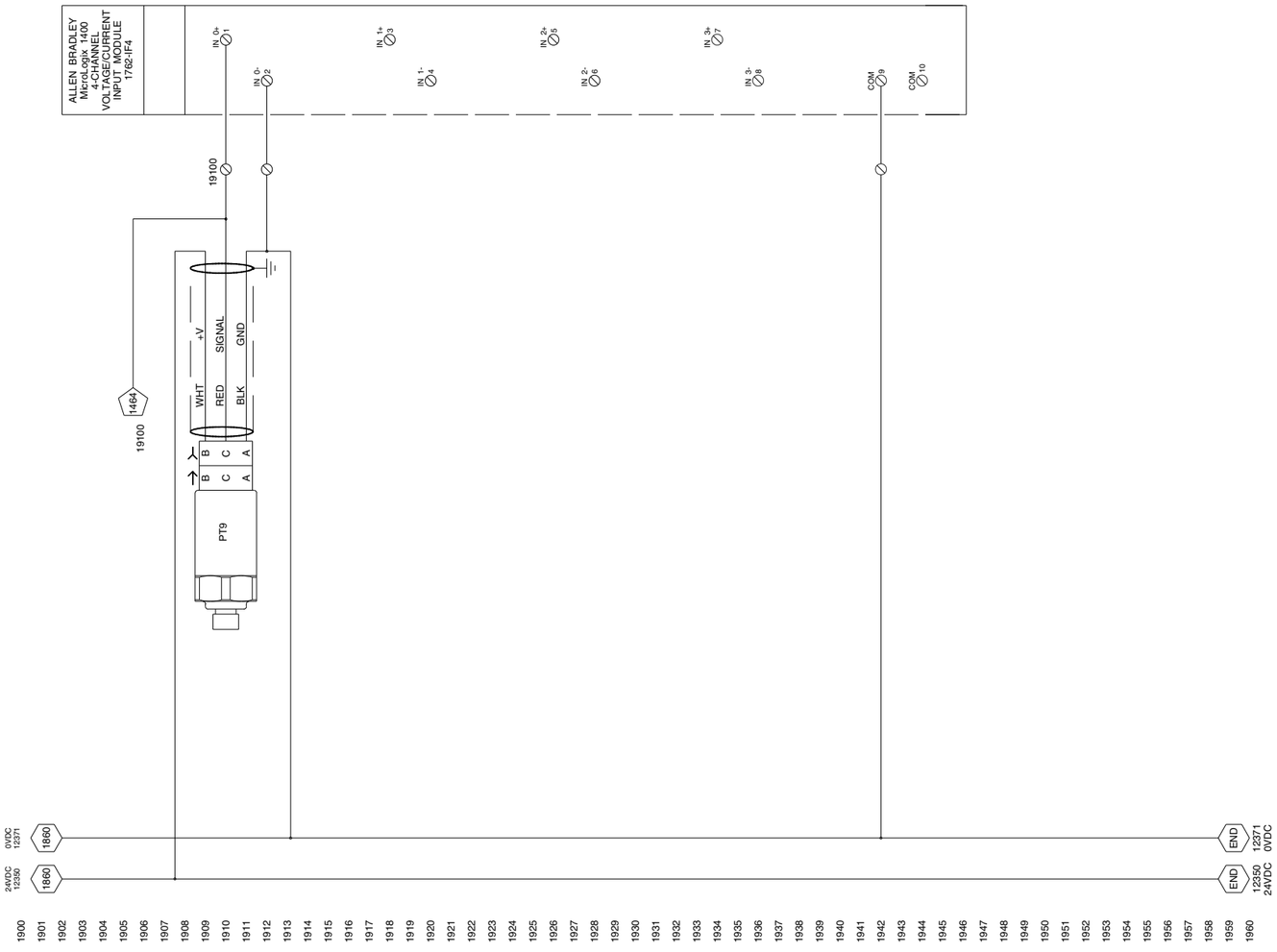
NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 9 OF 12	

DWG NO.	1016001-4	SH	10	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



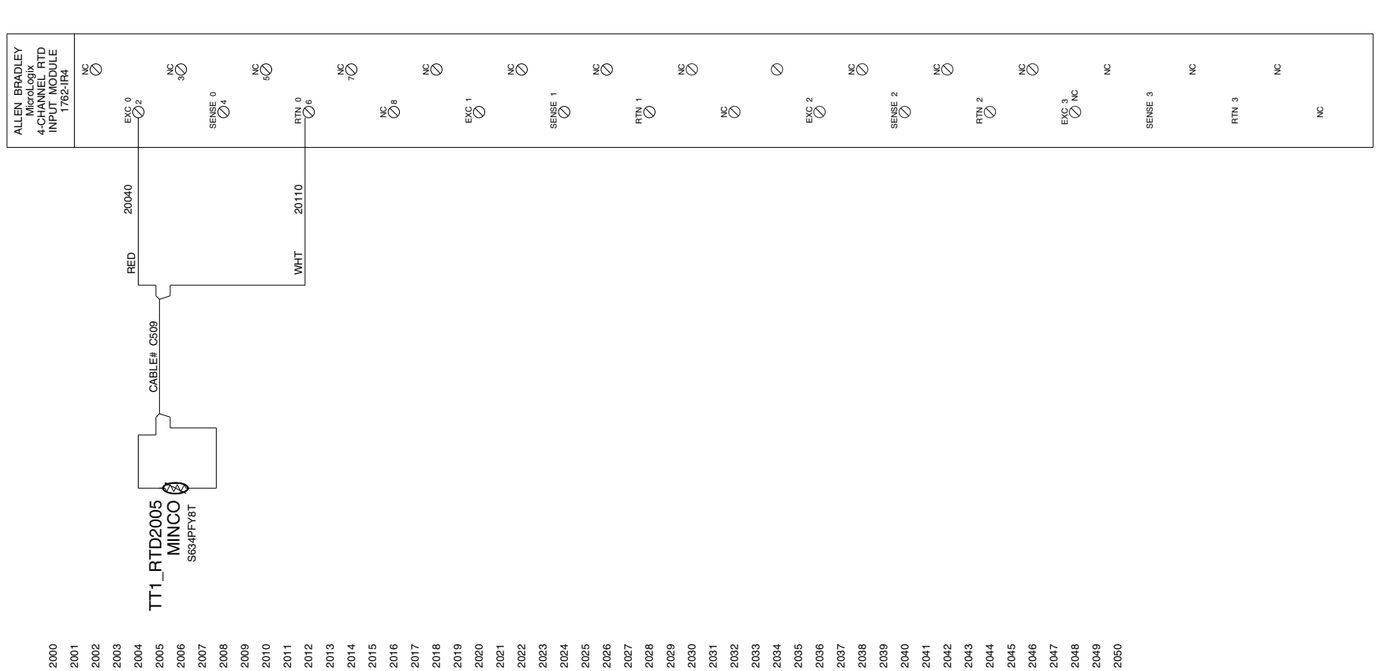
NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 10 OF 12	

DWG NO.	1016001-4	SH	11	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			



NOTES : UNLESS OTHERWISE SPECIFIED

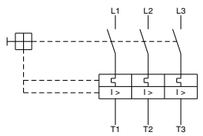
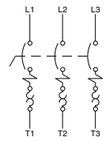
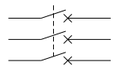
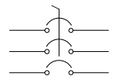
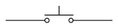
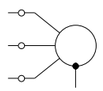
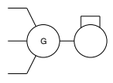
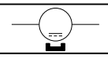
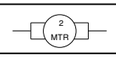
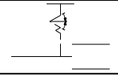
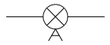
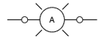
SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 11 OF 12	

DWG NO.	1016001-4	SH	12	REV	A

REVISIONS

ZONE	REV	DESCRIPTION	DATE	BY	APPROVED
		SEE SHEET 1			

IEC CROSS REFERENCE LEGEND

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		RELAY OR CONTACTOR, NORMALLY OPEN CONTACT
		RELAY OR CONTACTOR, NORMALLY CLOSED CONTACT
		CAPACITOR
		RELAY OR CONTACTOR COIL
		CIRCUIT BREAKER THERMAL & MAGNETIC TRIP
		CIRCUIT BREAKER, 3 POLE
		PUSH BUTTON, NO - MAINTAINED
		RESISTOR, VARIABLE
		MOTOR, 3-PHASE INDUCTION
		GENERATOR, 3-PHASE
		MOTOR, DC PERMANENT MAGNET
		LINE FILTER / REACTOR / TRANSFORMER
		MUSHROOM PUSHBUTTON, TWIST-LATCH
		FUSE
		MANUAL SWITCH, SPDT, CENTER-OFF
		INDICATOR LAMP, SWITCH LAMP, PANEL LAMP, STACK LIGHT (LETTER INDICATES COLOR)
		CABLE MARKERS
		TERMINALS
		SHIELD + DRAIN WIRE

IEC 60617 SYMBOL	MALABAR SYMBOL	DEVICE DESCRIPTION
		EARTH (GROUND)
		NOISELESS (CLEAN) EARTH (GROUND)
		PROTECTIVE EARTH (GROUND)
		EQUIPOTENTIAL BOND (FRAME GROUND)
		SOLENOID VALVE
		LEVEL SWITCH, CLOSE ON RISE
		LEVEL SWITCH, OPEN ON RISE
		RESISTANCE HEATER ELEMENT
		BUZZER, AUDIBLE ALARM
		VARISTOR
		PLUG / JACK

NOTES : UNLESS OTHERWISE SPECIFIED

SIZE	CAGE CODE	DWG NO.	REV
D	94861	1016001-4	A
SCALE 1/1		SHEET 12 OF 12	

MALABAR™ INTERNATIONAL
A TRONAIR COMPANY

APPENDIX III

Control System Operation
Control System Configuration Record

Control System Operation

Model 1016 CSC

	OPERATING MODE	FACTORY PRESET GPM	ADJ. RANGE GPM	SOLENOID VALVES									VAC PUMP[3]	HEATER	REGULATOR RG2
				LV1	LV2	LV3	LV4	LV5	LV6	LV7	LV8[2]	LV9			
AIRCRAFT	**FILLING OF WHOLE SYSTEM**														
	START	4	TBD	-	ON	-	ON	ON	-	-	ON	-	ON	A	-
	ADD 8 ½ GALLONS	4	TBD	ON	-	-	ON	ON	-	-	ON	-	ON	A	-
	STABILIZATION	4	TBD	-	ON	-	ON	ON	-	-	ON	-	ON	A	-
	TURN OFF VALVES	NA	NA	-	ON	-	-	-	-	-	ON	-	ON	-	-
	BLEED	4 – 11	TBD	-	ON	-	ON	ON	-	-	ON	-	ON	A	-
	TURN OFF VALVES	NA	NA	-	ON	-	-	-	-	-	ON	-	ON	-	-
	TOP UP OF ACCUMULATOR	0.53 MAX	TBD	-	ON	-	ON	-	-	-	ON	-	ON	-	-
	PRESSURIZE	0.53 MAX	TBD	-	ON	-	ON	-	-	-	ON	-	ON	-	-
	DEPRESSURIZE	0.53 MAX	TBD	-	-	-	-	-	-	ON	ON	-	ON	-	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	DRAINAGE OF WHOLESYSTEM														
	N_2 VENT TO 0 PSI	NA	NA	-	-	-	-	-	-	ON	ON	-	-	-	-
	N_2 DRAIN (PURGE)	NA	NA	-	-	-	-	-	ON	-	ON	ON	-	-	ON
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	TOP UP OF ACCUMULATOR	0.53 MAX	TBD	-	ON	-	ON	-	-	-	ON	-	ON	-	-
	PRESSURIZE	0.53 MAX	TBD	-	ON	-	ON	-	-	-	ON	-	ON	-	-
	DEPRESSURIZE	0.53 MAX	TBD	-	-	-	-	-	-	ON	ON	-	ON	-	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	VCRU & ACU/SCS CHILLER														
	TOP UP	MAX	TBD	-	ON	ON	-	ON	-	-	ON	-	A	A	-
	N_2 DRAIN (PURGE)	NA	NA	-	-	-	-	-	ON	-	ON	ON	-	A	ON
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	A	-
	SYSTEM BLEED	4 – 11	TBD	-	ON	-	ON	ON	-	-	ON	-	A	A	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
CSC	**BLEED HOSES**	4	TBD	ON	-	-	ON	ON	-	-	ON	-	ON	A	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	PREHEAT	4	TBD	-	ON	-	ON	ON	-	-	ON	-	A	A	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	DRAIN HOSES, N_2	NA	NA	-	-	-	-	-	ON	-	ON	ON	-	-	ON
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-
	DEAERATION OF SUBRESERVOIR	NA	NA	-	-	-	-	-	-	-	ON	-	A	A	-
	MODE END	NA	NA	-	-	-	-	-	-	-	ON	-	A	-	-

KEY: ON.....Energized -.....De-energized A.....Allowed NA.....Not Applicable

Solenoid Valve Functions [1], [2]

LV1: Main Reservoir Pump Suction Supply (NC)LV2: Sub Reservoir Pump Suction Supply (NC)
LV3: VCRU & ACU/SCS Chiller Top Up Supply (NC)LV4: Main Supply Line Shutoff (NC)
LV5: Main Return Line to Sub Reservoir Shutoff (NC) LV6: Main Return Line to Waste Reservoir Shutoff (NC)
LV7: Main Return Line to Waste Reservoir Slow Pressure Bleed Shutoff (NC)LV8: Equalizer Valve, vents return line to reservoir (NO)
LV9: Nitrogen Regulator RG2 to Main Supply Line Shutoff (NC)

Notes:
All solenoid valves are normally closed except LV8.
LV8 (N.O. equalizer valve) turns on (closes) when MASTER switch is on, opens when MASTER switch is off or E-Stop.
VACUUM PUMP can be turned on/off with a touchscreen button in modes except N_2 DRAIN, CSC BLEED HOSES and FILLING OF WHOLE SCS SYSTEM. Cannot turn on in N_2 DRAIN. Cannot turn off in CSC BLEED HOSES and FILLING OF WHOLE SCS SYSTEM.
The hourmeter on the instrument panel accumulates main pump runtime.

Control System Configuration Record

Variable Frequency Drive (VFD1) Configuration

Allen-Bradley PowerFlex 523 Drive: 25A-B011N104		
SNK/SRC Jumper: SRC (down) Analog Out Sel Jumper: 0-10V (up)		
***Parameter**	**Value**	**Function / Comments**
P031	208	Motor Nameplate Volts
P032	60	Motor Nameplate Hz
P033	8.6	Motor Overload Current (A)
P034	10.2	Motor Nameplate FLA
P035	3	Motor Nameplate Poles
P036	1755	Motor Nameplate RPM
P046	2	Start Source (2 = “DigIn TrmBlk”)
P047	5	Speed Reference (5 = “0-10V Input”)

Parameters not listed are left at the factory default values. See PowerFlex 520-Series UserManual
***Note: The Parameters are locked at the factory. If necessary, contact Malabar for instructions.**

Variable Frequency Drive (VFD2) Configuration

Allen-Bradley PowerFlex 523 Drive: 25A-B2P5N104		
SNK/SRC Jumper: SRC (down) Analog Out Sel Jumper: 0-10V (up)		
***Parameter**	**Value**	**Function / Comments**
P031	230	Motor Nameplate Volts
P032	60	Motor Nameplate Hz
P033	2.5	Motor Overload Current (A)
P034	1.7	Motor Nameplate FLA
P035	4	Motor Nameplate Poles
P036	1750	Motor Nameplate RPM
P046	2	Start Source (2 = “DigIn TrmBlk”)
P047	7	Speed Reference (7 = “Preset Freq”)
**A410	10	Preset Frequency (Hz)

Parameters not listed are left at the factory default values. See PowerFlex 520-Series UserManual
***Note: The Parameters are locked at the factory. If necessary, contact Malabar for instructions.**
****Note: To get to A410, press Sel or Esc for the menu and press Esc until the far left character (parameter group letter) flashes. Use Up/Down Arrow to scroll through the group list and press Enter when A is shown. Use Up/Down Arrow until A410 is shown and press Enter twice to edit the parameter value, set it to 10 using Up/Down Arrow.**

PLC Configuration and Program Download

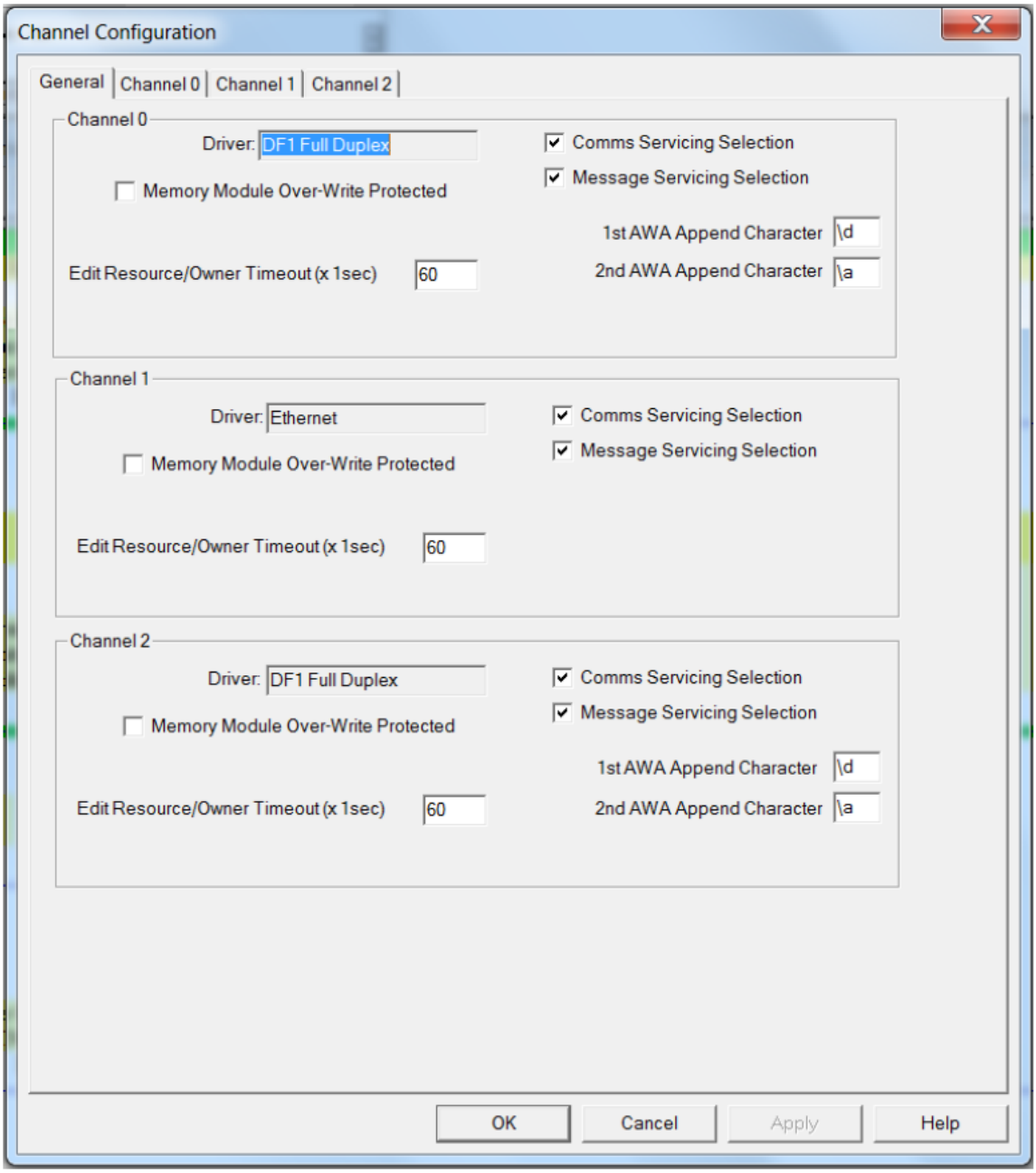
1. At PLC LCD screen display, Scroll to ADVANCED SET > press OK > scroll to ENET CONFIG > press OK > STATUS > press OK > input IP address 192.168.50.102 > press OK > SUBNET > press OK > input 255.255.255 > press OK > press ESC until main menu is shown.
2. NOTE: There are two ways to perform the program download. From a PC withRSLogix500 or a preprogrammed memory module.

Program Download with preprogrammed Memory Module:

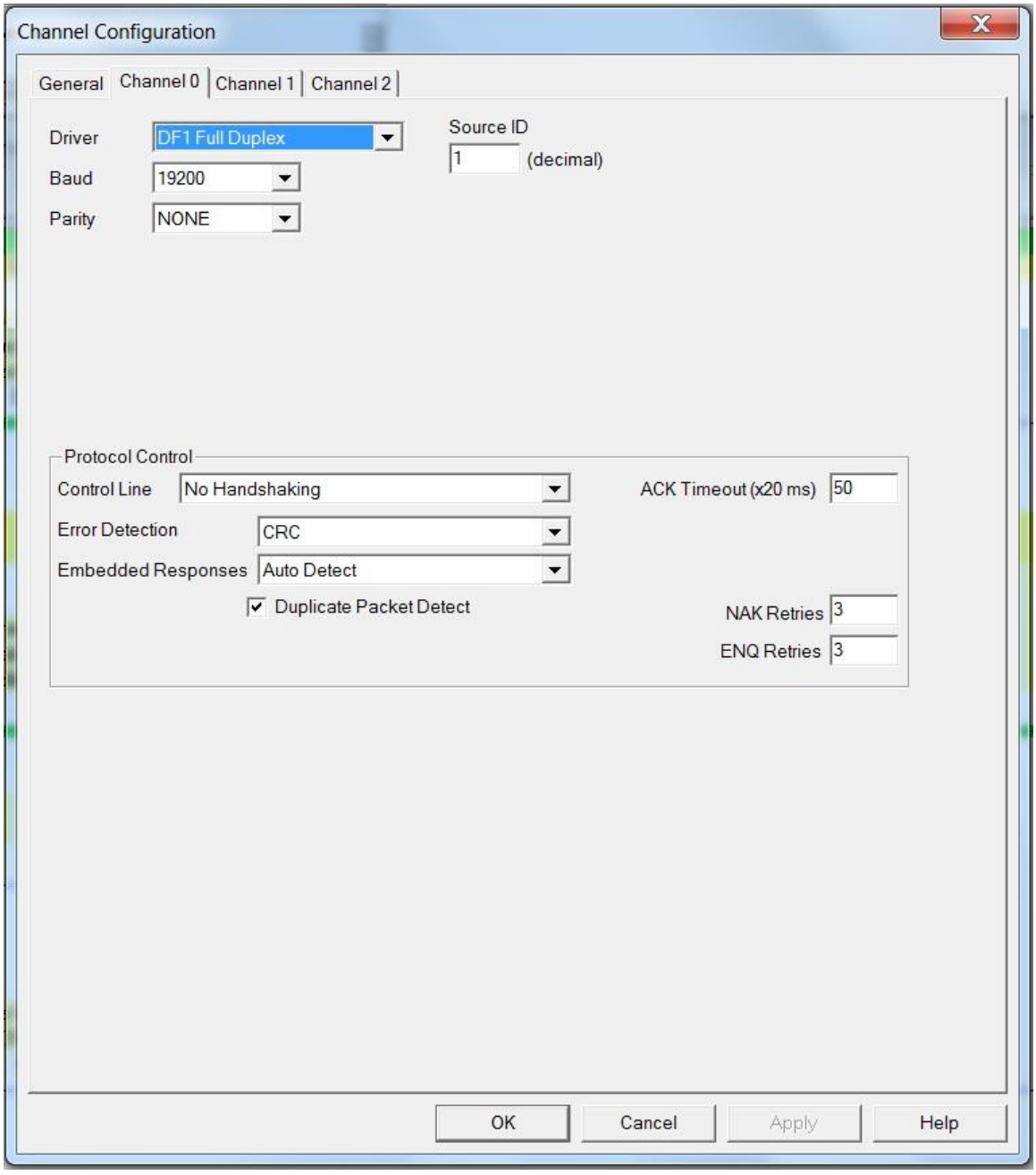
a. Install preprogrammed memory module into PLC memory module slot.
b. At PLC LCD screen display, press OK > scroll to ADVANCED SET > press OK > scroll to COMMS EEPROM > press OK > scroll to LOAD MM > press OK (green run light will blink to indicate successful download).

Program Download using PC with RSLogix500:
NOTE: The PLC IP address and the PC IP address used for comm channel 0 communication using an ethernet crossover cable must match in the first three decimal number positions (PLC IP address is 192.168.50.100 and thePC IP address is 192.168.50.102) for comm 0 to work.

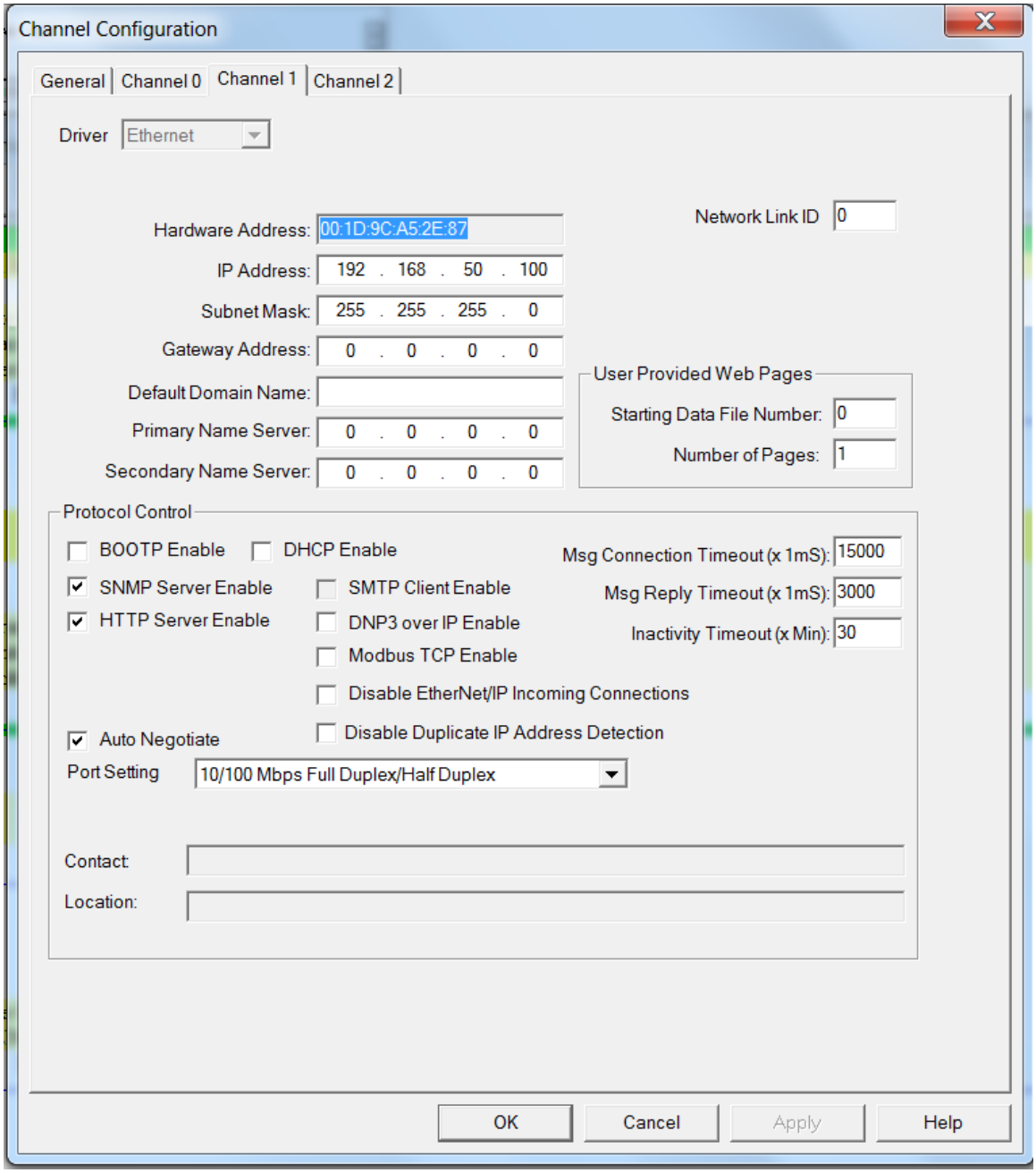
a. Install ethernet crossover cable from PC to PLC.
b. Open COOLANT SERVICE CART program file ie. 1016_Rn ("n" = revisionletter) in RSLogix500.
c. Configure RSLogix500 software:
   - Select CONTROLLER PROPERTIES from file tree in left menu > select Micrologix 1400 series B (NOTE: This enables program download for type Aand B PLCs) > select APPLY > Select OK to exit screen.
   - Select CHANNEL CONFIGURATION from file tree in left menu > see belowfigure 1 to ensure all settings in GENERAL MENU are set as indicated.
     Change settings to match figure 1 where applicable > select CHANNEL 0 > see below figure 2 to ensure all settings in CHANNEL 0 are set as indicated.
     Change settings to match figure 2 where applicable > select CHANNEL 1 > see below figure 3 to ensure all settings in CHANNEL 1 are set as indicated.
     Change settings to match figure 3 where applicable > select APPLY > selectOK to exit.



GENERAL MENU


Channel Configuration
General
Channel 0
Channel 1
Channel 2
Driver
DF1 Full Duplex
Baud
19200
Parity
NONE
Source ID
1
(decimal)
Protocol Control
Control Line
No Handshaking
ACK Timeout (x20 ms)
50
Error Detection
CRC
Embedded Responses
Auto Detect
Duplicate Packet Detect
NAK Retries
3
ENQ Retries
3
OK
Cancel
Apply
Help

CHANNEL 0



CHANNEL 1

3. Select drop down menu COMMS > select SYSTEM COMMS > Ensure IP 192.168.50.100 is connected > highlight connection > select DOWNLOAD.
4. View PLC to ensure download was successful.

PLC Program Reference

Configuration & Data Table Pre-set Values Malabar

PLC Configuration

Allen-Bradley MicroLogix 1400 Controller: 1766-L32BXBAExpansion I/O-
- Slot 1: 1762-OW16
- Slot 2: 1762-IF4
- Slot 3: 1762-IF4
- Slot 4: 1762-IF4
- Slot 5: 1762-IR4

Memory Module: 1766-MM1 S:1/8 (Fault Override)=1
- S:1/10 (Load on Mem. Error) =0 S:1/11 (Load Always) =1
- S:1/12 (Go to Run Mode Behavior) =1
- Data Table Memory Module/Download Protection is set for B3, N7, F8.

Channel 0 Configuration:
- DF1 Full Duplex, AWA append 1st=\d, 2nd=\a 19200, none
- Protocol Control: No Handshaking

Channel 1 Configuration:
- Ethernet, 10/100 Mbps Full Duplex/Half Duplex IP Address: 192.168.50.100
- Subnet Mask: 255.255.255.0
- Protocol Control: SNMP & HTTP Enabled, Auto Negotiate

Channel 2 Configuration:
- DF1 Full Duplex

Program File Name: 1016_V*n* ("*n*" = Version number)

Processor Name: COOLANT SERVICE CART1016



APPENDIX IV

Allen Bradley
MicroLogic 1400 Programmable Controllers

User Manual

Allen-Bradley

MicroLogix 1400 Programmable Controllers

Bulletin 1766 Controllers and 1762 Expansion I/O









Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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Summary of Changes

To help you find new and updated information in this release of the manual, we have included change bars as shown to the right of this paragraph.

The table below lists the sections that document new features and additional or updated information about existing features.

Summary of Changes

Topic	Page
Viewing and changing of protocol configuration through LCD	59
MicroLogix 1400 LCD Menu Structure Tree updated with Protocol Configuration	60
Protocol Configuration step-by-step guide	116

Firmware Revision History

Features are added to the controllers through firmware upgrades. See the latest release notes, 1766-RN001, to be sure that your controller's firmware is at the level you need. Firmware upgrades are not required, except to allow you access to the new features. You can only upgrade firmware within the same series of controller.

Notes:

Summary of Changes

Firmware Revision History. iii

Preface

Who Should Use this Manual 17
Purpose of this Manual 17
Related Documentation. 18
Common Techniques Used in this Manual. 18

Chapter 1

Hardware Overview

Hardware Features 1
Component Descriptions 2
MicroLogix 1400 Memory Module and Built-in Real-Time Clock . . 2
1762 Expansion I/O 3
Communication Cables 4
Programming 5
Communication Options 5

Chapter 2

Install Your Controller

Agency Certifications. 7
Compliance to European Union Directives. 7
EMC Directive. 7
Low Voltage Directive 8
Installation Considerations 8
Safety Considerations 9
Hazardous Location Considerations 9
Disconnecting Main Power. 10
Safety Circuits 10
Power Distribution 10
Periodic Tests of Master Control Relay Circuit 11
Power Considerations 11
Isolation Transformers. 11
Power Supply Inrush. 11
Loss of Power Source 12
Input States on Power Down 12
Other Types of Line Conditions. 12
Preventing Excessive Heat 12
Master Control Relay. 13
Using Emergency-Stop Switches 14
Schematic (Using IEC Symbols) 15
Schematic (Using ANSI/CSA Symbols). 16
Installing a Memory Module 16
Using the Battery 17
Connecting the Battery Wire Connector 19
Controller Mounting Dimensions 20
Controller and Expansion I/O Spacing 20
Mounting the Controller 20

DIN Rail Mounting. 22
Panel Mounting 23
1762 Expansion I/O Dimensions 24
Mounting 1762 Expansion I/O. 24
DIN Rail Mounting. 24
Panel Mounting 25
Connecting Expansion I/O 26

Chapter 3

Wire Your Controller

Wiring Requirements 27
Wiring Recommendation 27
Wire without Spade Lugs. 28
Wire with Spade Lugs 28
Using Surge Suppressors 29
Recommended Surge Suppressors 30
Grounding the Controller. 31
Wiring Diagrams 32
Terminal Block Layouts 33
Sinking and Sourcing Wiring Diagrams 36
1766-L32BWA, 1766-L32AWA, 1766-L32BXB, 1766-L32BWAA, 1766-L32AWAA, 1766-L32BXBA Wiring Diagrams 36
Controller I/O Wiring. 38
Minimizing Electrical Noise 38
Wiring Your Analog Channels 39
Analog Channel Wiring Guidelines 40
Minimizing Electrical Noise on Analog Channels 41
Grounding Your Analog Cable 42
Expansion I/O Wiring. 42
Digital Wiring Diagrams 42
Analog Wiring 50

Chapter 4

Communication Connections

Supported Communication Protocols. 59
Default Communication Configuration. 60
Using the Communications Toggle Functionality. 60
Changing Communication Configuration 61
Connecting to the RS-232 Port. 63
Making a DF1 Point-to-Point Connection. 64
Using a Modem 65
Connecting to a DF1 Half-Duplex Network 68
Connecting to a RS-485 Network. 70
DH-485 Configuration Parameters 71
Recommended Tools 73
DH-485 Communication Cable 73

Connecting the Communication Cable to the DH-485 Connector . . 74
Grounding and Terminating the DH-485 Network 75
Connecting the AIC+ 76
Cable Selection Guide 77
Recommended User-Supplied Components 80
Safety Considerations 81
Install and Attach the AIC+ 81
Powering the AIC+ 82
Connecting to DeviceNet 83
Cable Selection Guide 83
Connecting to Ethernet 84
Ethernet Connections 85

Chapter 5

Using the LCD

Operating Principles 88
Main Menu and Default Screen 91
Operating Buttons 93
Using Menus to Choose Values 93
Selecting Between Menu Items 93
Cursor Display 94
Setting Values 95
I/O Status 95
Viewing I/O Status 96
Monitor User Defined Target Files 97
Target User Defined File Number (TUF) 97
Monitoring a Bit File 98
Monitoring Integer Files 102
Monitoring Double Integer files 107
Monitor Floating point Files 113
Monitor System Status Files 113
Using the Mode Switch 114
Controller Modes 115
Changing Mode Switch Position 115
Using a User Defined LCD Screen 117
User Defined LCD Screen 118
Configuring Advanced Settings 119
Changing Key In Mode 120
Key In Modes 120
Changing Key In Mode 120
Using Communications Toggle Functionality 122
Ethernet Network Configuration 122
Viewing Ethernet Status 122
Configuring the IP Address 124
Configuring the Ethernet Port 128

Configuring Ethernet Protocol Setup. 130
Using Trim Pots. 133
Trim Pot Operation 133
Changing Data Value of a Trim Pot 134
Trim Pot Configuration in LCD Function File 135
Error Conditions 135
Viewing System Information 136
Viewing Fault Code 137
Saving/Loading Communication EEPROM 138
Saving Communication EEPROM 138
Loading communication EEPROM 141
LCD setup 141
Configuring contrast value 142
Configuring the backlight 143
Protocol Configuration 144
Modbus RTU Slave 144

Chapter 6

Using Real-Time Clock and Memory Modules

Real-Time Clock Operation 147
Operation at Power-up and Entering a Run or Test Mode 147
Writing Data to the Real-Time Clock 147
RTC Battery Operation 148
Memory Module Operation 148
User Program , User Data, Datalog and Recipe Back-up 149
Program Compare 149
Data File Download Protection 149
Memory Module Write Protection 149
Removal/Insertion Under Power 150
Memory Module Information File 150
Program /Data Download 150
Program /Data Upload 150

Chapter 7

Online Editing

Directions and Cautions for MicroLogix 1400 Online Editing User 151
A Download is Required Before Starting Online Editing 151
Types of Online Editing 152
Edit Functions in Runtime Online Editing. 153
Edit Functions in Program Online Editing 153

Appendix A

Specifications

Specifications for Inputs 155
Specifications for Outputs in Hazardous Locations (Class 1, Division 2, Groups A, B, C, D) 157

Specifications for Outputs in (Non-Hazardous) Locations only 158
Working Voltage 161
Expansion I/O Specifications 162
Digital I/O Modules 162
Analog Modules 169

Appendix B

Replacement Parts

MicroLogix 1400 Replacement Kits 179
Lithium Battery (1747-BA) 179
Installation 179
Battery Handling 181
Storage 181
Transportation 181
Disposal 183

Appendix C

Troubleshooting Your System

Understanding the Controller Status Indicators 185
Controller Status LED Indicators 185
Status Indicators on the LCD 186
I/O Status Indicators on the LCD 187
Normal Operation 187
Error Conditions 187
Controller Error Recovery Model 188
Analog Expansion I/O Diagnostics and Troubleshooting 190
Module Operation and Channel Operation 190
Power-up Diagnostics 190
Critical and Non-Critical Errors 191
Module Error Definition Table 191
Error Codes 192
Calling Rockwell Automation for Assistance 193

Appendix D

Using ControlFLASH to Upgrade Your Operating System

Preparing for Firmware Upgrade 195
Install ControlFLASH Software 195
Prepare the Controller for Firmware Upgrade 196
Using ControlFLASH for Firmware Upgrade 197
ControlFLASH Error Messages 207
Missing or Corrupt OS state 209
Recovering from Missing or Corrupt OS State 210

Appendix E

Connecting to Networks via RS-232/RS-485 Interface

RS-232 Communication Interface 211
RS-485 Communication Interface 211
DF1 Full-Duplex Protocol 211

DF1 Half-Duplex Protocol 212
DF1 Half-Duplex Operation 212
Considerations When Communicating as a DF1 Slave on a Multi-drop Link 214
Using Modems with MicroLogix Programmable Controllers 214
DH-485 Communication Protocol 215
DH-485 Configuration Parameters 216
Devices that use the DH-485 Network 216
Important DH-485 Network Planning Considerations 217
Example DH-485 Connections 221
Modbus Communication Protocol 223
ASCII 223
Distributed Network Protocol (DNP3) 223

Appendix F

MicroLogix 1400 Distributed Network Protocol (DNP3)

Channel Configuration for DNP3 Slave 225
Channel 0 and Channel 2 Link Layer Configuration 227
Channel 1 Link Layer Configuration 228
DNP3 Slave Application Layer Configuration 230
Channel 0 and Channel 2 Link Layer Configuration Parameters . 232
Channel 1(Ethernet) Link Layer Configuration Parameters 236
DNP3 Slave Application Layer Configuration Parameters 241
DNP3 Slave Application Layer 254
Function Codes 254
Internal Indications 259
DNP3 Objects and MicroLogix 1400 Data Files 260
DNP3 Data Files 264
DNP 3 Configuration Files 265
DNP3 Binary Input Object 269
DNP3 Binary Output Object 271
DNP3 Double Bit Binary Input Object 274
DNP3 Counter Object 276
DNP3 Frozen Counter Object 279
DNP3 Analog Input Object 281
DNP3 Analog Output Object 285
DNP3 BCD Object 287
DNP3 Data Set Object 289
Object Quality Flags 299
DNP3 Device Attribute Object 303
Event Reporting 307
Generating Events 307
Control Generating Event 311
Reporting Event By Polled Response 312
Reporting Event By Unsolicited Response 313
Collision Avoidance 315

Time Synchronization 316
Download a User Program via DNP3 Network 317
Default Directories and Files 318
Generating *.IMG files using RSLogix 500/RSLogix Micro 318
Rules for File Authentication 320
Rules for Downloading a User Program 321
Rules for Uploading a User Program 322
Rules for Initializing a User Program 324
Rules for uploading Communication Status Files 324
Starting and Stopping User Programs (Mode Change) via DNP3 Network 324
Initialize User Program 325
Start User Program 325
Stop User Program 325
Diagnostics 326
Diagnostics for Ethernet Channel (Channel 1) 332
Diagnostics for Secure Authentication 339
Function Codes 341
Implementation Table 344

Appendix G

Connecting to Networks via Ethernet Interface

MicroLogix 1400 Controllers and Ethernet Communication 355
MicroLogix 1400 Performance Considerations 356
MicroLogix 1400 and PC Connections to the Ethernet Network 357
Ethernet Network Topology 357
Connecting an Ethernet switch on the Ethernet Network 357
Cables 358
Ethernet Connections 360
Duplicate IP address Detection 361
Configuring the Ethernet Channel on the MicroLogix 1400 362
Configuration Using RSLogix 500/RSLogix Micro Programming Software 364
Configuration Via BOOTP 364
Using the Rockwell Automation BOOTP/DHCP Utility 365
Using a DHCP Server To Configure Your Processor 367
Using Subnet Masks and Gateways 368
Manually Configuring Channel 1 for Controllers on Subnets 369
MicroLogix 1400 Embedded Web Server Capability 369

Appendix H

System Loading and Heat Dissipation

System Loading Calculations 371
System Loading Example Calculations 372
System Loading Worksheet 373

Current Loading. 373
Calculating Heat Dissipation 375

Glossary

Index

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual
- the purpose of this manual
- related documentation
- conventions used in this manual
- Rockwell Automation support

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use MicroLogix 1400 controllers.

You should have a basic understanding of electrical circuitry and familiarity with relay logic. If you do not, obtain the proper training before using this product.

Purpose of this Manual

This manual is a reference guide for MicroLogix 1400 controllers and expansion I/O. It describes the procedures you use to install, wire, and troubleshoot your controller. This manual:

- explains how to install and wire your controllers
- gives you an overview of the MicroLogix 1400 controller system

Refer to publication 1766-RM001, MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual for the MicroLogix 1400 instruction set and for application examples to show the instruction set in use. Refer to your RSLogix 500/RSLogix Micro programming software user documentation for more information on programming your MicroLogix 1400 controller.

Related Documentation

The following documents contain additional information concerning Rockwell Automation products. To obtain a copy, contact your local Rockwell Automation office or distributor.

Resource	Description
MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual 1766-RM001	Information on the MicroLogix 1400 Controllers instruction set.
MicroLogix 1400 Programmable Controllers Installation Instructions 1766 -IN001	Information on mounting and wiring the MicroLogix 1400 Controllers, including a mounting template for easy installation.
Advanced Interface Converter (AIC+) User Manual 1761-UM004	A description on how to install and connect an AIC+. This manual also contains information on network wiring.
DeviceNet Interface User Manual 1761-UM005	Information on how to install, configure, and commission a DNI.
DF1 Protocol and Command Set Reference Manual 1770-6.5.16	Information on DF1 open protocol.
Modbus Protocol Specifications Available from www.modbus.org	Information about the Modbus protocol.
Distributed Network Protocol(DNP3) Specifications Available from www.dnp.org	Information about the Distributed Network Protocol.
Allen-Bradley Programmable Controller Grounding and Wiring Guidelines 1770-4.1	In-depth information on grounding and wiring Allen-Bradley programmable controllers.
Application Considerations for Solid-State Controls SGI-1.1	A description of important differences between solid-state programmable controller products and hard-wired electromechanical devices.
National Electrical Code - Published by the National Fire Protection Association of Boston, MA.	An article on wire sizes and types for grounding electrical equipment.
Allen-Bradley Publication Index SD499	A complete listing of current documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages.
Allen-Bradley Industrial Automation Glossary AG-7.1	A glossary of industrial automation terms and abbreviations.

Common Techniques Used in this Manual

The following conventions are used throughout this manual:

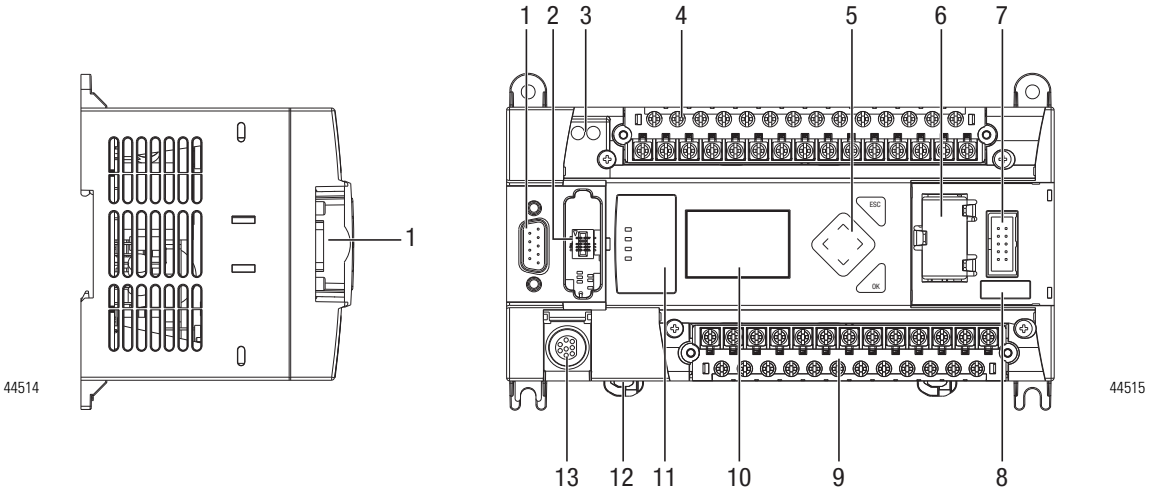
- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- *Italic* type is used for emphasis.

Hardware Overview

Hardware Features

The Bulletin 1766, MicroLogix 1400 programmable controller contains a power supply, input and output circuits, a processor, an isolated combination RS-232/485 communication port, an Ethernet port, and a non-isolated RS-232 communication port. Each controller supports 32 discrete I/O points(20 digital inputs, 12 discrete outputs) and 6 analog I/O points(4 analog inputs and 2 analog outputs : 1766-L32BWAA, 1766-AWAA and 1766-BXBA only).

The hardware features of the controller are shown below.



Left side view

Top view

	Description
1	Comm port 2 - 9-pin D-Shell RS-232C connector
2	Memory module (refer to MicroLogix 1400 Memory Module Installation Instructions, publication 1766-IN010A for instructions on installing the memory module).
3	User 24V (for 1766-BWA and 1766-BWAA only)
4	Input terminal block
5	LCD Display Keypad (ESC, OK, Up, Down, Left, Right)
6	Battery compartment
7	1762 expansion bus connector
8	Battery connector
9	Output terminal block
10	LCD Display

	Description
11	Indicator LED panel
12	Comm port 1 - RJ45 connector
13	Comm port 0 - 8-pin mini DIN RS-232C/RS-485 connector

Controller Input and Output Description

Catalog Number	Description				
	Input Power	User Power	Embedded Discrete I/O	Embedded Analog I/O	Comm. Ports
1766-L32BWA	100/240V AC	24V DC	12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 12 Relay Outputs	None	1 RS232/RS485[1] 1 Ethernet 1 RS232[2]
1766-L32AWA		None	20 120V AC Inputs 12 Relay Outputs		
1766-L32BXB	24V DC		12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 6 Relay Outputs 3 Fast DC Outputs 3 Normal DC Outputs		
1766-L32BWAA	100/240V AC	24V DC	12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 12 Relay Outputs	4 Voltage Inputs 2 Voltage Outputs	
1766-L32AWAA		None	20 120V AC Inputs 12 Relay Outputs		
1766-L32BXBA	24V DC		12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 6 Relay Outputs 3 Fast DC Outputs 3 Normal DC Outputs		

(1) Isolated RS-232/RS-485 combo port.

(2) Non-isolated RS-232. Standard D-sub connector

Component Descriptions

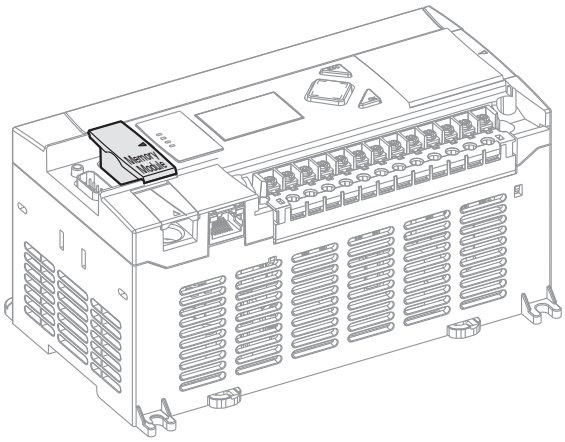
MicroLogix 1400 Memory Module and Built-in Real-Time Clock

The controller has a built-in real-time clock to provide a reference for applications that need time-based control.

The controller is shipped with a memory module port cover in place. You can order a memory module, 1766-MM1, as an accessory. The memory module provides optional backup of your user program and data, and is a means to transport your programs between controllers.

The program and data in your MicroLogix 1400 is non-volatile and is stored when the power is lost to the controller. The memory module provides additional backup that can be stored separately. The memory module does not increase the available memory of the controller.

Figure 1 - 1766-MM1 Memory Module



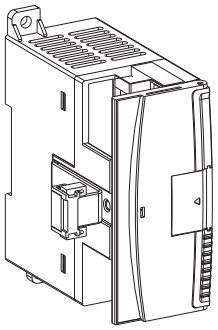
1762 Expansion I/O

1762 expansion I/O can be connected to the MicroLogix 1400 controller, as shown below.

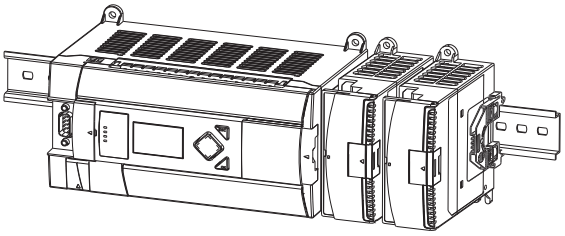
TIP A maximum of seven I/O modules, in *any* combination, can be connected to a controller. See Appendix H to determine how much heat a certain combination generates.

Figure 2 - 1762 Expansion I/O

1762 Expansion I/O



1762 Expansion I/O Connected to MicroLogix 1400 Controller



Expansion I/O

Catalog Number	Description
Digital	
1762-IA8	8-Point 120V AC Input Module
1762-IQ8	8-Point Sink/Source 24V DC Input Module
1762-IQ16	16-Point Sink/Source 24V DC Input Module
1762-IQ32T	32-Point Sink/Source 24V DC Input Module
1762-OA8	8-Point 120/240V AC Triac Output Module
1762-OB8	8-Point Sourcing 24V DC Output Module

Expansion I/O

Catalog Number	Description
1762-OB16	16-Point Sourcing 24V DC Output Module
1762-OB32T	32-Point Sourcing 24V DC Output Module
1762-OV32T	32-Point Sinking 24V DC Output Module
1762-OW8	8-Point AC/DC Relay Output Module
1762-OW16	16-Point AC/DC Relay Output Module
1762-OX6I	6-Point Isolated AC/DC Relay Output Module
1762-IQ8OW6	8-Point Sink/Source 24V DC Input and 6-Point AC/DC Relay Output Module
Analog	
1762-IF4	4-Channel Voltage/Current Analog Input Module
1762-OF4	4-Channel Voltage/Current Analog Output Module
1762-IF2OF2	Combination 2-Channel Input 2-Channel Output Voltage/Current Analog Module
Temperature	
1762-IR4	4-Channel RTD/Resistance Input Module
1762-IT4	4-Channel Thermocouple/mV Input Module

Communication Cables

Use only the following communication cables with the MicroLogix 1400 controllers. These cables are required for Class I Div. 2 applications.

- 1761-CBL-AM00 Series C or later
- 1761-CBL-AP00 Series C or later
- 1761-CBL-PM02 Series C or later
- 1761-CBL-HM02 Series C or later
- 2707-NC9 Series C or later
- 1763-NC01 Series A or later
- 1747-CP3 Series A or later



ATTENTION: UNSUPPORTED CONNECTION
Do not connect a MicroLogix 1400 controller to another MicroLogix family controller such as MicroLogix 1000, MicroLogix 1200, MicroLogix 1500, or the network port of a 1747-DPS1 Port Splitter using a 1761-CBL-AM00 (8-pin mini-DIN to 8-pin mini-DIN) cable or equivalent.
This type of connection will cause damage to the RS-232/485 communication port (Channel 0) of the MicroLogix 1400 and/or the controller itself. The communication pins used for RS-485 communications on the MicroLogix 1400 are alternately used for 24V power on the other MicroLogix controllers and the network port of the 1747-DPS1 Port Splitter.

Programming

Programming the MicroLogix 1400 controller is done using RSLogix 500/RSLogix Micro, Revision 8.10.00 or later for Series A controllers

and 8.30.00 or later for Series B controllers. Communication cables for programming are available separately from the controller and software.

Communication Options

The MicroLogix 1400 controllers provide three communications ports, an isolated combination RS-232/485 communication port (Channel 0), an Ethernet port (Channel 1) and a non-isolated RS-232 communication port (Channel 2).

The Channel 0 and Channel 2 ports on the MicroLogix 1400 can be connected to the following:

- operator interfaces, personal computers, etc. using DF1 Full Duplex point-to-point
- a DH-485 network
- a DF1 Radio Modem network
- a DF1 half-duplex network as an RTU Master or RTU Slave
- a Modbus network as an RTU Master or RTU Slave
- an ASCII network
- a DeviceNet network as a slave or peer using a DeviceNet Interface (catalog number 1761-NET-DNI)
- an Ethernet network using the Ethernet Interface module (catalog number 1761-NET-ENI, or 1761-NET-ENIW)
- a DNP3 network as a Slave

When connecting to RS-485 network using DH-485, DF1 Half-Duplex Master/Slave, Modbus RTU Master/Slave or DNP3 Slave protocols, the MicroLogix 1400 can be connected directly via Channel 0 without an Advanced Interface Converter, catalog number 1761-NET-AIC. The Channel 0 combo port provides both RS-232 and RS-485 isolated connections. The appropriate electrical interface is selected through your choice of communication cable. The existing MicroLogix 1761 communication cables provide an interface to the RS-232 drivers. The 1763-NC01 cable provides an interface to the RS-485 drivers.

The controller may also be connected to serial devices, such as bar code readers, weigh scales, serial printers, and other intelligent devices, using ASCII. See Default Communication Configuration on page 60 for the configuration settings for Channel 0. MicroLogix 1400 can be connected directly to RS-485 network via channel 0, using ASCII.

The MicroLogix 1400 supports EtherNet/IP communication via the Ethernet communication Channel 1. In addition, either Modbus TCP or DNP3 over IP can be enabled for Channel 1. You can connect your controller to a local area network that provides communication between various devices at 10 Mbps or 100 Mbps. This port supports CIP explicit messaging (message exchange) only. The controller cannot be used for CIP implicit messaging (real-time I/O messaging). The controller also includes an embedded web server which allows

viewing of not only module information, TCP/IP configuration, and diagnostic information, but also includes the data table memory map and data table monitor screen using a standard web browser.

See Chapter 4 for more information on connecting to the available communication options.

Install Your Controller

This chapter shows you how to install your controller. The only tools you require are a flat or Phillips head screwdriver and drill. Topics include:

- agency certifications
- compliance to European Union Directives
- installation considerations
- safety considerations
- power considerations
- preventing excessive heat
- master control relay
- installing a memory module
- using the battery
- controller mounting dimensions
- controller and expansion I/O spacing
- mounting the controller
- mounting 1762 expansion I/O
- connecting 1762 expansion I/O

Agency Certifications

- UL Listed Industrial Control Equipment for use in Class I, Division 2, Hazardous Locations, Groups A, B, C, D
- CE marked for all applicable directives
- C-Tick marked for all applicable acts
- C-UL Listed Industrial Control Equipment for use in Canada

Compliance to European Union Directives

This product has the CE mark and is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 2004/108/EC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)

- EN 61131-2; Programmable Controllers (Clause 11)
- EN 61000-6-4
  EMC - Part 6-4: Generic Standards - Emission Standard for Industrial Environments
- EN 61000-6-2
  EMC - Part 6-2: Generic Standards - Immunity for Industrial Environments

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 2006/95/ECLow Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 - Equipment Requirements and Tests.

For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- *Industrial Automation Wiring and Grounding Guidelines for Noise Immunity*, publication 1770-4.1
- *Guidelines for Handling Lithium Batteries*, publication AG-5.4
- *Automation Systems Catalog*, publication B115

Installation Considerations

Most applications require installation in an industrial enclosure (Pollution Degree 2[(1)]) to reduce the effects of electrical interference (Over Voltage Category II[(2)]) and environmental exposure. Locate your controller as far as possible from power lines, load lines, and other sources of electrical noise such as hard-contact switches, relays, and AC motor drives. For more information on proper grounding guidelines, see the *Industrial Automation Wiring and Grounding Guidelines* publication 1770-4.1.



ATTENTION: Electrostatic discharge can damage semiconductor devices inside the controller. Do not touch the connector pins or other sensitive areas.



ATTENTION: Vertical mounting of the controller is not supported due to heat build-up considerations.

(1) Pollution Degree 2 is an environment where normally only non-conductive pollution occurs except that occasionally temporary conductivity caused by condensation shall be expected.

(2) Overvoltage Category II is the load level section of the electrical distribution system. At this level, transient voltages are controlled and do not exceed the impulse voltage capability of the products insulation.

ATTENTION: Be careful of metal chips when drilling mounting holes for your controller or other equipment within the enclosure or panel. Drilled fragments that fall into the controller or I/O modules could cause damage. Do not drill holes above a mounted controller if the protective debris shields are removed or the processor is installed.

WARNING: Do not place the MicroLogix 1400 Programmable Controller in direct sunlight. Prolonged exposure to direct sunlight could degrade the LCD display and have adverse effects on the controller.
The controller is not designed for outdoor use.

Safety Considerations

Safety considerations are an important element of proper system installation. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance. We recommend reviewing the following safety considerations.

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following WARNING statement applies to use in hazardous locations.

WARNING: EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off.
- Do not connect or disconnect components unless power has been switched off.
- This product must be installed in an enclosure. All cables connected to the product must remain in the enclosure or be protected by conduit or other means.
- All wiring must comply with N.E.C. article 501-4(b).

Use only the following communication cables in Class I, Division 2 hazardous locations.

Environment Classification	Communication Cables
Class I, Division 2 Hazardous Environment	1761-CBL-AC00 Series C or later
	1761-CBL-AM00 Series C or later
	1761-CBL-AP00 Series C or later
	1761-CBL-PM02 Series C or later
	1761-CBL-HM02 Series C or later
	2707-NC9 Series C or later
	1763-NC01 Series A or later
	1747-CP3 Series

Disconnecting Main Power



WARNING: Explosion Hazard
Do not replace components, connect equipment, or disconnect equipment unless power has been switched off.

The main power disconnect switch should be located where operators and maintenance personnel have quick and easy access to it. In addition to disconnecting electrical power, all other sources of power (pneumatic and hydraulic) should be de-energized before working on a machine or process controlled by a controller.

Safety Circuits



WARNING: Explosion Hazard
Do not connect or disconnect connectors while circuit is live.

Circuits installed on the machine for safety reasons, like overtravel limit switches, stop push buttons, and interlocks, should always be hard-wired directly to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized, thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

Power Distribution

There are some points about power distribution that you should know:

- The master control relay must be able to inhibit all machine motion by removing power to the machine I/O devices when the relay is de-energized. It is recommended that the controller remain powered even when the master control relay is de-energized.

- If you are using a DC power supply, interrupt the load side rather than the AC line power. This avoids the additional delay of power supply turn-off. The DC power supply should be powered directly from the fused secondary of the transformer. Power to the DC input and output circuits should be connected through a set of master control relay contacts.

Periodic Tests of Master Control Relay Circuit

Any part can fail, including the switches in a master control relay circuit. The failure of one of these switches would most likely cause an open circuit, which would be a safe power-off failure. However, if one of these switches shorts out, it no longer provides any safety protection. These switches should be tested periodically to assure they will stop machine motion when needed.

Power Considerations

The following explains power considerations for the micro controllers.

Isolation Transformers

You may want to use an isolation transformer in the AC line to the controller. This type of transformer provides isolation from your power distribution system to reduce the electrical noise that enters the controller and is often used as a step-down transformer to reduce line voltage. Any transformer used with the controller must have a sufficient power rating for its load. The power rating is expressed in volt-amperes (VA).

Power Supply Inrush

During power-up, the MicroLogix 1400 power supply allows a brief inrush current to charge internal capacitors. Many power lines and control transformers can supply inrush current for a brief time. If the power source cannot supply this inrush current, the source voltage may sag momentarily.

The only effect of limited inrush current and voltage sag on the MicroLogix 1400 is that the power supply capacitors charge more slowly. However, the effect of a voltage sag on other equipment should be considered. For example, a deep voltage sag may reset a computer connected to the same power source. The following considerations determine whether the power source must be required to supply high inrush current:

- The power-up sequence of devices in a system.
- The amount of the power source voltage sag if the inrush current cannot be supplied.
- The effect of voltage sag on other equipment in the system.

If the entire system is powered-up at the same time, a brief sag in the power source voltage typically will not affect any equipment.

Loss of Power Source

The power supply is designed to withstand brief power losses without affecting the operation of the system. The time the system is operational during power loss is called program scan hold-up time after loss of power. The duration of the power supply hold-up time depends on the type and state of the I/O, but is typically between 10 milliseconds and 3 seconds. When the duration of power loss reaches this limit, the power supply signals the processor that it can no longer provide adequate DC power to the system. This is referred to as a power supply shutdown. The processor then performs an orderly shutdown of the controller.

Input States on Power Down

The power supply hold-up time as described above is generally longer than the turn-on and turn-off times of the inputs. Because of this, the input state change from “On” to “Off” that occurs when power is removed may be recorded by the processor before the power supply shuts down the system. Understanding this concept is important. The user program should be written to take this effect into account.

Other Types of Line Conditions

Occasionally the power source to the system can be temporarily interrupted. It is also possible that the voltage level may drop substantially below the normal line voltage range for a period of time. Both of these conditions are considered to be a loss of power for the system.

Preventing Excessive Heat

For most applications, normal convective cooling keeps the controller within the specified operating range. Ensure that the specified temperature range is maintained. Proper spacing of components within an enclosure is usually sufficient for heat dissipation.

In some applications, a substantial amount of heat is produced by other equipment inside or outside the enclosure. In this case, place blower fans inside

the enclosure to assist in air circulation and to reduce "hot spots" near the controller.

Additional cooling provisions might be necessary when high ambient temperatures are encountered.

TIP Do not bring in unfiltered outside air. Place the controller in an enclosure to protect it from a corrosive atmosphere. Harmful contaminants or dirt could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to protect against heat build-up within the enclosure.

Master Control Relay

A hard-wired master control relay (MCR) provides a reliable means for emergency machine shutdown. Since the master control relay allows the placement of several emergency-stop switches in different locations, its installation is important from a safety standpoint. Overtravel limit switches or mushroom-head push buttons are wired in series so that when any of them opens, the master control relay is de-energized. This removes power to input and output device circuits. Refer to the figures on pages 15 and 16.



ATTENTION: Never alter these circuits to defeat their function since serious injury and/or machine damage could result.

TIP If you are using an external DC power supply, interrupt the DC output side rather than the AC line side of the supply to avoid the additional delay of power supply turn-off.

The AC line of the DC output power supply should be fused.

Connect a set of master control relays in series with the DC power supplying the input and output circuits.

Place the main power disconnect switch where operators and maintenance personnel have quick and easy access to it. If you mount a disconnect switch inside the controller enclosure, place the switch operating handle on the outside of the enclosure, so that you can disconnect power without opening the enclosure.

Whenever any of the emergency-stop switches are opened, power to input and output devices should be removed.

When you use the master control relay to remove power from the external I/O circuits, power continues to be provided to the controller's power supply so that diagnostic indicators on the processor can still be observed.

The master control relay is not a substitute for a disconnect to the controller. It is intended for any situation where the operator must quickly de-energize I/O devices only. When inspecting or installing terminal connections, replacing

output fuses, or working on equipment within the enclosure, use the disconnect to shut off power to the rest of the system.

TIP Do not control the master control relay with the controller. Provide the operator with the safety of a direct connection between an emergency-stop switch and the master control relay.

Using Emergency-Stop Switches

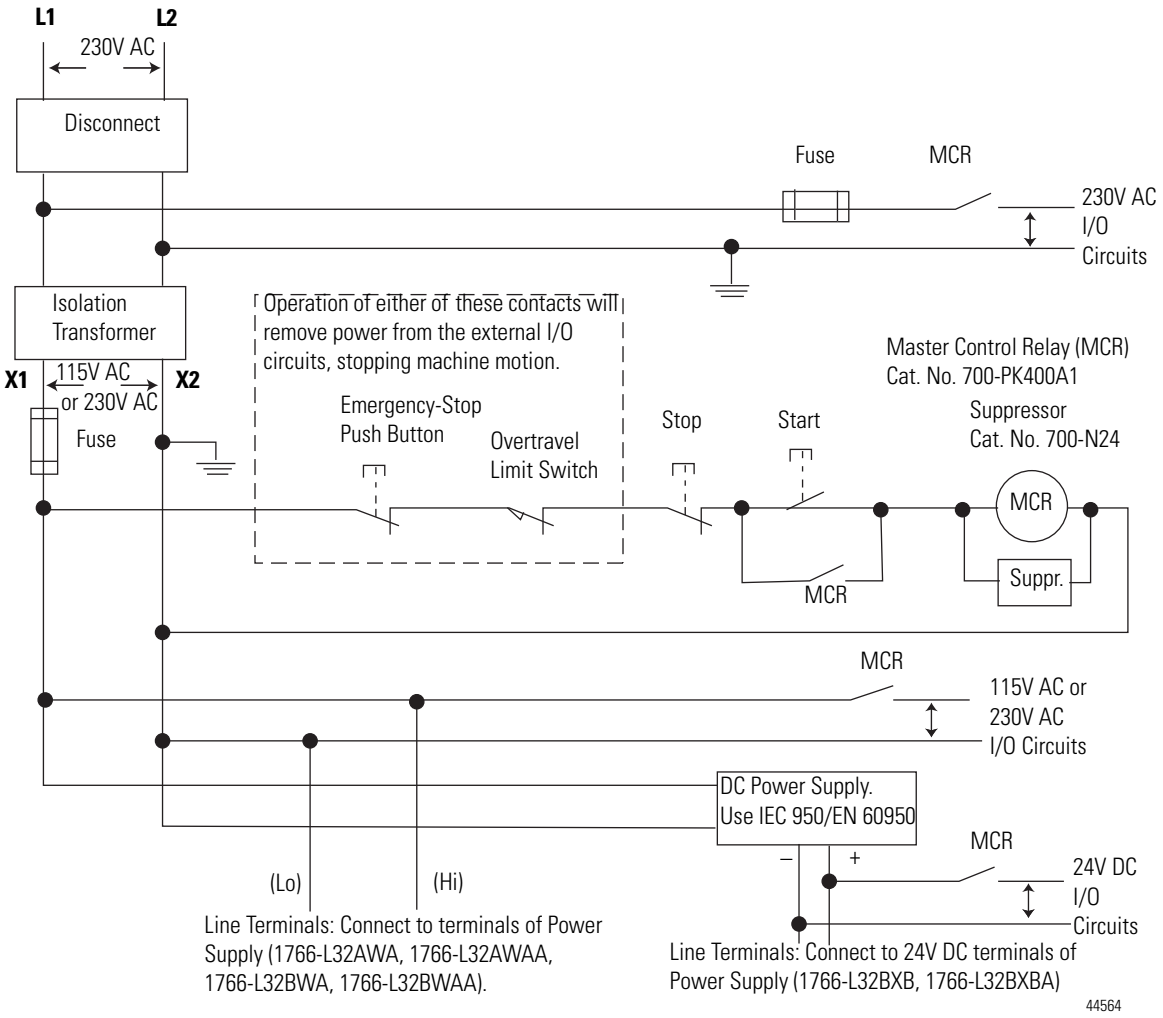
When using emergency-stop switches, adhere to the following points:

- Do not program emergency-stop switches in the controller program. Any emergency-stop switch should turn off all machine power by turning off the master control relay.
- Observe all applicable local codes concerning the placement and labeling of emergency-stop switches.
- Install emergency-stop switches and the master control relay in your system. Make certain that relay contacts have a sufficient rating for your application. Emergency-stop switches must be easy to reach.
- In the following illustration, input and output circuits are shown with MCR protection. However, in most applications, only output circuits require MCR protection.

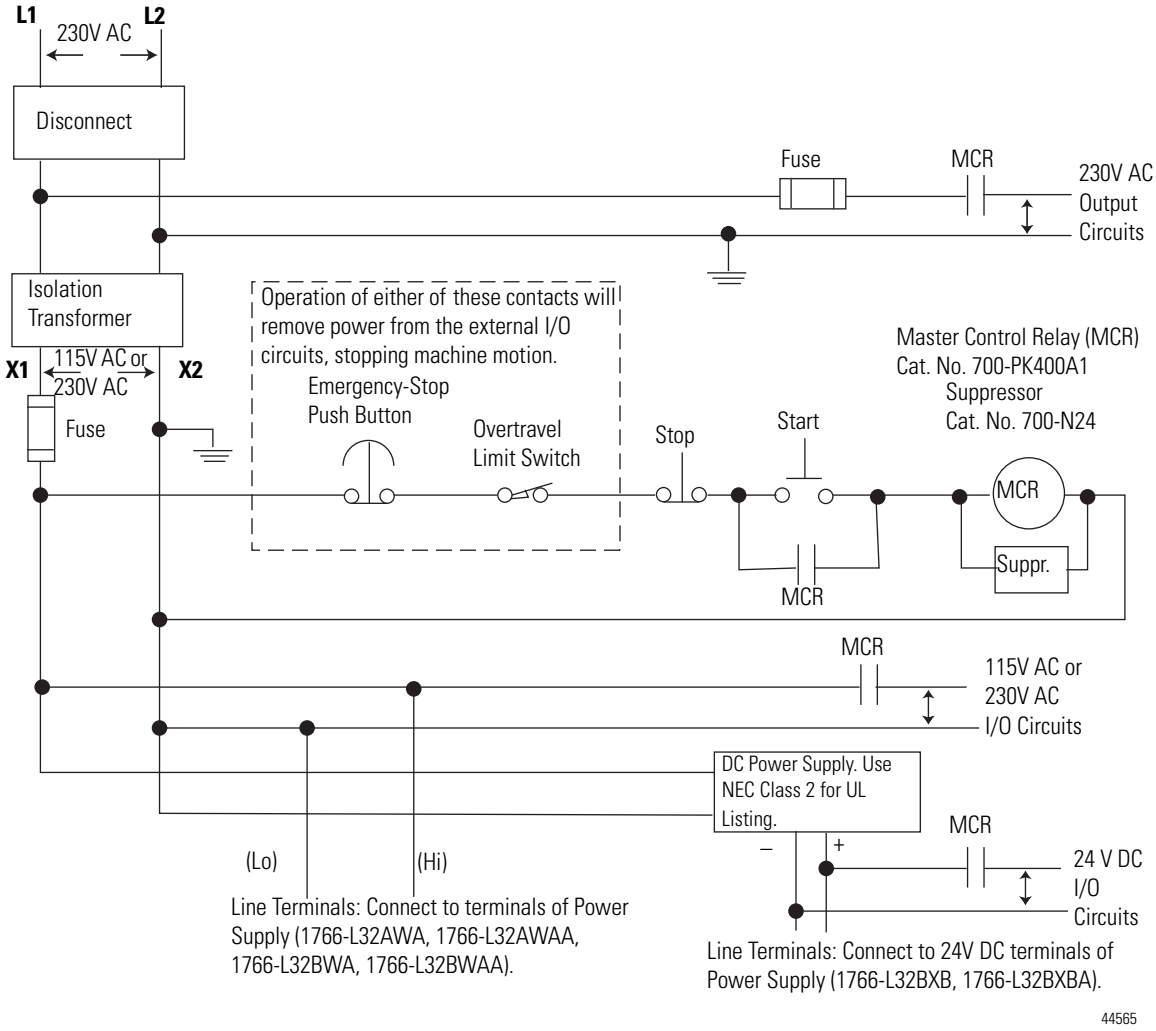
The following illustrations show the Master Control Relay wired in a grounded system.

TIP In most applications input circuits do not require MCR protection; however, if you need to remove power from all field devices, you must include MCR contacts in series with input power wiring.

Schematic (Using IEC Symbols)

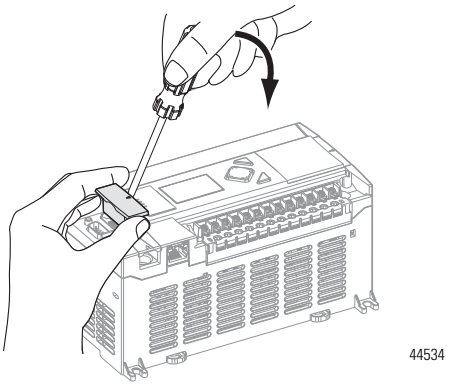


Schematic (Using ANSI/CSA Symbols)

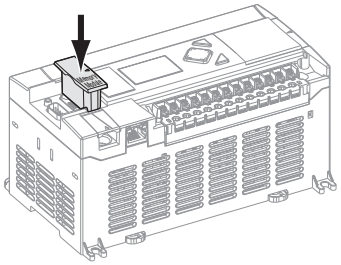


Installing a Memory Module

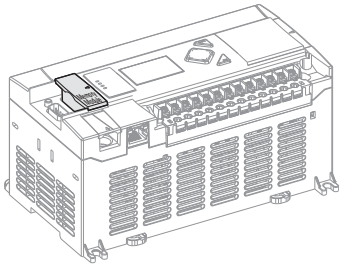
1. Remove the memory module port cover.



2. Align the connector on the memory module with the connector pins on the controller.



3. Firmly seat the memory module into the controller.



4. Use a screwdriver as in step 1 to remove the memory module in the future.

Using the Battery

The MicroLogix 1400 controller is equipped with a replaceable battery (catalog number 1747-BA). The Battery Low indicator on the LCD display of the controller shows the status of the replaceable battery. When the battery is low, the indicator is set (displayed as a solid rectangle). This means that either the battery wire connector is disconnected, or the battery may fail within 2 weeks if it is connected.

IMPORTANT

The MicroLogix 1400 controller ships with the battery wire connector connected.

Ensure that the battery wire connector is inserted into the connector port if your application needs battery power. For example, when using a real-time clock (RTC).

Replacing the battery when the controller is powered down will lose all user application memory. Replace the battery when the controller is powered on.

Refer to the SLC 500 Lithium Battery Installation Instructions, publication 1747-IN515, for more information on installation, handling, usage, storage, and disposal of the battery.

See RTC Battery Operation on page 120, for more information on the use of the battery in relation with RTC.

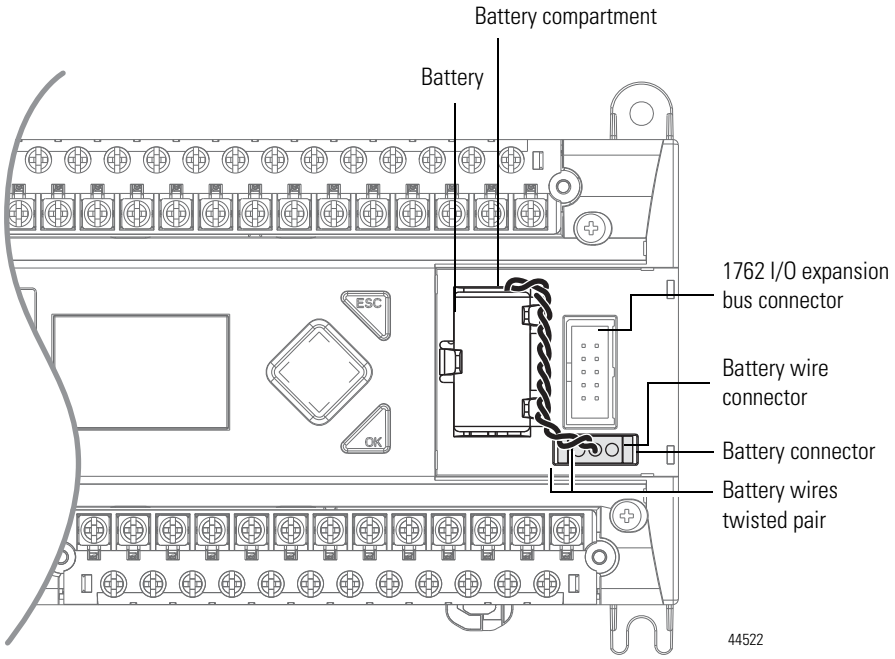
WARNING: When you connect or disconnect the battery an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that the area is nonhazardous before proceeding.
For Safety information on the handling of lithium batteries, including handling and disposal of leaking batteries, see Guidelines for Handling Lithium Batteries, publication AG 5-4.

IMPORTANT When the controller's Battery Low indicator is set (displayed as a solid rectangle) with the battery wire connector connected, you should install a new battery immediately.

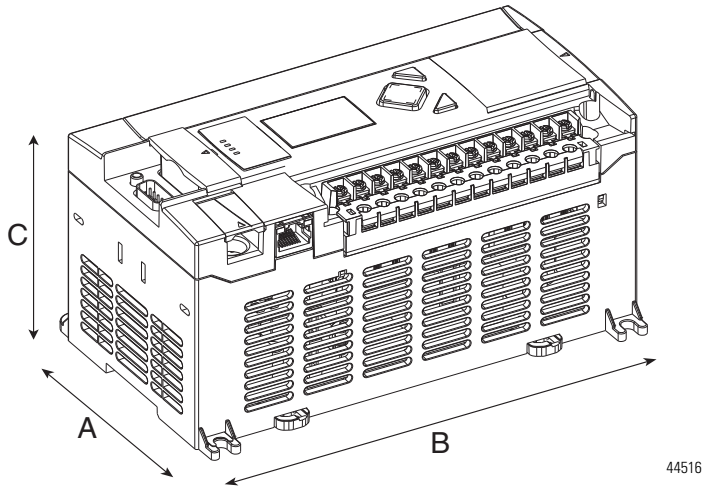
Connecting the Battery Wire Connector

Follow the procedure below to connect the battery wire connector to the battery connector.

1. Insert the replaceable battery wire connector into the controller's battery connector.
2. Secure the battery connector wires so that it does not block the 1762 expansion bus connector as shown below.



Controller Mounting Dimensions

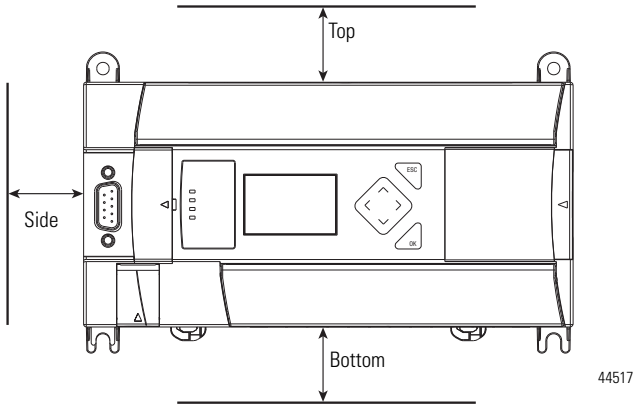


1766-L32BWA, 1766-L32AWA, 1766-L32BXB, 1766-L32BWAA, 1766-L32AWAA, 1766-L32BXBA

Dimension	Measurement
A	90 mm (3.5 in.)
B	180 mm (7.087 in.)
C	87 mm (3.43 in.)

Controller and Expansion I/O Spacing

The controller mounts horizontally, with the expansion I/O extending to the right of the controller. Allow 50 mm (2 in.) of space on all sides of the controller system for adequate ventilation. Maintain spacing from enclosure walls, wireways, adjacent equipment, and so on, as shown below.

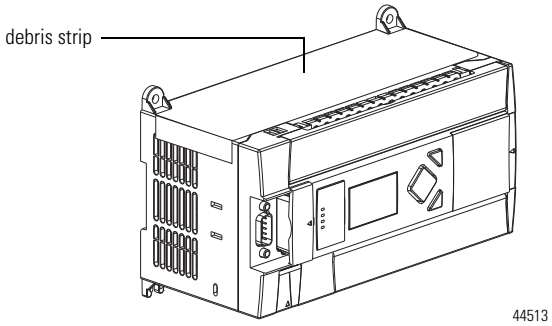


Mounting the Controller

MicroLogix 1400 controllers are suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment

is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits not exceeding Over Voltage Category II[2] (IEC 60664-1).[3]

ATTENTION: Do not remove the protective debris shield until after the controller and all other equipment in the panel near the controller are mounted and wiring is complete. Once wiring is complete, remove protective debris shield. Failure to remove shield before operating can cause overheating.



ATTENTION: Electrostatic discharge can damage semiconductor devices inside the controller. Do not touch the connector pins or other sensitive areas.

TIP For environments with greater vibration and shock concerns, use the panel mounting method described on page 23, rather than DIN rail mounting.

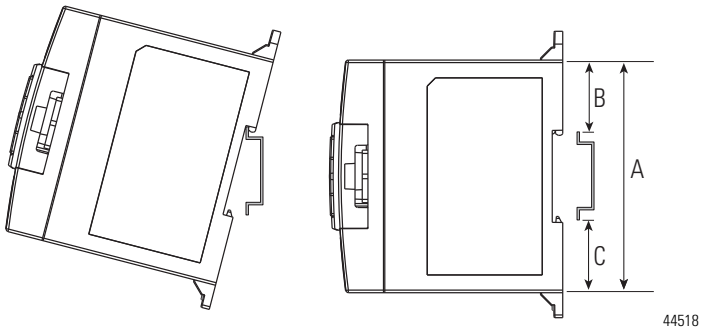
(1) Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.

(2) Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.

(3) Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

DIN Rail Mounting

The maximum extension of the latch is 14 mm (0.55 in.) in the open position. A flat-blade screwdriver is required for removal of the controller. The controller can be mounted to EN50022-35x7.5 or EN50022-35x15 DIN rails. DIN rail mounting dimensions are shown below.



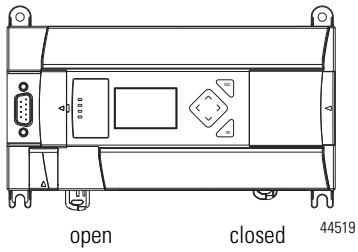
Dimension	Height
A	90 mm (3.5 in.)
B	27.5 mm (1.08 in.)
C	27.5 mm (1.08 in.)

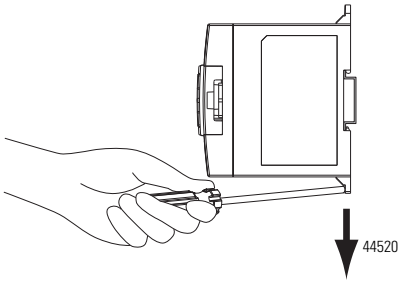
Follow this procedure to install your controller on the DIN rail.

1. Mount your DIN rail. (Make sure that the placement of the controller on the DIN rail meets the recommended spacing requirements, see Controller and Expansion I/O Spacing on page 20. Refer to the mounting template inside the back cover of this document.)
2. Close the DIN latch, if it is open.
3. Hook the top slot over the DIN rail.
4. While pressing the controller down against the top of the rail, snap the bottom of the controller into position.
5. Leave the protective debris shield attached until you are finished wiring the controller and any other devices.

To remove your controller from the DIN rail:

1. Place a flat-blade screwdriver in the DIN rail latch at the bottom of the controller.
2. Holding the controller, pry downward on the latch until the latch locks in the open position.
3. Repeat steps 1 and 2 for the second DIN rail latch.
4. Unhook the top of the DIN rail slot from the rail.

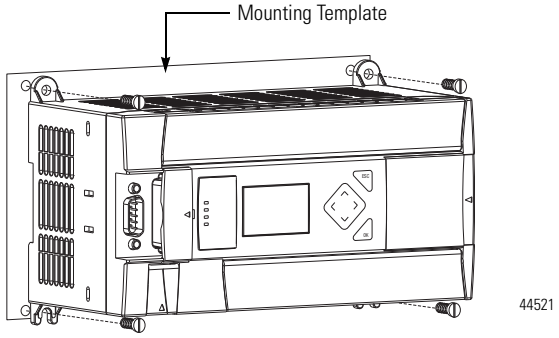




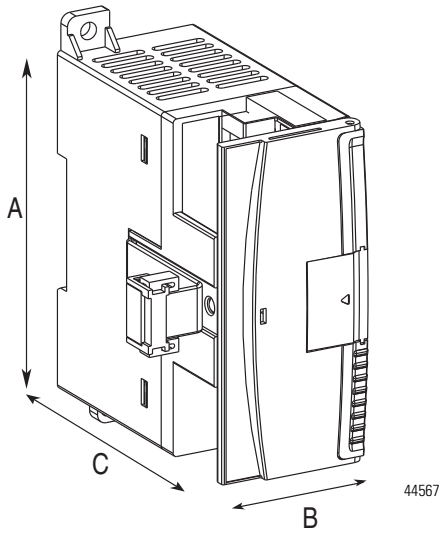
Panel Mounting

Mount to panel using #8 or M4 screws. To install your controller using mounting screws:

1. Remove the mounting template from inside the back cover of the *MicroLogix 1400 Programmable Controllers Installation Instructions*, publication 1766-IN001.
2. Secure the template to the mounting surface. (Make sure your controller is spaced properly. See Controller and Expansion I/O Spacing on page 20.)
3. Drill holes through the template.
4. Remove the mounting template.
5. Mount the controller.
6. Leave the protective debris shield in place until you are finished wiring the controller and any other devices.



1762 Expansion I/O Dimensions



Dimension	Measurement
A	90 mm (3.5 in.)
B	40 mm (1.57 in.)
C	87 mm (3.43 in.)

Mounting 1762 Expansion I/O

ATTENTION: During panel or DIN rail mounting of all devices, be sure that all debris such as metal chips and wire stands, is kept from falling into the module. Debris that falls into the module could cause damage when the module is under power.

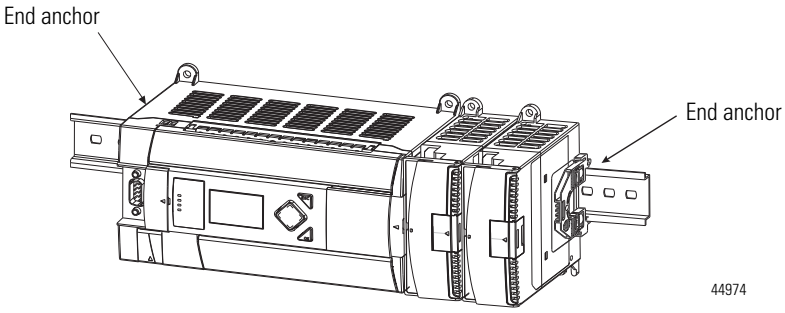
DIN Rail Mounting

The module can be mounted using the following DIN rails:

- 35 x 7.5 mm (EN 50 022 - 35 x 7.5), or
- 35 x 15 mm (EN 50 022 - 35 x 15).

Before mounting the module on a DIN rail, close the DIN rail latch. Press the DIN rail mounting area of the module against the DIN rail. The latch momentarily opens and locks into place.

Use DIN rail end anchors (Allen-Bradley part number 1492-EA35 or 1492-EAH35) for vibration or shock environments. The following illustration shows the location of the end anchors.



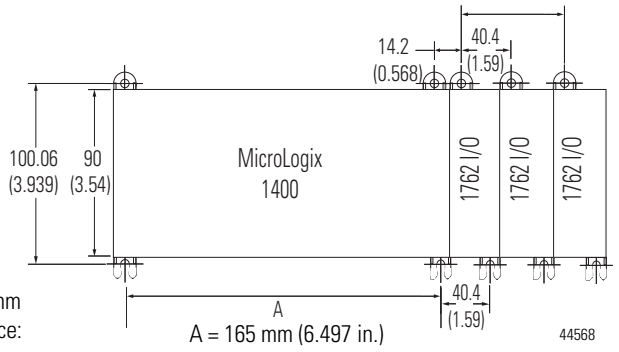
TIP 1762 expansion I/O must be mounted horizontally as illustrated.

TIP For environments with greater vibration and shock concerns, use the panel mounting method described below, instead of DIN rail mounting.

Panel Mounting

Use the dimensional template shown below to mount the module. The preferred mounting method is to use two M4 or #8 panhead screws per module. Mounting screws are required on every module.

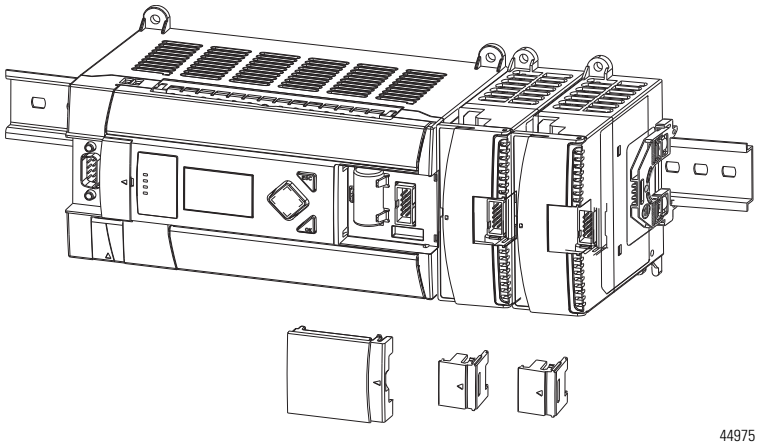
For more than 2 modules: (number of modules - 1) x 40 mm (1.59 in.)



NOTE: All dimensions are in mm (inches). Hole spacing tolerance: ±0.4 mm (0.016 in.).

Connecting Expansion I/O

The expansion I/O module is attached to the controller or another I/O module by means of a flat ribbon cable *after* mounting, as shown below.



TIP Use the pull loop on the connector to disconnect modules. Do not pull on the ribbon cable.

TIP Up to seven expansion I/O modules can be connected to a controller.

ATTENTION: Remove power before removing or inserting an I/O module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing the controller to fault
- causing an explosion in a hazardous environment

Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance, reducing product reliability.

WARNING: EXPLOSION HAZARD
In Class I, Division 2 applications, the bus connector must be fully seated and the bus connector cover must be snapped in place.

In Class I, Division 2 applications, all modules must be mounted in direct contact with each other as shown on page 26. If DIN rail mounting is used, an end stop must be installed ahead of the controller and after the last 1762 I/O module.

Wire Your Controller

This chapter describes how to wire your controller and expansion I/O. Topics include:

- wire requirements
- using surge suppressors
- grounding the controller
- wiring diagrams
- sinking and sourcing wiring diagrams
- controller I/O wiring
- wiring your analog channels
- expansion I/O wiring

Wiring Requirements

Wiring Recommendation



ATTENTION: Before you install and wire any device, disconnect power to the controller system.



ATTENTION: Calculate the maximum possible current in each power and common wire. Observe all electrical codes dictating the maximum current allowable for each wire size. Current above the maximum ratings may cause wiring to overheat, which can cause damage.
United States Only: If the controller is installed within a potentially hazardous environment, all wiring must comply with the requirements stated in the National Electrical Code 501-10 (b).

- Allow for at least 50 mm. (2 in.) between I/O wiring ducts or terminal strips and the controller.
- Route incoming power to the controller by a path separate from the device wiring. Where paths must cross, their intersection should be perpendicular.

TIP Do not run signal or communications wiring and power wiring in the same conduit. Wires with different signal characteristics should be routed by separate paths.

- Separate wiring by signal type. Bundle wiring with similar electrical characteristics together.
- Separate input wiring from output wiring.
- Label wiring to all devices in the system. Use tape, shrink-tubing, or other dependable means for labeling purposes. In addition to labeling, use colored insulation to identify wiring based on signal characteristics. For example, you may use blue for DC wiring and red for AC wiring.

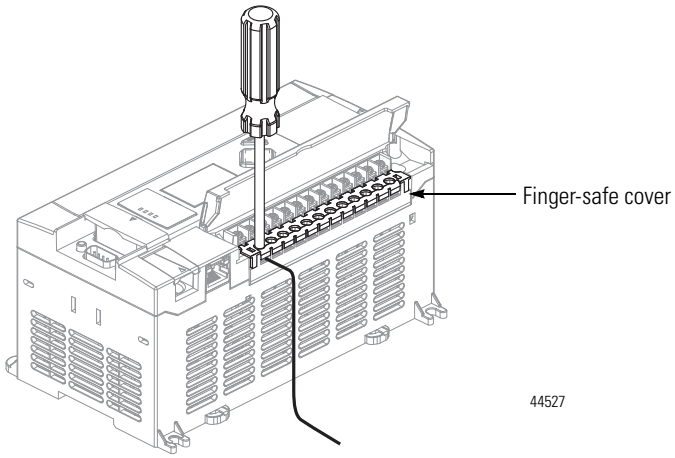
Wire Requirements

Wire Type		Wire Size (2 wire maximum per terminal screw)	
		1 wire per terminal	2 wire per terminal
Solid	Cu-90°C (194°F)	#12 to #20 AWG	#16 to #20 AWG
Stranded	Cu-90°C (194°F)	#14 to #20 AWG	#18 to #20 AWG

Wiring torque = 0.56 Nm (5.0 in-lb) rated

Wire without Spade Lugs

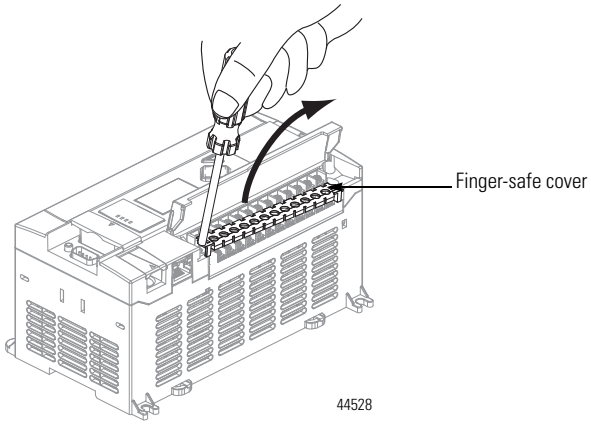
When wiring without spade lugs, it is recommended to keep the finger-safe covers in place. Loosen the terminal screw and route the wires through the opening in the finger-safe cover. Tighten the terminal screw making sure the pressure plate secures the wire.



Wire with Spade Lugs

The diameter of the terminal screw head is 5.5 mm (0.220 in.). The input and output terminals of the MicroLogix 1400 controller are designed for a 6.35 mm (0.25 in.) wide spade (standard for #6 screw for up to 14 AWG) or a 4 mm (metric #4) fork terminal.

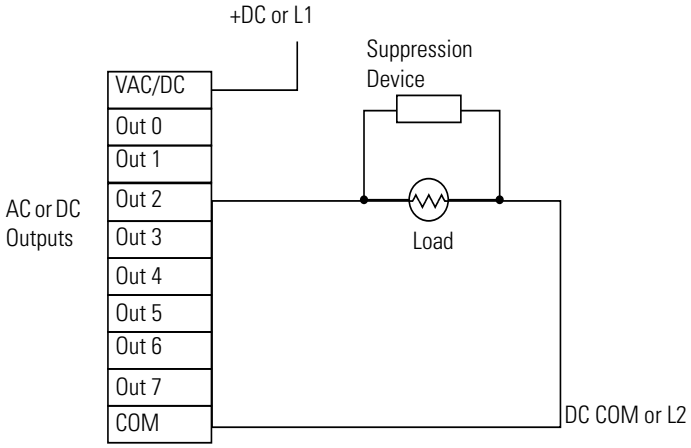
When using spade lugs, use a small, flat-blade screwdriver to pry the finger-safe cover from the terminal blocks as shown below. Then loosen the terminal screw.



Using Surge Suppressors

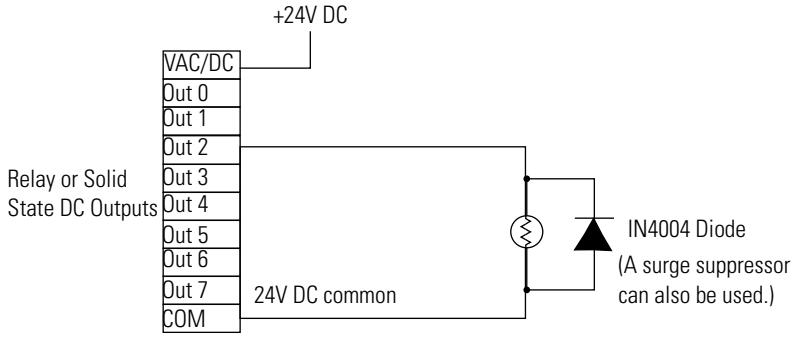
Because of the potentially high current surges that occur when switching inductive load devices, such as motor starters and solenoids, the use of some type of surge suppression to protect and extend the operating life of the controllers output contacts is required. Switching inductive loads without surge suppression can *significantly* reduce the life expectancy of relay contacts. By adding a suppression device directly across the coil of an inductive device, you prolong the life of the output or relay contacts. You also reduce the effects of voltage transients and electrical noise from radiating into adjacent systems.

The following diagram shows an output with a suppression device. We recommend that you locate the suppression device as close as possible to the load device.



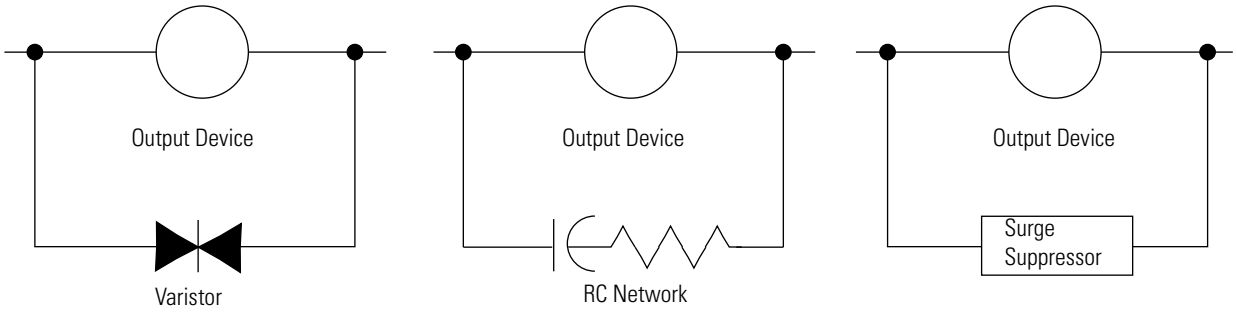
If the outputs are DC, we recommend that you use an 1N4004 diode for surge suppression, as shown below. For inductive DC load devices, a diode is suitable. A 1N4004 diode is acceptable for most applications. A surge suppressor can also be

used. See for recommended suppressors. As shown below, these surge suppression circuits connect directly across the load device.



Suitable surge suppression methods for inductive AC load devices include a varistor, an RC network, or an Allen-Bradley surge suppressor, all shown below. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device. See Recommended Surge Suppressors on page 30 for recommended suppressors.

Surge Suppression for Inductive AC Load Devices



Recommended Surge Suppressors

Use the Allen-Bradley surge suppressors shown in the following table for use with relays, contactors, and starters.

Recommended Surge Suppressors

Device	Coil Voltage	Suppressor Catalog Number	Type[4]
Bulletin 100/104K 700K	24…48V AC	100-KFSC50	RC
	110…280V AC	100-KFSC280	
	380…480V AC	100-KFSC480	
	12…55 V AC, 12…77V DC	100-KFSV55	MOV
	56…136 VAC, 78…180V DC	100-KFSV136	
	137…277V AC, 181…250 V DC	100-KFSV277	
	12…250V DC	100-KFSD250	Diode

Recommended Surge Suppressors

Device	Coil Voltage	Suppressor Catalog Number	Type[4]
Bulletin 100C, (C09 - C97)	24…48V AC	100-FSC48[1]	RC
	110…280V AC	100-FSC280[1]	
	380…480V AC	100-FSC480[1]	
	12…55V AC, 12…77V DC	100-FSV55[1]	MOV
	56…136V AC, 78…180V DC	100-FSV136[1]	
	137…277V AC, 181…250V DC	100-FSV277[1]	
	278…575V AC	100-FSV575[1]	
	12…250V DC	100-FSD250[1]	Diode
Bulletin 509 Motor Starter Size 0 - 5	12…120V AC	599-K04	MOV
	240…264V AC	599-KA04	
Bulletin 509 Motor Starter Size 6	12…120V AC	199-FSMA1[2]	RC
	12…120V AC	199-GSMA1[3]	MOV
Bulletin 700 R/RM Relay	AC coil	Not Required	
	24…48V DC	199-FSMA9	MOV
	50…120V DC	199-FSMA10	
	130…250V DC	199-FSMA11	
Bulletin 700 Type N, P, PK or PH Relay	6…150V AC/DC	700-N24	RC
	24…48V AC/DC	199-FSMA9	MOV
	50…120V AC/DC	199-FSMA10	
	130…250V AC/DC	199-FSMA11	
	6…300V DC	199-FSMZ-1	Diode
Miscellaneous electromagnetic devices limted to 35 sealed VA	6…150V AC/DC	700-N24	RC

(1) Catalog numbers for screwless terminals include the string 'CR' after '100-'.
For example: Cat. No. 100-FSC48 becomes Cat. No. 100-**CR**FSC48; Cat. No. 100-FSV55 becomes 100-**CR**FSV55; and so on.

(2) For use on the interposing relay.

(3) For use on the contactor or starter.

(4) RC Type not to be used with Triac outputs.
Varistor is not recommended for use on the relay outputs.

Grounding the Controller

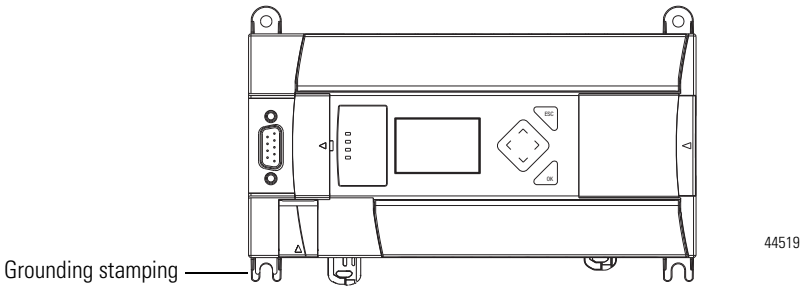
In solid-state control systems, grounding and wire routing helps limit the effects of noise due to electromagnetic interference (EMI). Run the ground connection from the ground screw of the controller to the ground bus prior to connecting any devices. Use AWG #14 wire. For AC-powered controllers, this connection must be made for safety purposes.

ATTENTION: All devices connected to the RS-232/485 communication port must be referenced to controller ground, or be floating (not referenced to a potential other than ground). Failure to follow this procedure may result in property damage or personal injury.

- For 1766-L32BWA and 1766-L32BWAA controllers, the COM of the sensor supply is also connected to chassis ground internally. The 24V DC sensor power source should not be used to power output circuits. It should only be used to power input devices.
- For 1766-L32BXB and 1766-L32BXBA controllers, the VDC NEUT or common terminal of the power supply is also connected to chassis ground internally.

This product is intended to be mounted to a well grounded mounting surface such as a metal panel. Refer to the *Industrial Automation Wiring and Grounding Guidelines,* publication 1770-4.1, for additional information. Additional grounding connections from the mounting tab or DIN rail, if used, are not required unless the mounting surface cannot be grounded.

TIP Use all four mounting positions for panel mounting installation.



ATTENTION: Remove the protective debris strip before applying power to the controller. Failure to remove the strip may cause the controller to overheat.

Wiring Diagrams

The following illustrations show the wiring diagrams for the MicroLogix 1400 controllers. Controllers with DC inputs can be wired as either sinking or sourcing inputs. (Sinking and sourcing does not apply to AC inputs.) Refer to Sinking and Sourcing Wiring Diagrams on page 36.

The controller terminal block layouts are shown below. The shading on the labels indicates how the terminals are grouped.

TIP

This ⏚ symbol denotes a protective earth ground terminal which provides a low impedance path between electrical circuits and earth for safety purposes and provides noise immunity improvement. This connection must be made for safety purposes on AC-powered controllers.

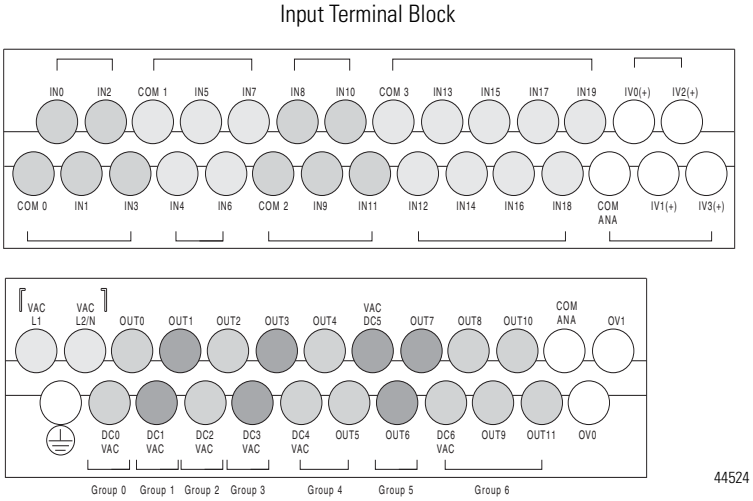
This ⏚ symbol denotes a functional earth ground terminal which provides a low impedance path between electrical circuits and earth for non-safety purposes, such as noise immunity improvement.

Terminal Block Layouts

ATTENTION: When you connect or disconnect the Removable Terminal Block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure. All wiring must be in accordance with Class I, Division 2 wiring methods of Article 501 of the National Electrical Code and/or in accordance with Section 18-1J2 of the Canadian Electrical Code, and in accordance with the authority having jurisdiction.

Figure 3 - 1766-L32BWA/L32BWAA



ATTENTION: The 24V DC sensor supply of the 1766-L32BWA and 1766-L32BWAA controllers should not be used to power output circuits. It should only be used to power input devices, for example, sensors and switches. See Master Control Relay on page 13 for information on MCR wiring in output circuits.

Figure 4 - 1766-L32AWA/L32AWAA

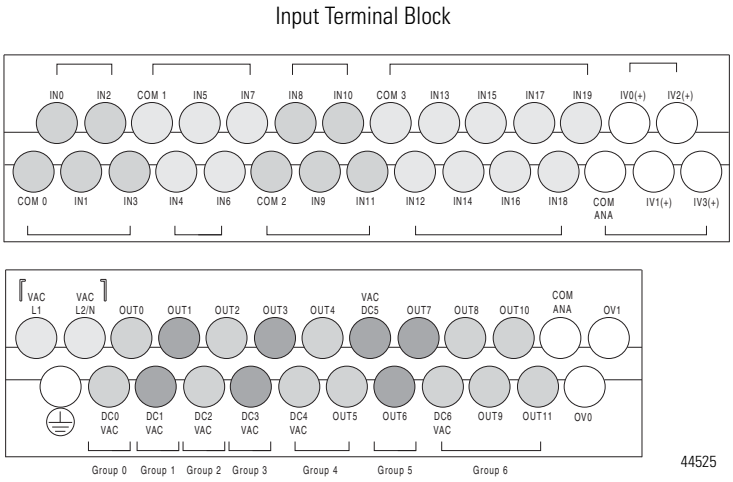
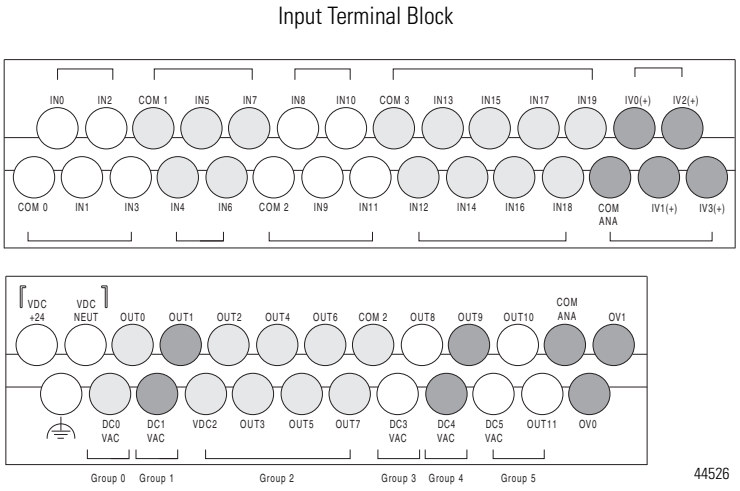


Figure 5 - 1766-L32BXB/L32BXBA



Wire Types and Sizes

Wire Type	Wire Size

Wire Types and Sizes

Solid wire	Cu-90·C (194·F)	14…22 AWG
Stranded wire	Cu-90·C (194·F)	16…22 AWG
Wiring torque = 0.791Nm (7 in-lb) rated.		

Output Terminal Grouping

Controllers	Output Group	Description	Outputs Voltage Terminal	Output Terminal
1766-L32BWA 1766--L32BWAA	Group 0	Isolated relay output	VAC/DC0	OUT 0
	Group 1	Isolated relay output	VAC/DC1	OUT 1
	Group 2	Isolated relay output	VAC/DC2	OUT 2
	Group 3	Isolated relay output	VAC/DC3	OUT 3
	Group 4	Isolated relay output	VAC/DC4	OUT 4, OUT 5
	Group 5	Isolated relay output	VAC/DC5	OUT 6, OUT 7
	Group 6	Isolated relay output	VAC/DC6	OUT 8…11
1766-L32AWA 1766-L32AWAA	Group 0	Isolated relay output	VAC/DC0	OUT 0
	Group 1	Isolated relay output	VAC/DC1	OUT 1
	Group 2	Isolated relay output	VAC/DC2	OUT 2
	Group 3	Isolated relay output	VAC/DC3	OUT 3
	Group 4	Isolated relay output	VAC/DC4	OUT 4, OUT 5
	Group 5	Isolated relay output	VAC/DC5	OUT 6, OUT 7
	Group 6	Isolated relay output	VAC/DC6	OUT 8…11
1766-L32BXB 1766-L32BXBA	Group 0	Isolated relay output	VAC/DC0	OUT 0
	Group 1	Isolated relay output	VAC/DC1	OUT 1
	Group 2	FET output	VDC2/COM 2	OUT 2…7
	Group 3	Isolated relay output	VAC/DC3	OUT 8
	Group 4	Isolated relay output	VAC/DC4	OUT 9
	Group 5	Isolated relay output	VAC/DC5	OUT 10, OUT 11



WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.



WARNING: The local programming terminal port is intended for temporary use only and must not be connected or disconnected unless the area is free of ignitable concentrations of flammable gases or vapors.

Sinking and Sourcing Wiring Diagrams

Any of the MicroLogix 1400 DC embedded input groups can be configured as sinking or sourcing depending on how the DC COM is wired on the group.

Type	Definition
Sinking Input	The input energizes when high-level voltage is applied to the input terminal (active high). Connect the power supply VDC (-) to the input group's COM terminal.
Sourcing Input	The input energizes when low-level voltage is applied to the input terminal (active low). Connect the power supply VDC (+) to the input group's COM terminal.

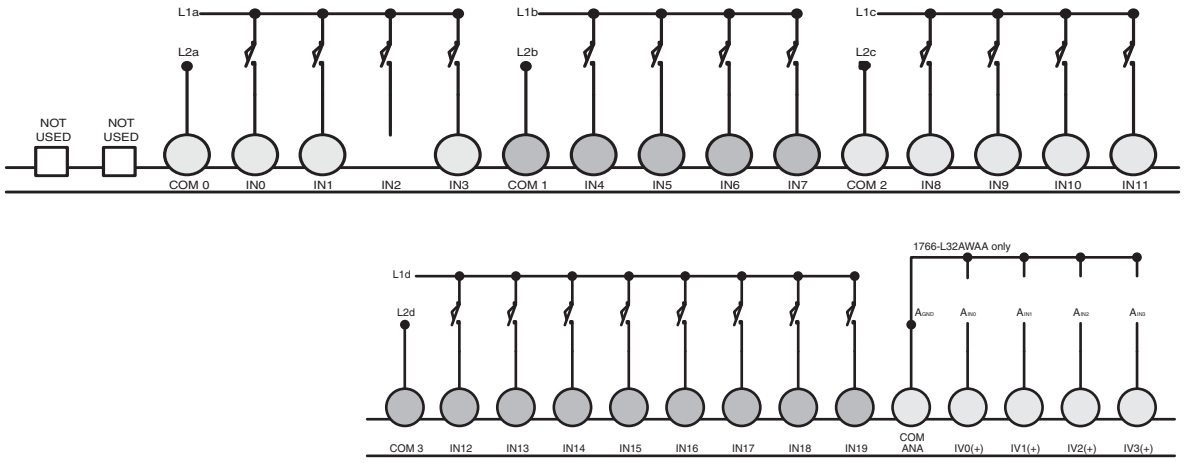


ATTENTION: The 24V DC sensor power source must not be used to power output circuits. It should only be used to power input devices (for example. sensors, switches). See Master Control Relay on page 13 for information on MCR wiring in output circuits.

1766-L32BWA, 1766-L32AWA, 1766-L32BXB, 1766-L32BWAA, 1766-L32AWAA, 1766-L32BXBA Wiring Diagrams

TIP In the following diagrams, lower case alphabetic subscripts are appended to common-terminal connections to indicate that different power sources may be used for different isolated groups, if desired.

Figure 6 - 1766-L32AWA/L32AWAA Input Wiring Diagram (1)



(1) "NOT USED" terminals are not intended for use as connection points.

Figure 7 - 1766-L32BWA/L32BWAA Sinking Input Wiring Diagram

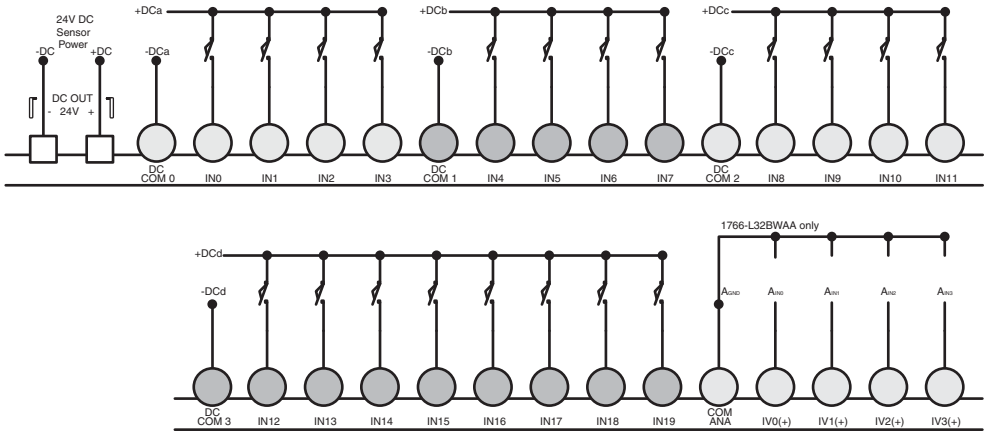


Figure 8 - 1766-L32BWA/L32BWAA Sourcing Input Wiring Diagram

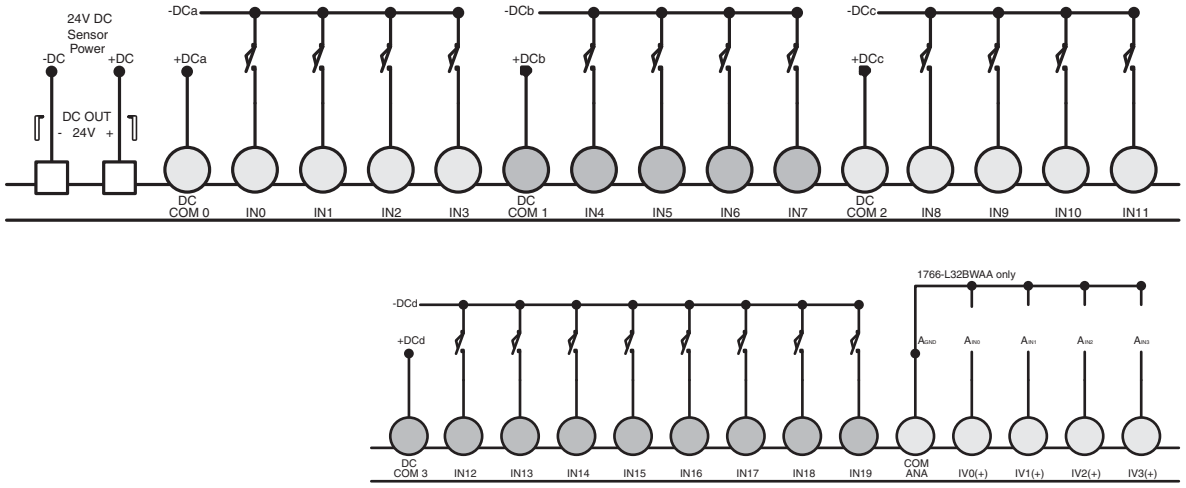


Figure 9 - 1766-L32BXB/L32BXBA Sinking Input Wiring Diagram

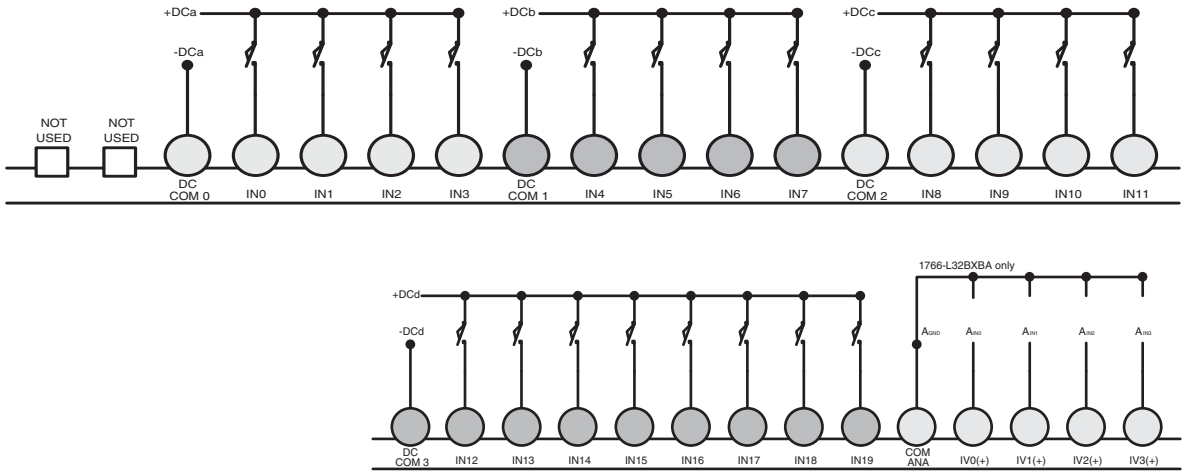


Figure 10 - 1766-L32BXB/L32BXBA Sourcing Input Wiring Diagram

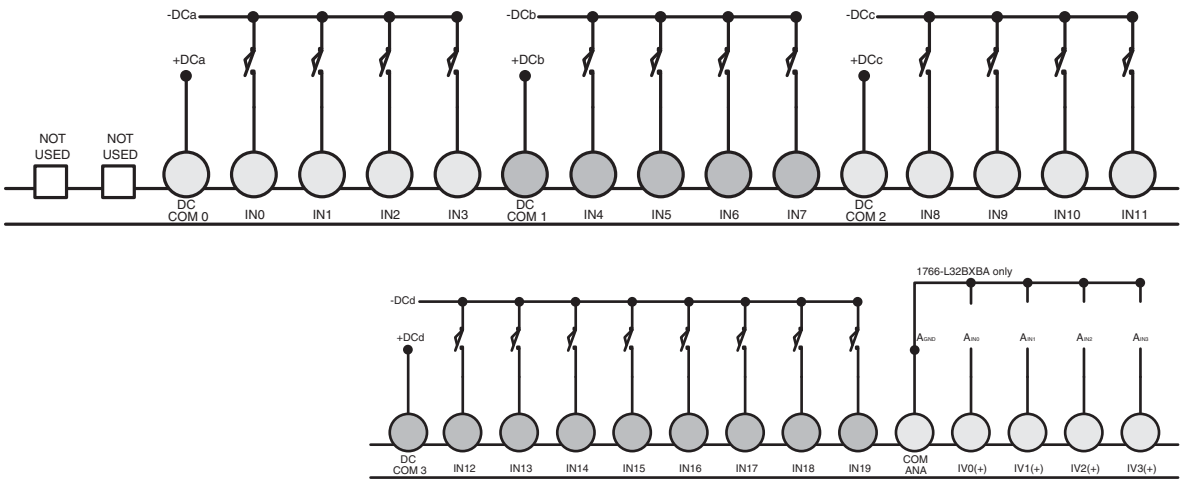


Figure 11 - 1766-L32AWA/L32AWAA and 1766-L32BWA/L32BWAA Output Wiring Diagram

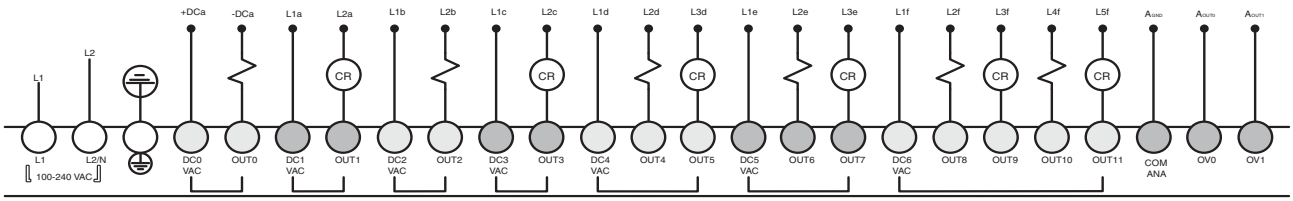
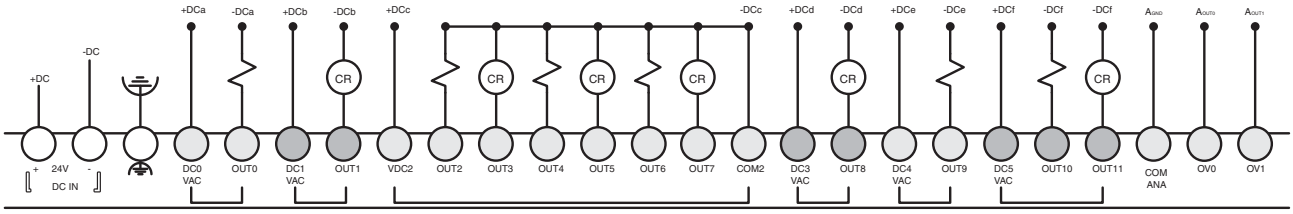


Figure 12 - 1766-L32BXB/L32BXBA Output Wiring Diagram



Controller I/O Wiring

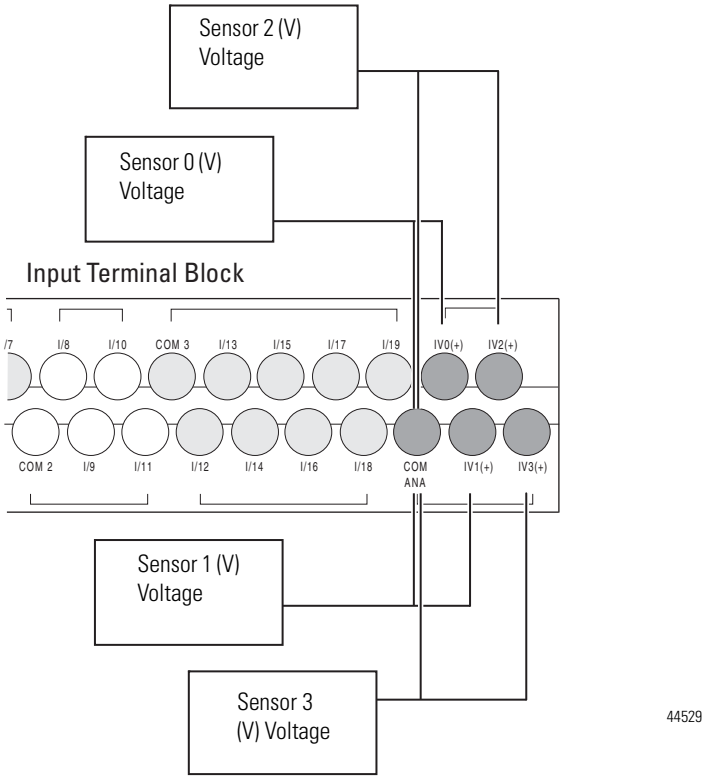
Minimizing Electrical Noise

Because of the variety of applications and environments where controllers are installed and operating, it is impossible to ensure that all environmental noise will be removed by input filters. To help reduce the effects of environmental noise, install the MicroLogix 1400 system in a properly rated (for example, NEMA) enclosure. Make sure that the MicroLogix 1400 system is properly grounded.

A system may malfunction due to a change in the operating environment after a period of time. We recommend periodically checking system operation, particularly when new machinery or other noise sources are installed near the MicroLogix 1400 system.

Wiring Your Analog Channels

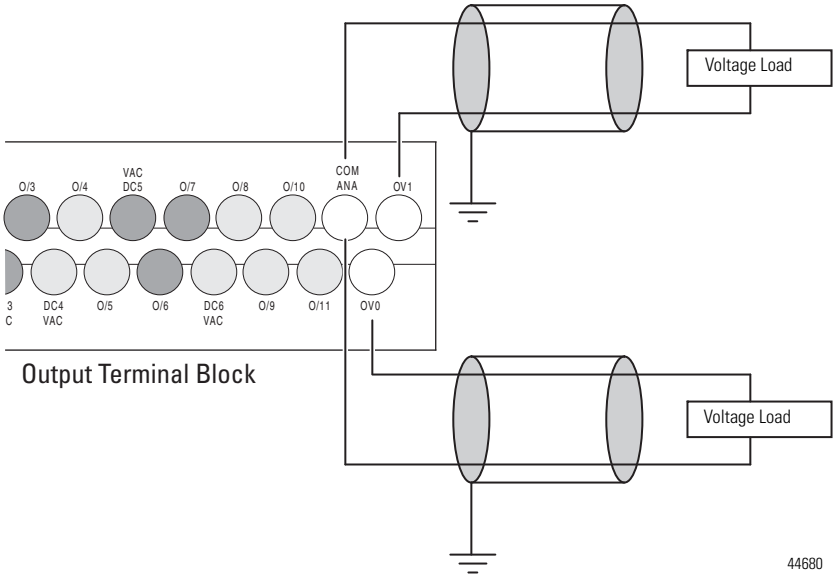
Analog input circuits can monitor voltage signals and convert them to serial digital data.



The controller does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications as shown.

The analog output can support a voltage function as shown in the following illustration.

Figure 13 - Analog Output

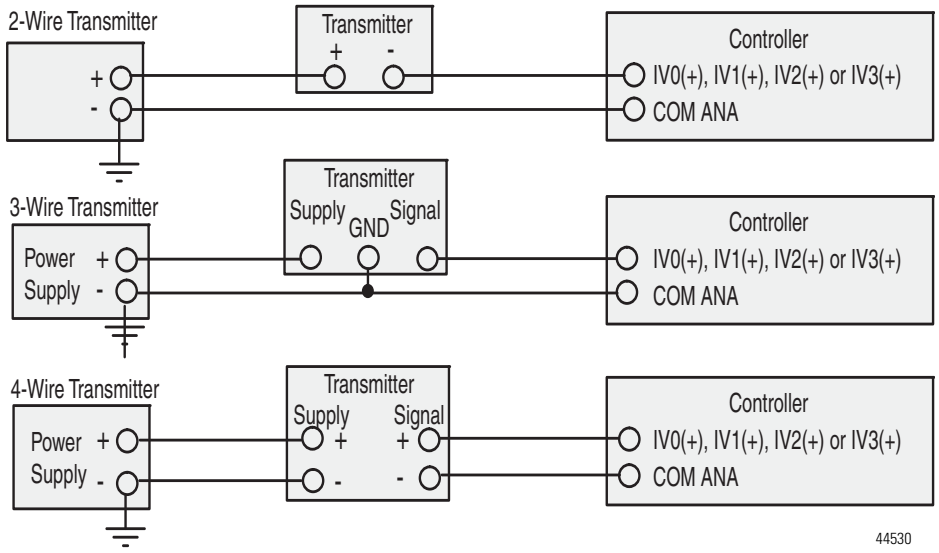


Analog Channel Wiring Guidelines

Consider the following when wiring your analog channels:

- The analog common (COM) is connected to earth ground inside the module. These terminals are not electrically isolated from the system. They are connected to chassis ground.
- Analog channels are not isolated from each other.
- Use Belden 8761, or equivalent, shielded wire.
- Under normal conditions, the drain wire (shield) should be connected to the metal mounting panel (earth ground). Keep the shield connection to earth ground as short as possible.
- To ensure optimum accuracy for voltage type inputs, limit overall cable impedance by keeping all analog cables as short as possible. Locate the I/O system as close to your voltage type sensors or actuators as possible.
- The controller does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications as shown below.

Figure 14 - Analog Input Transmitter Specifications



Minimizing Electrical Noise on Analog Channels

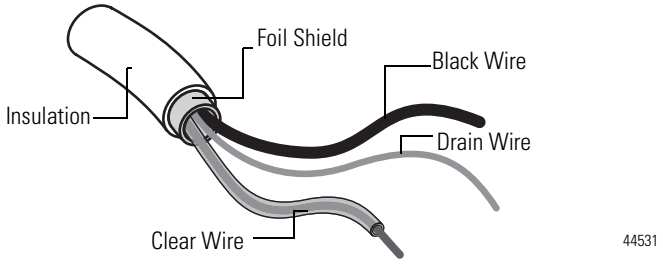
Inputs on analog channels employ digital high-frequency filters that significantly reduce the effects of electrical noise on input signals. However, because of the variety of applications and environments where analog controllers are installed and operated, it is impossible to ensure that all environmental noise will be removed by the input filters.

Several specific steps can be taken to help reduce the effects of environmental noise on analog signals:

- install the MicroLogix 1400 system in a properly rated enclosure, for example, NEMA. Make sure that the MicroLogix 1400 system is properly grounded.
- use Belden cable #8761 for wiring the analog channels, making sure that the drain wire and foil shield are properly earth grounded.
- route the Belden cable separately from any AC wiring. Additional noise immunity can be obtained by routing the cables in grounded conduit.

Grounding Your Analog Cable

Use shielded communication cable (Belden #8761). The Belden cable has two signal wires (black and clear), one drain wire, and a foil shield. The drain wire and foil shield must be grounded at one end of the cable.



IMPORTANT Do not ground the drain wire and foil shield at both ends of the cable

Expansion I/O Wiring

Digital Wiring Diagrams

The following illustrations show the digital expansion I/O wiring diagrams.

Figure 15 - 1762-IA8 Wiring Diagram

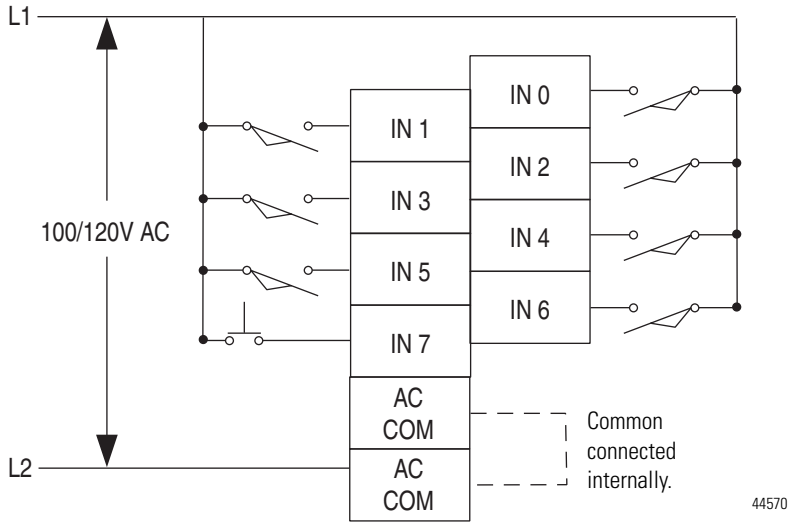


Figure 16 - 1762-IQ8 Wiring Diagram

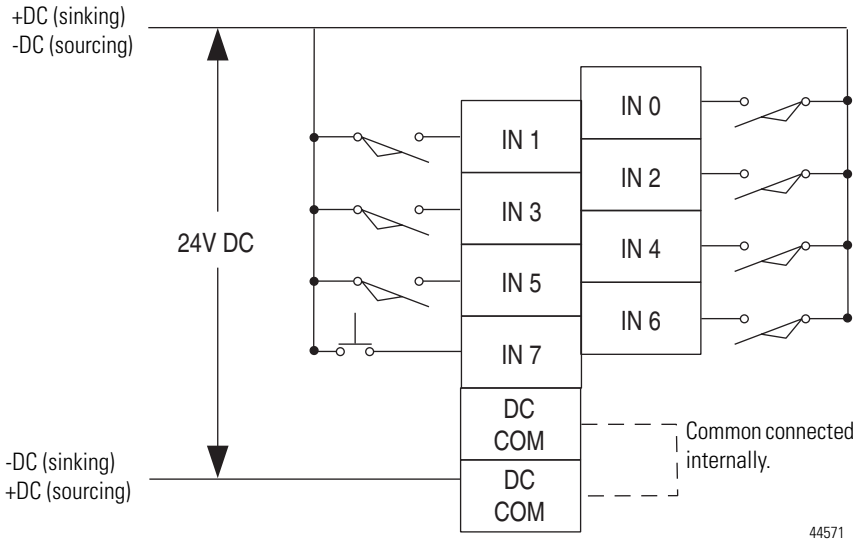


Figure 17 - 1762-IQ16 Wiring Diagram

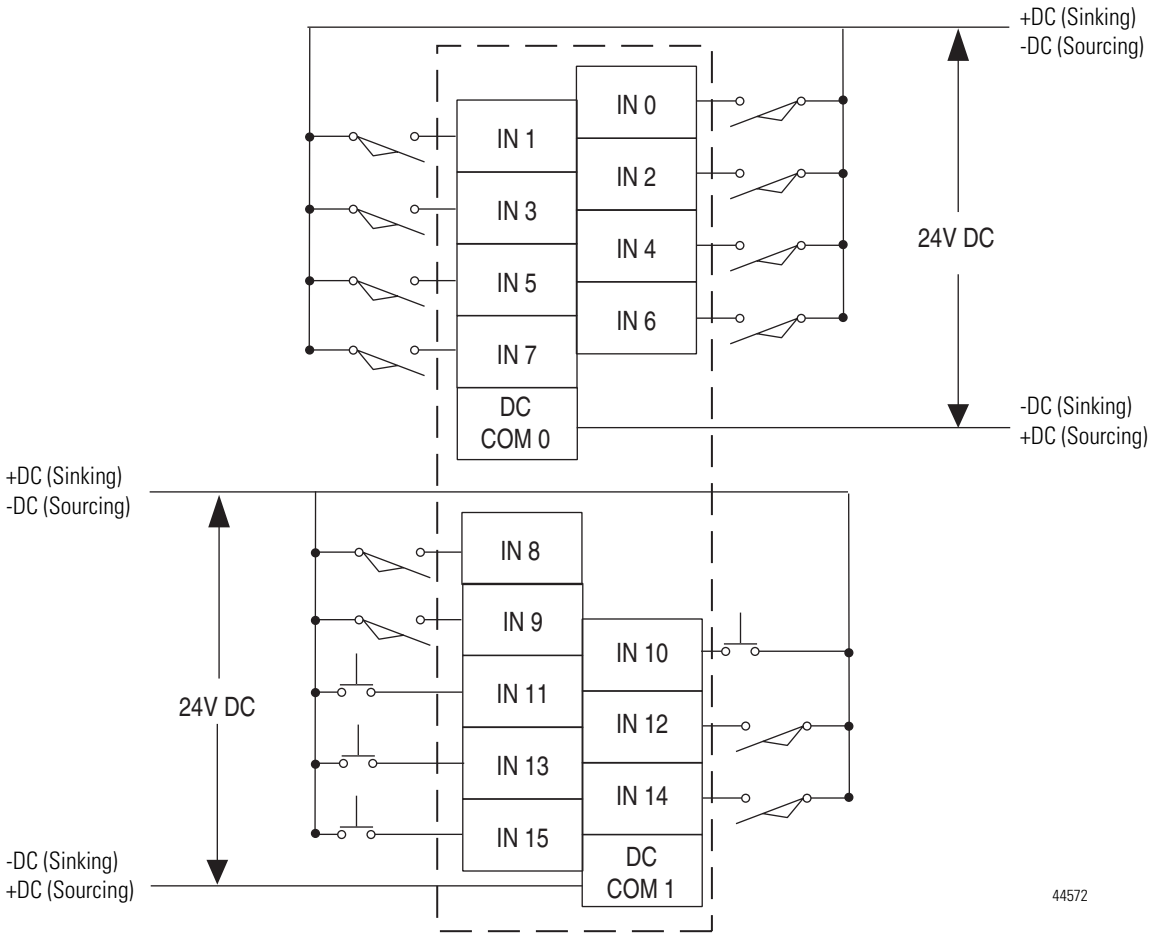


Figure 18 - 1762-IQ32T Wiring Diagram

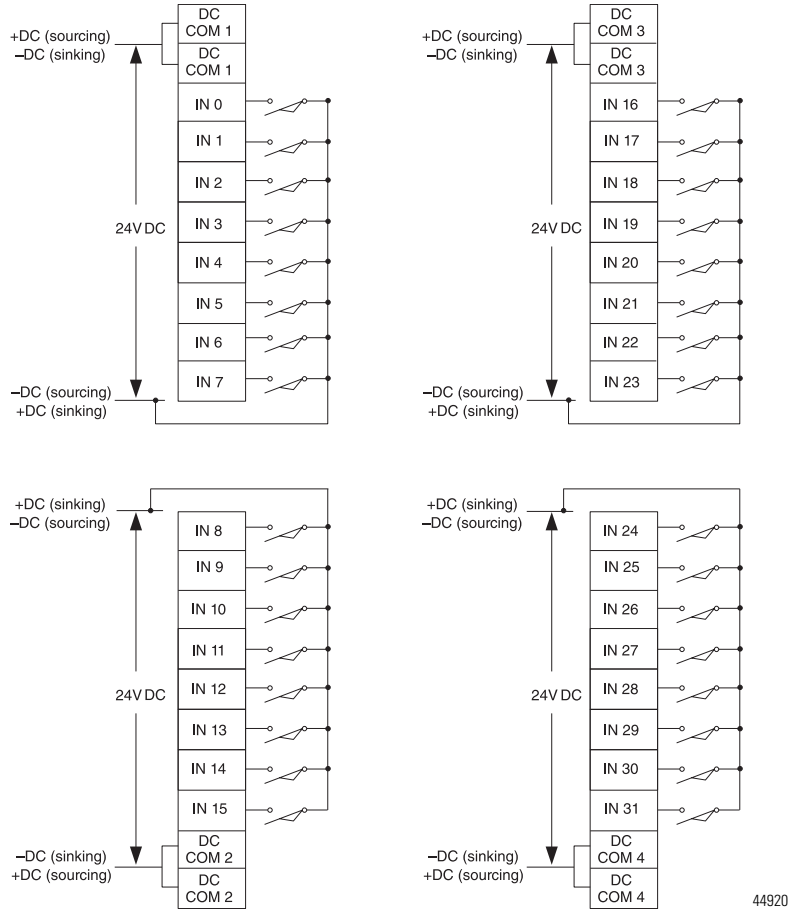


Figure 19 - 1762-OA8 Wiring Diagram

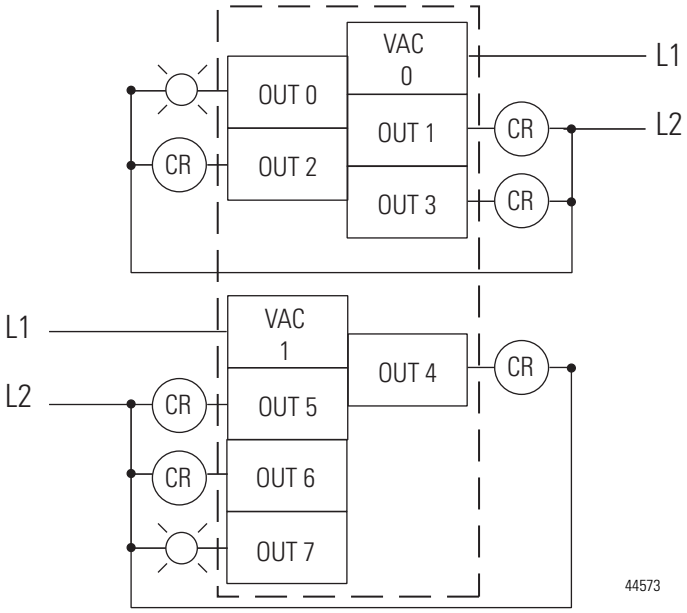


Figure 20 - 1762-OB8 Wiring Diagram

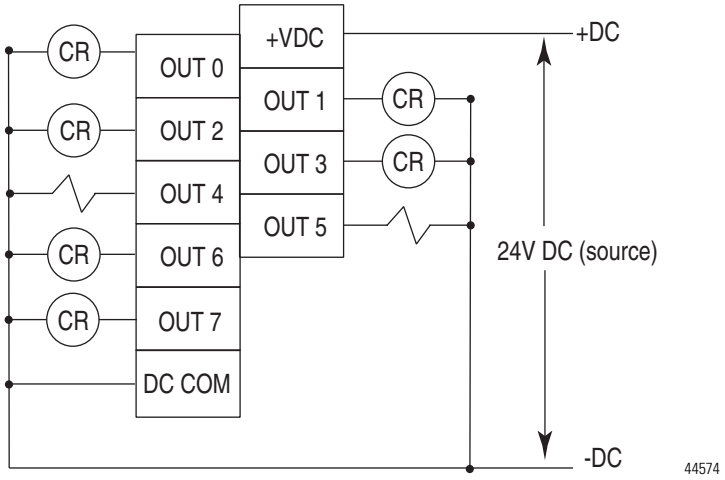


Figure 21 - 1762-OB16 Wiring Diagram

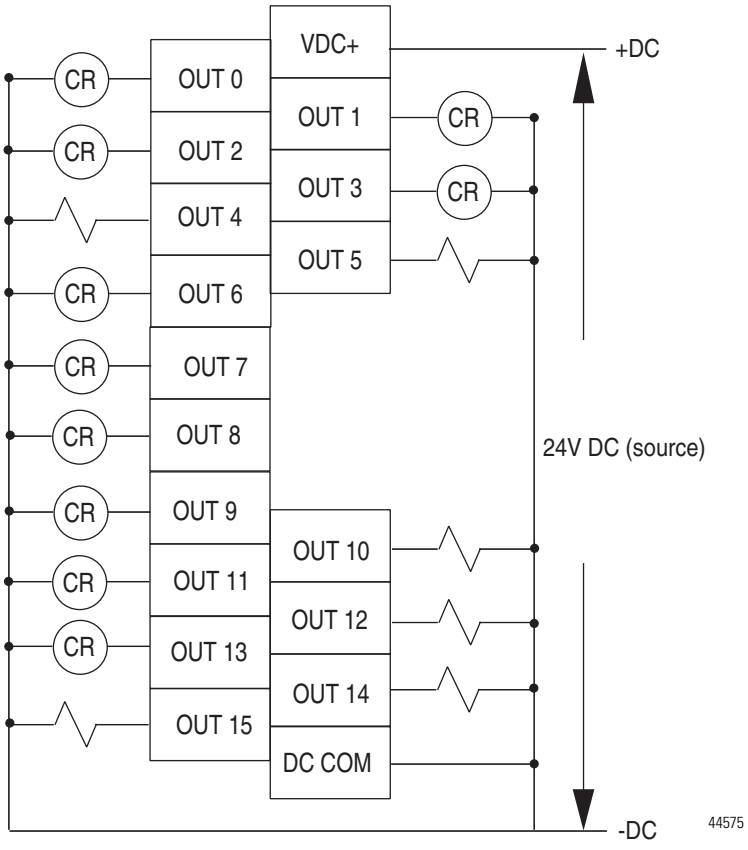


Figure 22 - 1762-OB32T Wiring Diagram

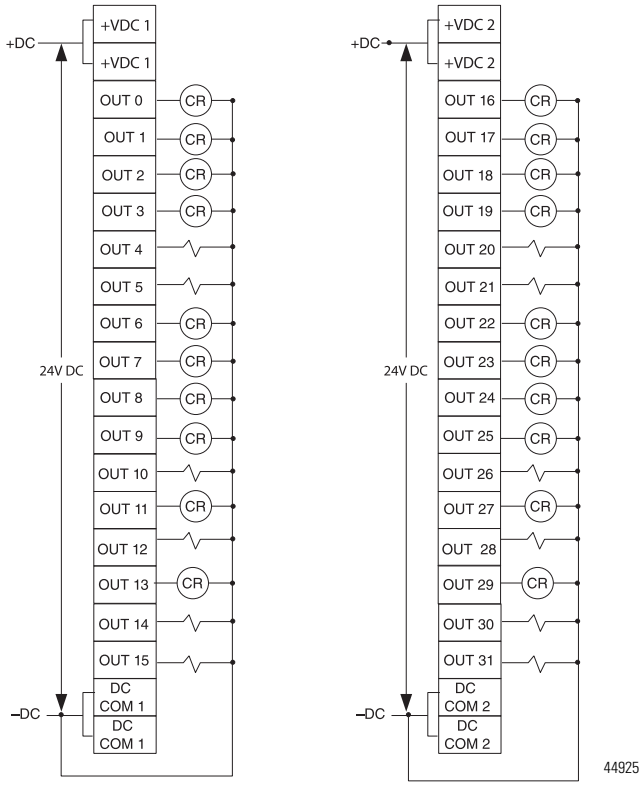


Figure 23 - 1762-OV32T Wiring Diagram

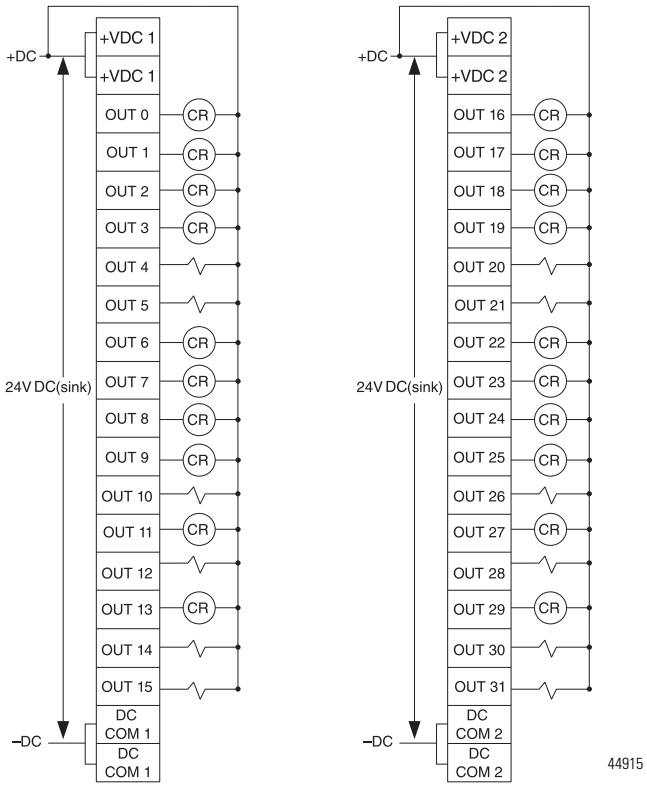


Figure 24 - 1762-OW8 Wiring Diagram

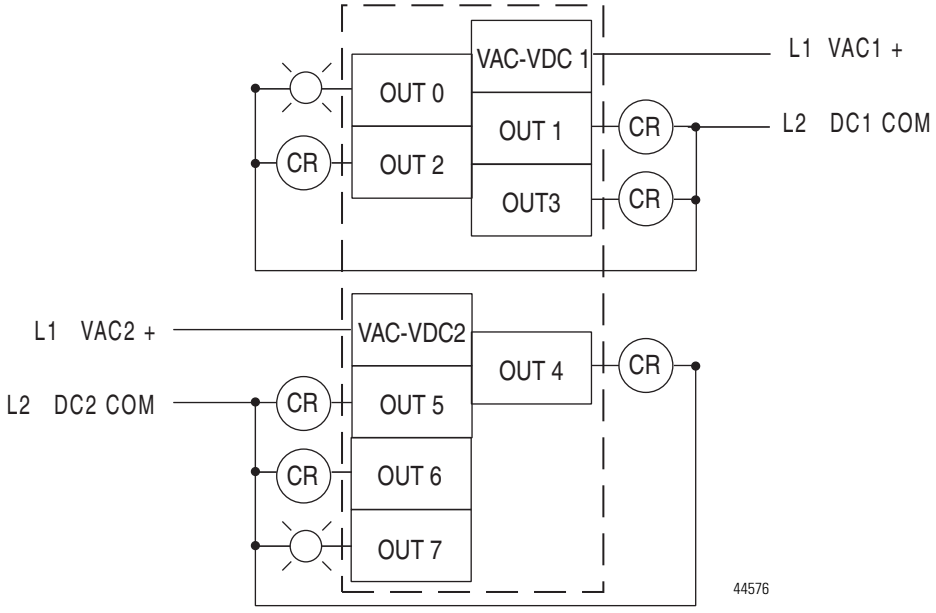


Figure 25 - 1762-OW16 Wiring Diagram

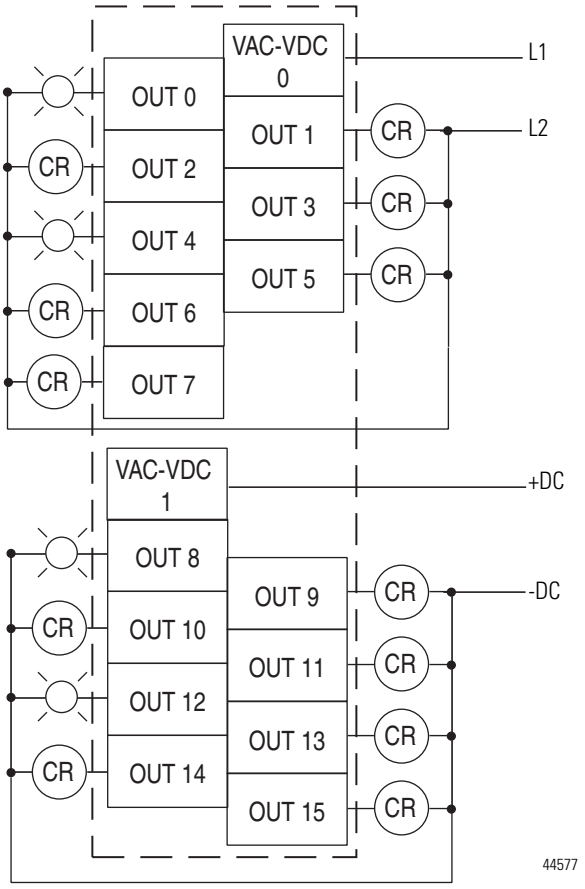


Figure 26 - 1762-OX6I Wiring Diagram

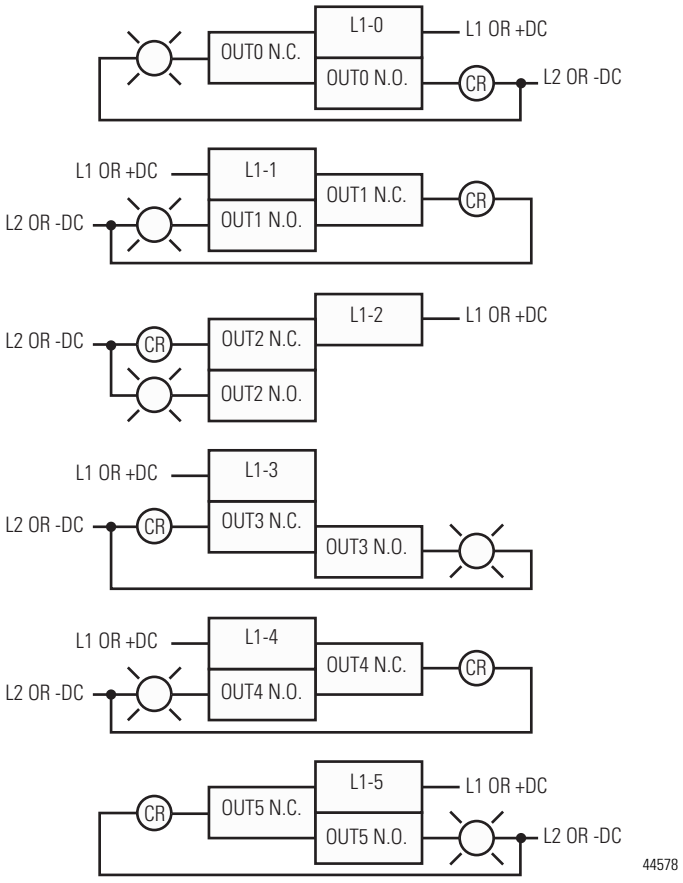
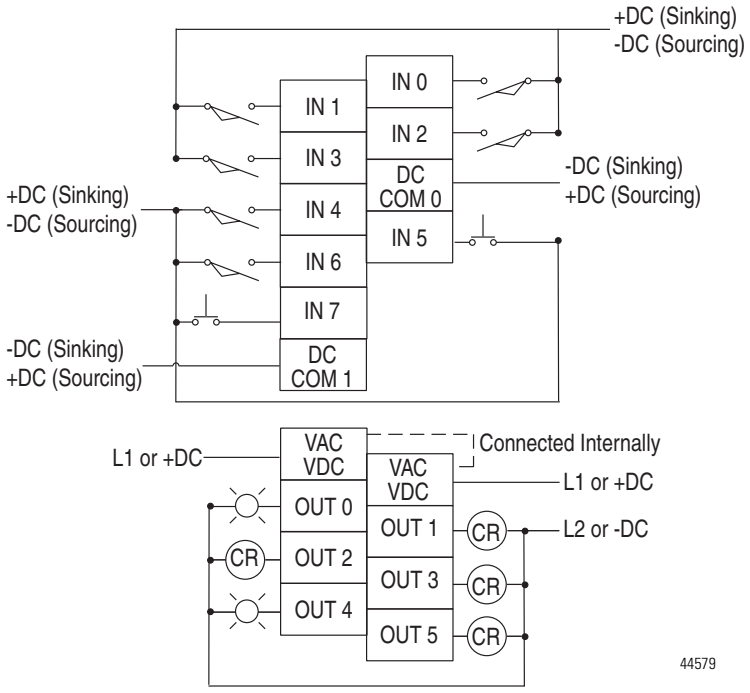


Figure 27 - 1762-IQ8OW6 Wiring Diagram



Analog Wiring

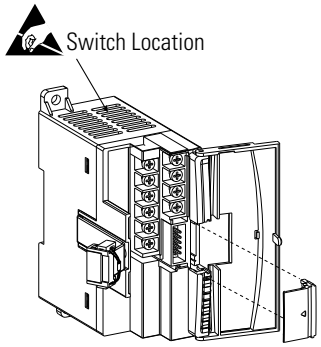
Consider the following when wiring your analog modules:

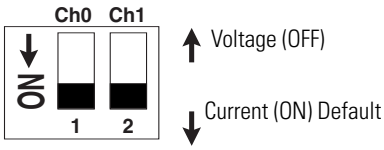
- The analog common (COM) is not connected to earth ground inside the module. All terminals are electrically isolated from the system.
- Channels are not isolated from each other.
- Use Belden 8761, or equivalent, shielded wire.
- Under normal conditions, the drain wire (shield) should be connected to the metal mounting panel (earth ground). Keep the shield connection to earth ground as short as possible.
- To ensure optimum accuracy for voltage type inputs, limit overall cable impedance by keeping all analog cables as short as possible. Locate the I/O system as close to your voltage type sensors or actuators as possible.
- The module does not provide loop power for analog inputs. Use a power supply that matches the input transmitter specifications.

1762-IF2OF2 Input Type Selection

Select the input type, current or voltage, using the switches located on the module's circuit board *and* the input type/range selection bits in the Configuration Data File. Refer to MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001. You can access the switches through the ventilation slots on the top of the module. Switch 1 controls

channel 0; switch 2 controls channel 1. The factory default setting for both switch 1 and switch 2 is Current. Switch positions are shown below.





1762-IF2OF2 Output Type Selection

The output type selection, current or voltage, is made by wiring to the appropriate terminals, Iout or Vout, *and* by the type/range selection bits in the Configuration Data File. Refer to MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

ATTENTION: Analog outputs may fluctuate for less than a second when power is applied or removed. This characteristic is common to most analog outputs. While the majority of loads will not recognize this short signal, it is recommended that preventive measures be taken to ensure that connected equipment is not affected.

1762-IF2OF2 Wiring

The following illustration shows the 1762-IF2OF2 analog expansion I/O terminal block.

Figure 28 - 1762-IF2OF2 Terminal Block Layout

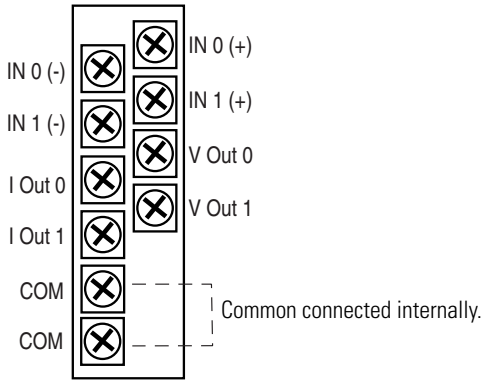


Figure 29 - Differential Sensor Transmitter Types

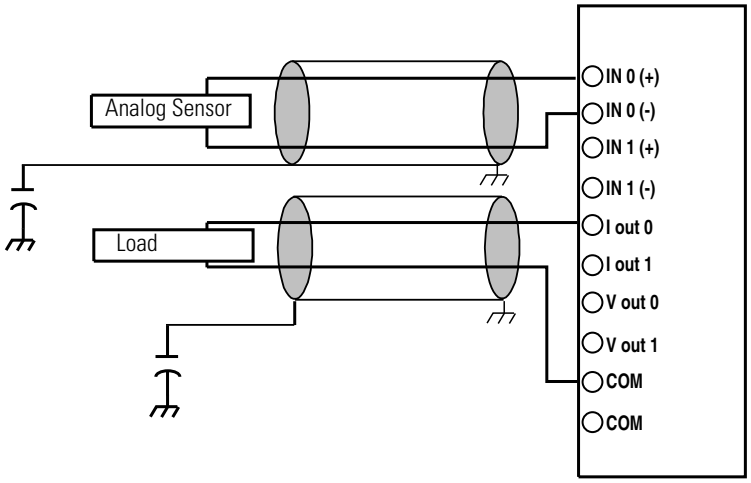
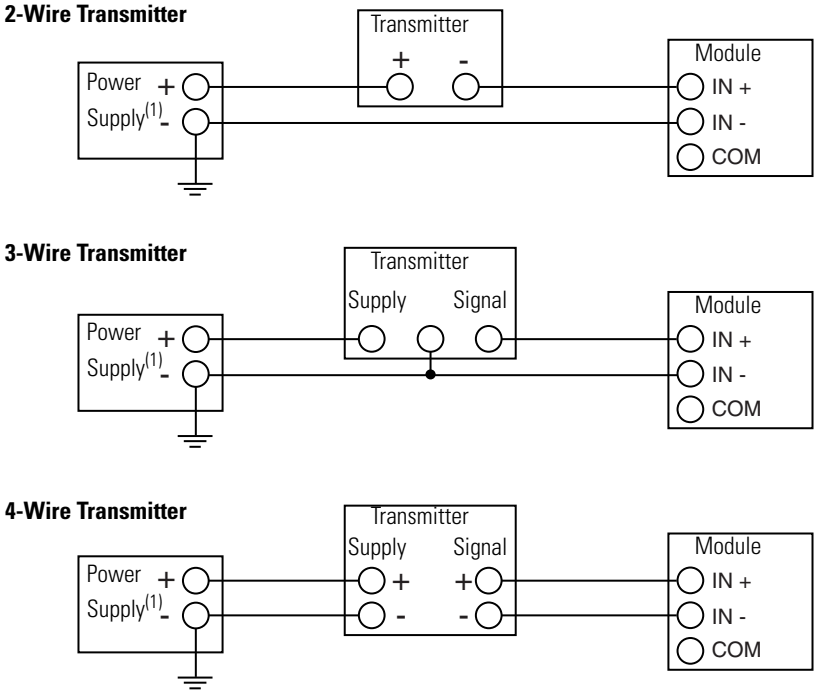


Figure 30 - Single-ended Sensor/Transmitter Types



(1) All power supplies rated N.E.C. Class 2.

1762-IF4 Input Type Selection

Select the input type, current or voltage, using the switches located on the module's circuit board *and* the input type/range selection bits in the Configuration Data File. Refer to *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001. You can access the switches through the ventilation slots on the top of the module.

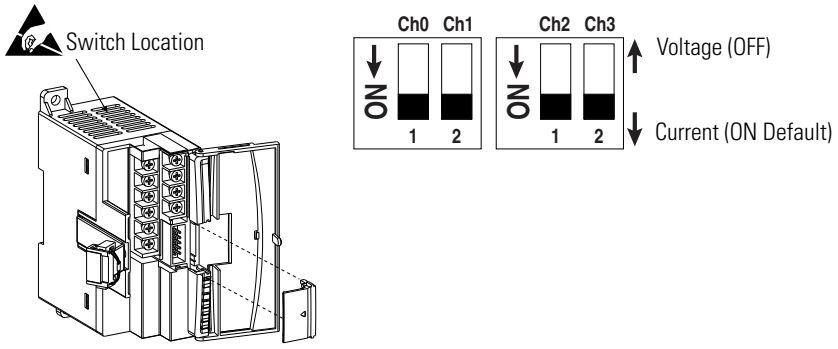


Figure 31 - 1762-IF4 Terminal Block Layout

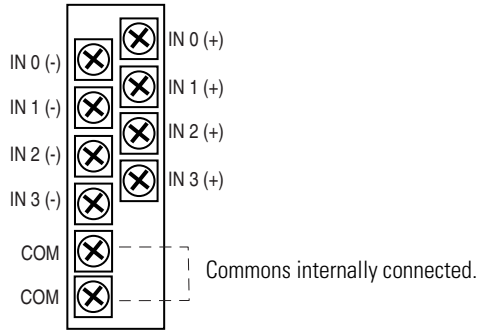
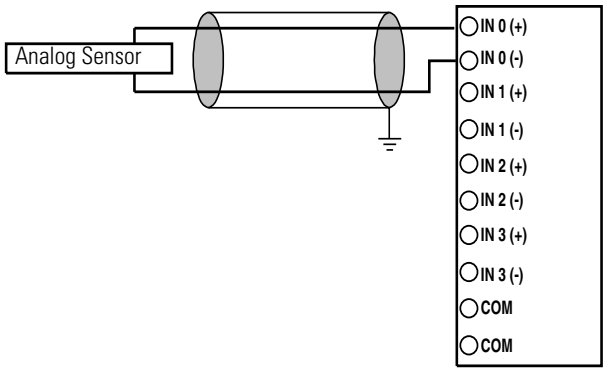
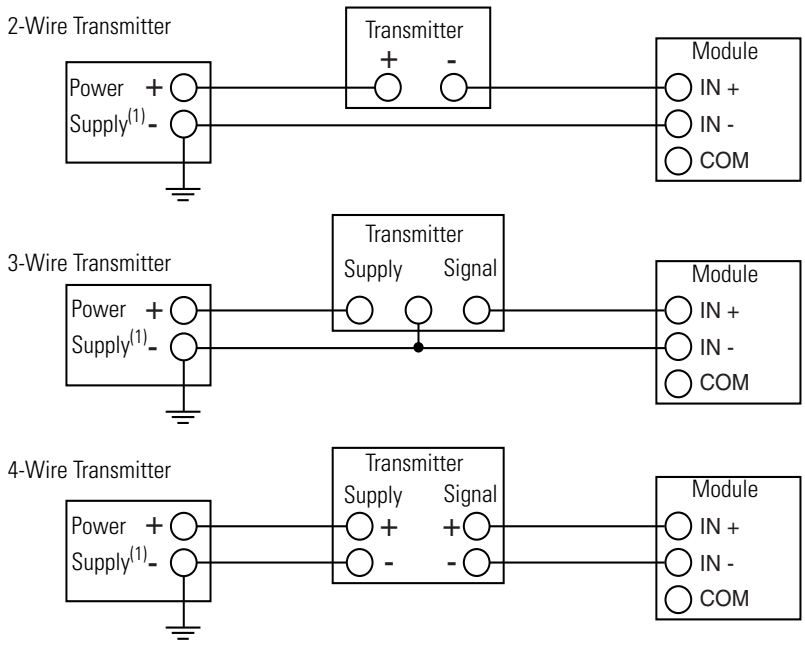


Figure 32 - Differential Sensor Transmitter Types



TIP Grounding the cable shield at the module end only usually provides sufficient noise immunity. However, for best cable shield performance, earth ground the shield at both ends, using a 0.01µF capacitor at one end to block AC power ground currents, if necessary.

Figure 33 - Sensor/Transmitter Types

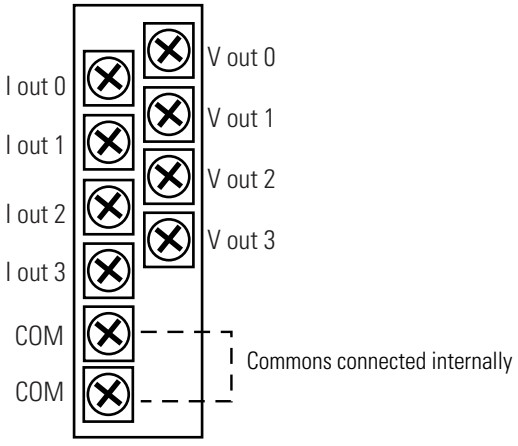


(1) All power supplies rated N.E.C. Class 2.

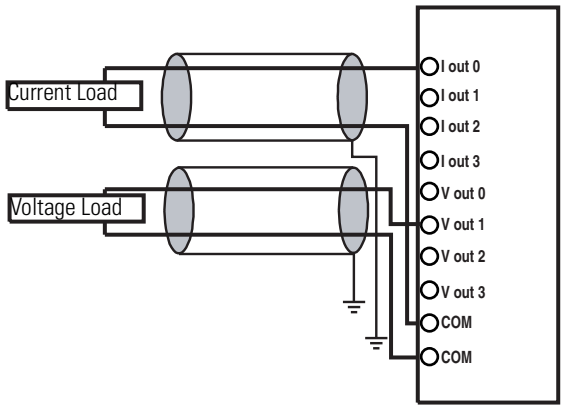
1762-OF4 Output Type Selection

The output type selection, current or voltage, is made by wiring to the appropriate terminals, Iout or Vout, *and* by the type/range selection bits in the Configuration Data File.

1762-OF4 Terminal Block Layout



1762-OF4 Wiring



Notes:

Communication Connections

This chapter describes how to communicate with your control system. The method you use and cabling required to connect your controller depends on what type of system you are employing. This chapter also describes how the controller establishes communication with the appropriate network. Topics include:

- supported communication protocols
- default communication configurations
- using communications toggle functionality
- connecting to RS-232 port
- connecting to RS-485 network
- connecting to AIC+
- connecting to DeviceNet
- connecting to Ethernet

The MicroLogix 1400 controllers provide three communication channels, an isolated RS-232/485 communication port (Channel 0), an Ethernet port (Channel 1) and a non-isolated RS-232 communication port (Channel 2).

Supported Communication Protocols

MicroLogix 1400 controllers support the following communication protocols from the primary RS-232/485 communication channel 0 and the RS-232 communication channel 2:

- DH-485
- DF1 Full-Duplex
- DF1 Half-Duplex Master and Slave
- DF1 Radio Modem
- Modbus RTU Master and Slave
- ASCII
- DNP3 Slave

The Ethernet communication channel, Channel 1, allows your controller to be connected to a local area network for various devices providing 10 Mbps/100 Mbps transfer rate. MicroLogix 1400 controllers support Ethernet/IP with CIP explicit messaging (message exchange), BOOTP/DHCP Client, HTTP Server, SMTP Client, DNS Client, SNMP Server, Socket Interface with CIP Generic messaging, Modbus TCP Client/Server and DNP3 over IP. MicroLogix 1400 controllers do not support Ethernet I/O master capability through CIP implicit messaging (real-time I/O messaging).

For more information on MicroLogix 1400 communications, refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

Default Communication Configuration

The MicroLogix 1400 communication Channel 0 has the following default communication configuration.

TIP For Channel 0, the default configuration is present when:

- The controller is powered-up for the first time.
- The communications toggle functionality specifies default communications (specified using the LCD Display. The DCOMM indicator on the LCD Display is on, that is, lit in solid rectangle).
- An OS upgrade is completed.

See Chapter 5 for more information about using the LCD Display.

See Appendix E for more information about communicating.

DF1 Full-Duplex Default Configuration Parameters

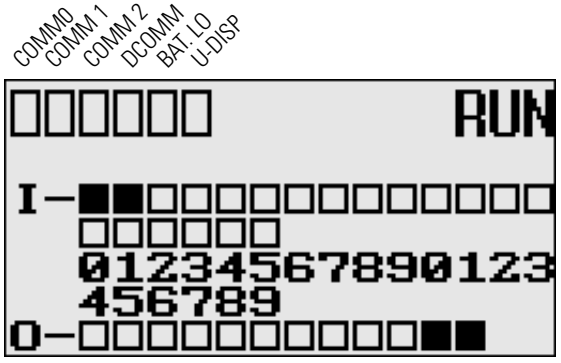
Parameter	Default
Baud Rate	19.2 KBps
Parity	none
Source ID (Node Address)	1
Control Line	no handshaking
Error Detection	CRC
Embedded Responses	auto detect
Duplicate Packet (Message) Detect	enabled
ACK Timeout	50 counts
NAK retries	3 retries
ENQ retries	3 retries
Stop Bits	1
Data Bits	8

Using the Communications Toggle Functionality

The Communications Toggle Functionality can be operated using the LCD display on the controller, as shown below.

Use the Communications Toggle Functionality to change from the user-defined communication configuration to the default communications mode and back on Channel 0. The Default Communications (DCOMM) indicator on the LCD display operates to show when the controller is in the default communications

mode. Hold down the OK key more than 5 seconds to toggle the communication mode on the Main Menu screen.



TIP The Communication Toggle Functionality only affects the communication configuration of Channel 0.

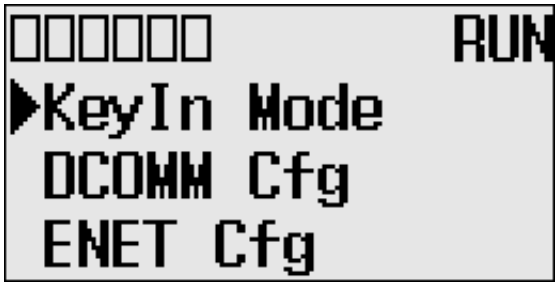
Changing Communication Configuration

Follow the procedure below to change from the user-defined communication configuration to the default communications mode and back. In this example, we will start from the Main Menu screen of the LCD display, as shown below. If necessary, press ESC repeatedly until you return to the Main Menu screen.

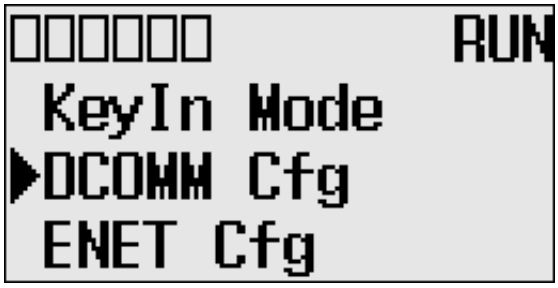
1. On the Main Menu screen, select Advance Set by using the Up and Down keys on the LCD keypad. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



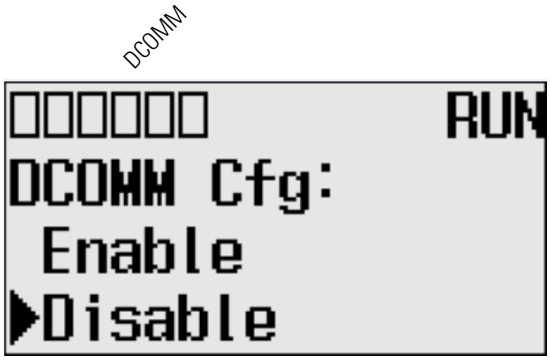
2. Press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed.



3. Select DCOMM Cfg using the Up and Down keys, and then press the OK key.

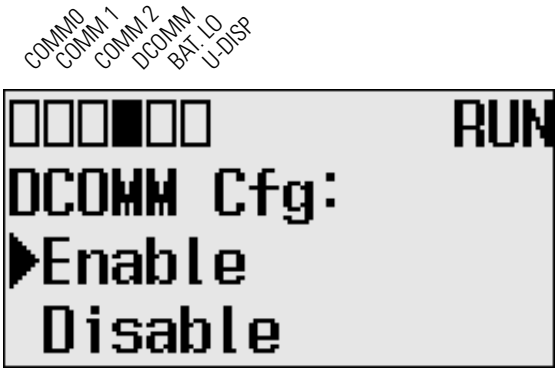


4. The DCOMM Configuration screen is displayed. In this example, the current status is Disable.

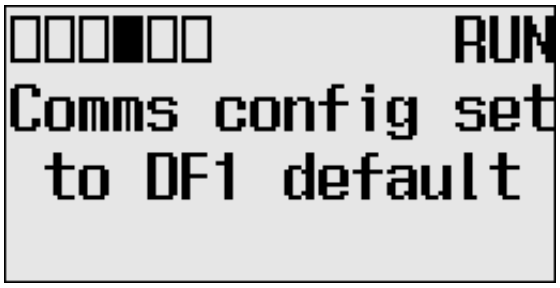


The DCOMM status indicator, which is the fourth of the six indicators at the top left of the LED display, is displayed as an empty rectangle. It means that the communication configuration is set to a user-defined communication mode at present.

5. Use the up arrow to change the indicator position so that it is pointing to Enable. Press the OK key to change to the default communication mode.



The DCOMM Mode Change Notification screen is displayed. It indicates that the communication configuration is changed to the default communication mode. The DCOMM status indicator is displayed in solid rectangle.



If you change to the user-defined configuration from the default configuration mode by selecting Disable and pressing the OK key, the DCOMM Mode Change Notification will be displayed.



6. Press the ESC key to return to the Advanced Set Menu screen, as shown in step 3.

Connecting to the RS-232 Port

There are two ways to connect the MicroLogix 1400 programmable controller to your personal computer using the DF1 protocol: using a point-to-point connection, or using a modem. Descriptions of these methods follow.

ATTENTION: All devices connected to the RS-232/485 communication port must be referenced to controller ground, or be floating (not referenced to a potential other than ground). Failure to follow this procedure may result in property damage or personal injury.

- For 1766-L32BWA controllers, the COM of the sensor supply is also connected to chassis ground internally. The 24V DC sensor power source should not be used to power output circuits. It should only be used to power input devices.
- For 1766-L32BXB controllers, the VDC NEUT or common terminal of the power supply is also connected to chassis ground internally.

Available Communication Cables

Communication Cables	Length
1761-CBL-AM00 Series C or later cables are required for Class I Div 2 applications.	45 cm (17.7 in.)
1761-CBL-AP00 Series C or later cables are required for Class I Div 2 applications.	45 cm (17.7 in.)
1761-CBL-PM02 Series C or later cables are required for Class I Div 2 applications.	2 m (6.5 ft)
1761-CBL-HM02 Series C or later cables are required for Class I Div 2 applications.	2 m (6.5 ft)
2707-NC9 Series C or later cables are required for Class I Div 2 applications.	15 m (49.2 ft)
1763-NC01 Series A or later	30 cm (11.8 in.)
1747-CP3 Series A or later	3 m (9.8 ft)

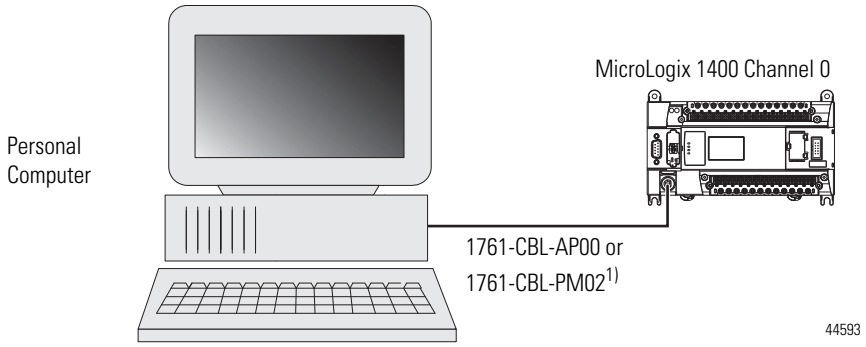
ATTENTION: UNSUPPORTED CONNECTION
Do not connect a MicroLogix 1400 controller to another MicroLogix family controller such as MicroLogix 1000, MicroLogix 1200, MicroLogix 1500, or to the 1747-DPS1 Network port using a 1761-CBL-AM00 (8-pin mini-DIN to 8-pin mini-DIN) cable or equivalent.
This type of connection will cause damage to the RS-232/485 communication port (Channel 0) of the MicroLogix 1400 and/or the controller itself. Communication pins used for RS-485 communications are alternately used for 24V power on the other MicroLogix controllers and the 1747-DPS1 network port .

Making a DF1 Point-to-Point Connection

You can connect the MicroLogix 1400 programmable controller to your personal computer using a serial cable (1761-CBL-PM02) from your personal computer's serial port to the controller's Channel 0. The recommended protocol for this configuration is DF1 Full-Duplex.

You can connect a MicroLogix 1400 controller to your personal computer directly without using an external optical isolator, such as Advanced Interface

Converter (AIC+), catalog number 1761-NET-AIC, as shown in the illustration below, because Channel 0 is isolated within the controller.

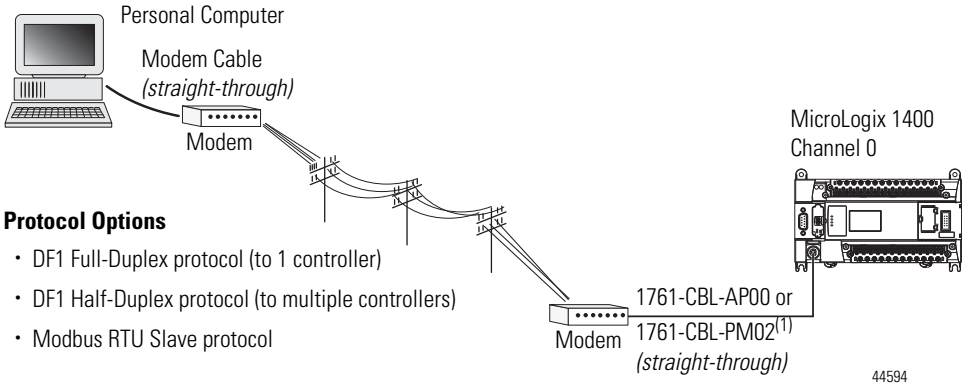


(1) Series C or later cables are required for Class I Div 2 applications.

Using a Modem

You can use modems to connect a personal computer to one MicroLogix 1400 controller (using DF1 Full-Duplex protocol), to multiple controllers (using DF1 Half-Duplex protocol), or Modbus RTU Slave protocol via Channel 0, as shown in the following illustration. (See Appendix E for information on types of modems you can use with the micro controllers.)

IMPORTANT	Do not attempt to use DH-485 protocol through modems under any circumstance. The communication timing using DH-485 protocol is not supported by modem communications.

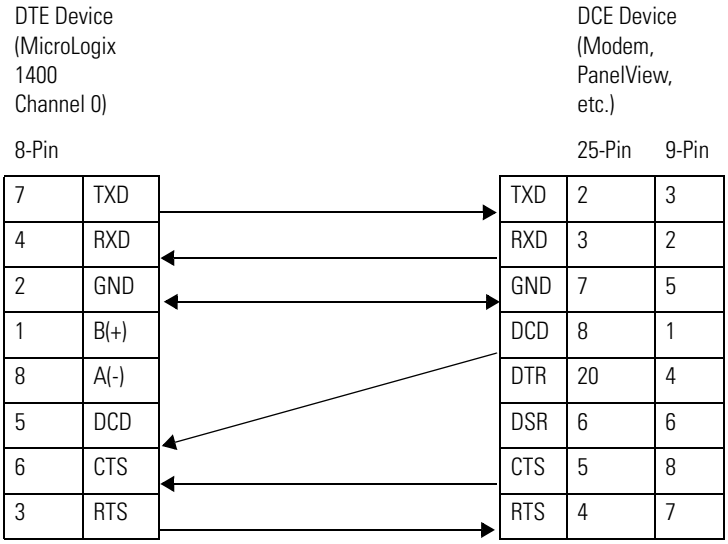


(1) Series C or later cables are required for Class I Div 2 applications.

You can connect a MicroLogix 1400 controller to your modem directly without using an external optical isolator, such as AIC+, catalog number 1761-NET-AIC, as shown in the illustration below, because Channel 0 is isolated within the controller.

MicroLogix 1400 Channel 0 to Modem Cable Pinout

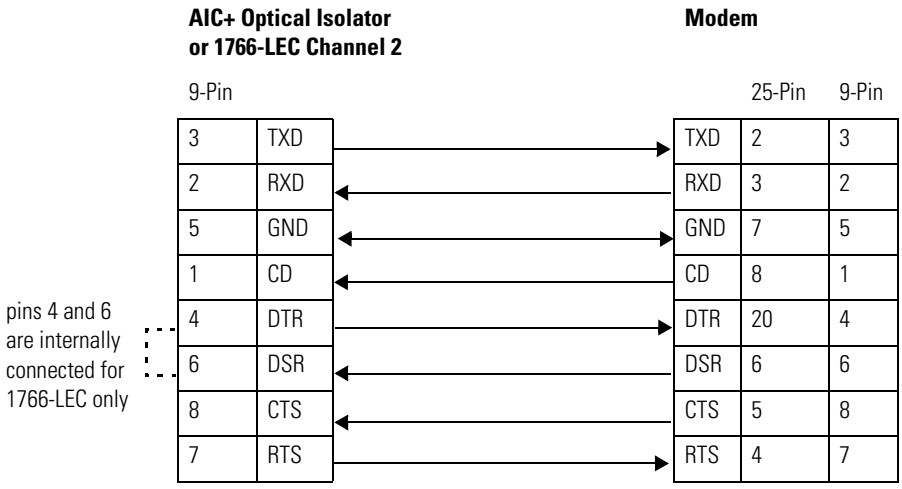
When connecting MicroLogix 1400 Channel 0 to a modem using an RS-232 cable, the maximum that the cable length may be extended is 15.24 m (50 ft).



ATTENTION: Do not connect pins 1 and 8. This connection will cause damage to the RS-232/485 communication port (channel 0) of the MicroLogix 1400 and/or the controller itself.

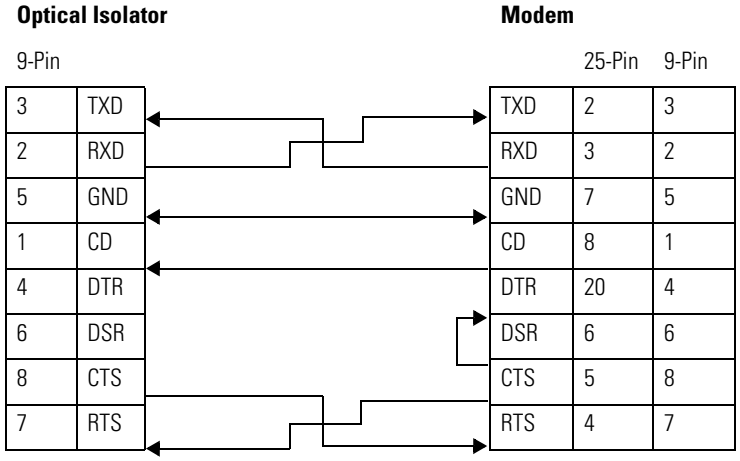
Constructing Your Own Modem Cable

If you construct your own modem cable, the maximum cable length is 15.24 m (50 ft) with a 25-pin or 9-pin connector. Refer to the following typical pinout for constructing a *straight-through* cable:



Constructing Your Own Null Modem Cable

If you construct your own null modem cable, the maximum cable length is 15.24m (50 ft) with a 25-pin or 9-pin connector. Refer to the following typical pinout:



Connecting to a DF1 Half-Duplex Network

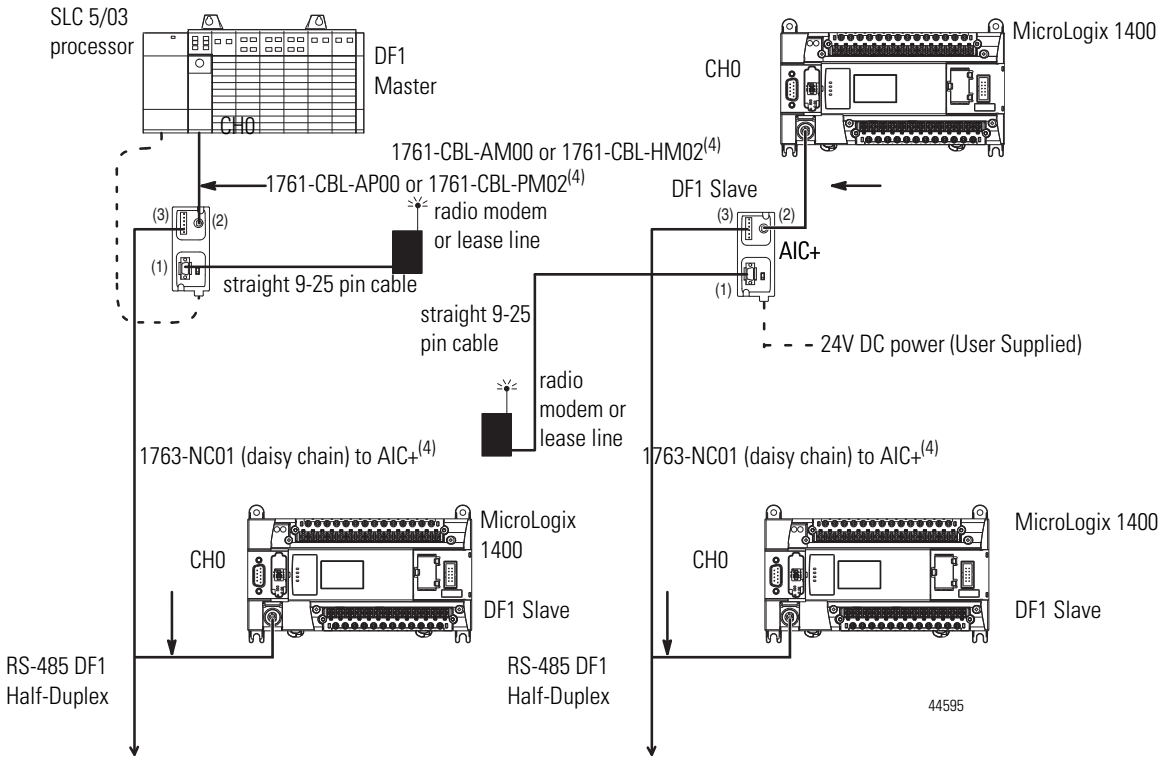
When a communication port is configured for DF1 Half-Duplex Slave, available parameters include the following:

DF1 Half-Duplex Configuration Parameters

Parameter	Options
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19.2 KBps, 38.4 KBps
Parity	none, even
Node Address	0...254 decimal
Control Line	no handshaking, half duplex modem (RTS/CTS handshaking, no handshaking (485 network)
Error Detection	CRC, BCC
EOT Suppression	enabled, disabled When EOT Suppression is enabled, the slave does not respond when polled if no message is queued. This saves modem transmission power and time when there is no message to transmit.
Duplicate Packet (Message) Detect	enabled, disabled Detects and eliminates duplicate responses to a message. Duplicate packets may be sent under noisy communication conditions if the sender's Message Retries are not set to 0.
Poll Timeout (x20 ms)	0...65,535 (can be set in 20 ms increments) Poll Timeout only applies when a slave device initiates a MSG instruction. It is the amount of time that the slave device waits for a poll from the master device. If the slave device does not receive a poll within the Poll Timeout, a MSG instruction error is generated, and the ladder program needs to requeue the MSG instruction. If you are using a MSG instruction, it is recommended that a Poll Timeout value of zero not be used. Poll Timeout is disabled when set to zero.
RTS Off Delay (x20 ms)	0...65,535 (can be set in 20 ms increments) Specifies the delay time between when the last serial character is sent to the modem and when RTS is deactivated. Gives the modem extra time to transmit the last character of a packet.
RTS Send Delay (x20 ms)	0...65,535 (can be set in 20 ms increments) Specifies the time delay between setting RTS until checking for the CTS response. For use with modems that are not ready to respond with CTS immediately upon receipt of RTS.
Message Retries	0...255 Specifies the number of times a slave device attempts to resend a message packet when it does not receive an ACK from the master device. For use in noisy environments where message packets may become corrupted in transmission.
Pre Transmit Delay (x1 ms)	0...65,535 (can be set in 1 ms increments) • When the Control Line is set to *no handshaking*, this is the delay time before transmission. Required for 1761-NET-AIC physical Half-Duplex networks. The 1761-NET-AIC needs delay time to change from transmit to receive mode. • When the Control Line is set to *DF1 Half-Duplex Modem*, this is the minimum time delay between receiving the last character of a packet and the RTS assertion.

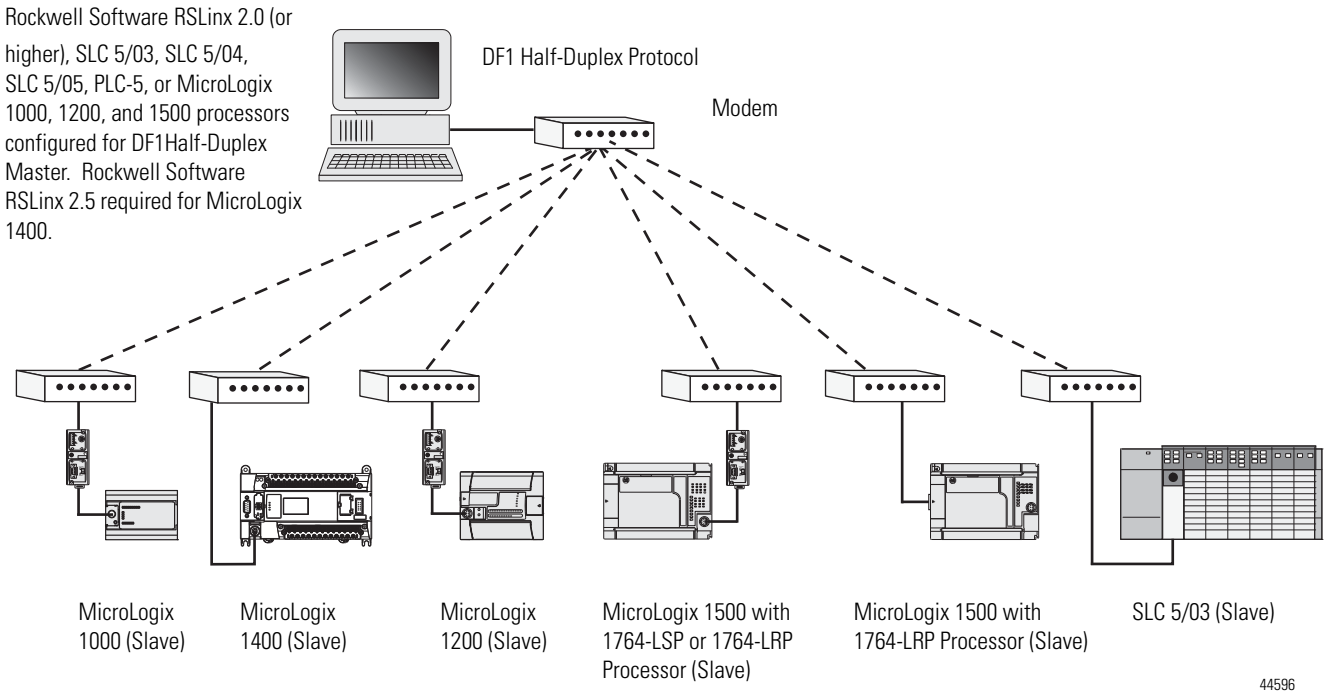
DF1 Half-Duplex Master-Slave Network

Use the following diagram for DF1 Half-Duplex Master-Slave protocol without hardware handshaking.



(1) DB-9 RS-232 port
(2) mini-DIN 8 RS-232 port
(3) RS-485 port
(4) Series C or later cables are required for Class I Div 2 applications.

DF1 Half-Duplex Network (Using PC and Modems)

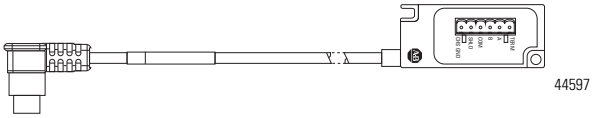


Connecting to a RS-485 Network

The network diagrams on the next pages provide examples of how to connect MicroLogix 1400 controllers to the RS-485 network.

You can connect a MicroLogix 1400 controller to your RS-485 network directly without using an external optical isolator, such as Advanced Interface Converter (AIC+), catalog number 1761-NET-AIC, as shown in the illustrations below, because Channel 0 is isolated within the controller.

TIP Use a 1763-NC01 Series A or later (8-pin mini-DIN to 6-pin RS-485 connector) cable or equivalent to connect a MicroLogix 1400 controller to a RS-485 network.



MicroLogix 1400 controllers support various protocols on the RS-485 network, including DH-485, DF1 Half-Duplex Master/Slave, Modbus RTU Master/Slave, ASCII and DNP3 Slave protocols. In this section, DH-485 protocol is used as an example. Any physical connection should be the same as other protocols.

DH-485 Configuration Parameters

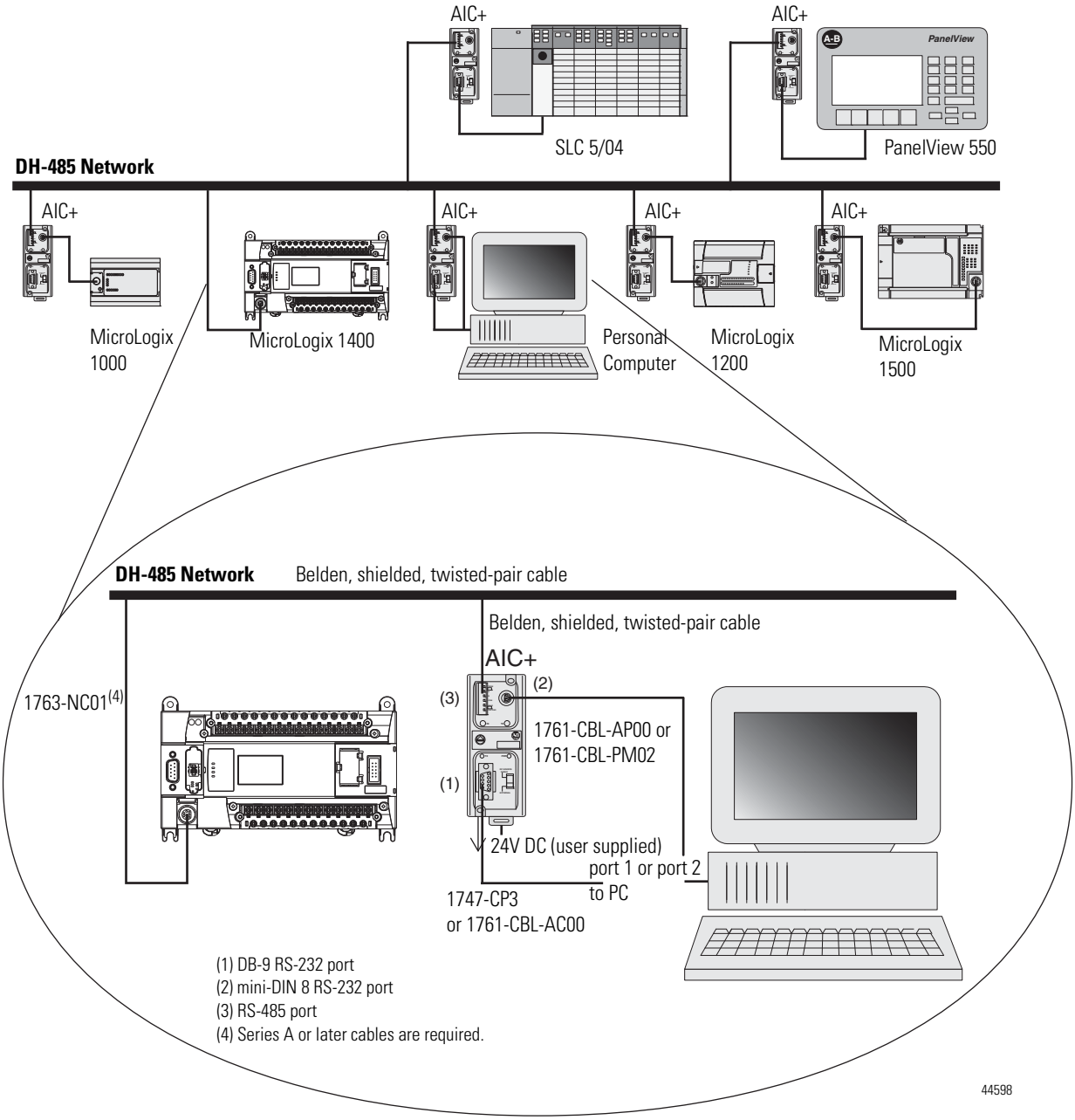
When MicroLogix communications are configured for DH-485, the following parameters can be changed:

DH-485 Configuration Parameters

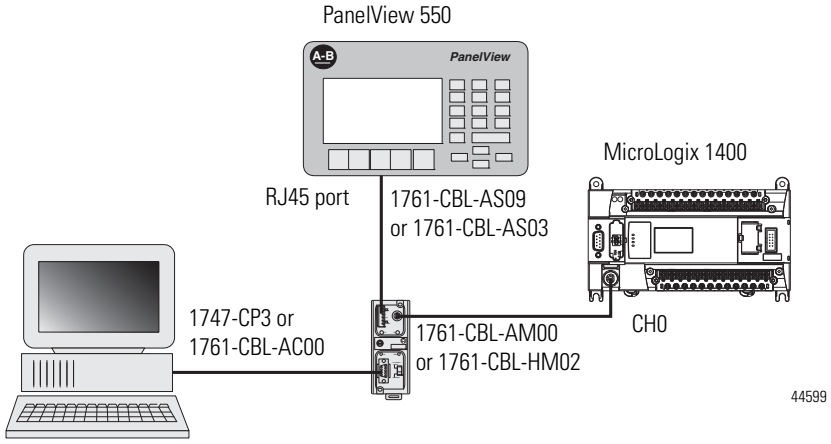
Parameter	Options
Baud Rate	9600, 19.2 KBps
Node Address	1...31 decimal
Token Hold Factor	1...4

See Software Considerations on page 191 for tips on setting the parameters listed above.

DH-485 Network with a MicroLogix 1400 Controller



Typical 3-Node Network (Channel 0 Connection)



Recommended Tools

To connect a DH-485 network to additional devices, you need tools to strip the shielded cable and to attach the cable to the AIC+ Advanced Interface Converter. We recommend the following equipment (or equivalent):

Working with Cable for DH-485 Network

Description	Part Number	Manufacturer
Shielded Twisted Pair Cable	#3106A or #9842	Belden
Stripping Tool	Not Applicable	Not Applicable
1/8" Slotted Screwdriver	Not Applicable	Not Applicable

DH-485 Communication Cable

The suggested DH-485 communication cable is either Belden #3106A or #9842. The cable is jacketed and shielded with one or two twisted-wire pairs and a drain wire.

One pair provides a balanced signal line and one additional wire is used for a common reference line between all nodes on the network. The shield reduces the effect of electrostatic noise from the industrial environment on network communication.

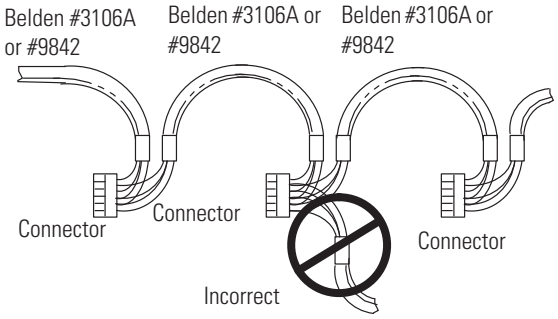
The communication cable consists of a number of cable segments daisy-chained together. The total length of the cable segments cannot exceed 1219 m (4000 ft). However, two segments can be used to extend the DH-485 network to 2438 m (8000 ft). For additional information on connections using the AIC+, refer to the Advanced Interface Converter (AIC+) User Manual, publication 1761-6.4.

When cutting cable segments, make them long enough to route them from one AIC+ to the next, with sufficient slack to prevent strain on the connector. Allow enough extra cable to prevent chafing and kinking in the cable.

Use these instructions for wiring the Belden #3106A or #9842 cable. (See Cable Selection Guide on page 77 if you are using standard Allen-Bradley cables.)

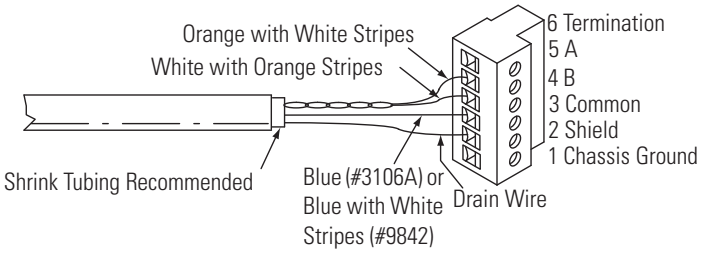
Connecting the Communication Cable to the DH-485 Connector

TIP A daisy-chained network is recommended. Do *not* make the incorrect connection shown below:



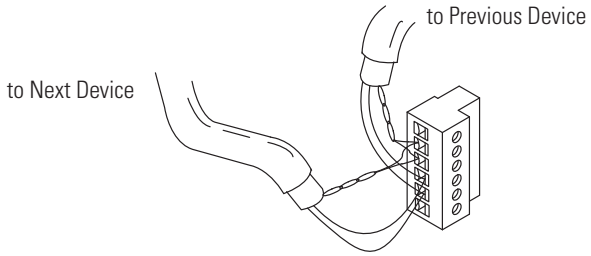
Single Cable Connection

When connecting a single cable to the DH-485 connector, use the following diagram.



Multiple Cable Connection

When connecting multiple cables to the DH-485 connector, use the following diagram.



Connections using Belden #3106A Cable

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non-jacketed	Terminal 2 - Shield
Blue	Blue	Terminal 3 - (Common)
White/Orange	White with Orange Stripe	Terminal 4 - (Data B)
	Orange with White Stripe	Terminal 5 - (Data A)

Connections using Belden #9842 Cable

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non-jacketed	Terminal 2 - Shield
Blue/White	White with Blue Stripe	Cut back - no connection[1]
	Blue with White Stripe	Terminal 3 - (Common)
White/Orange	White with Orange Stripe	Terminal 4 - (Data B)
	Orange with White Stripe	Terminal 5 - (Data A)

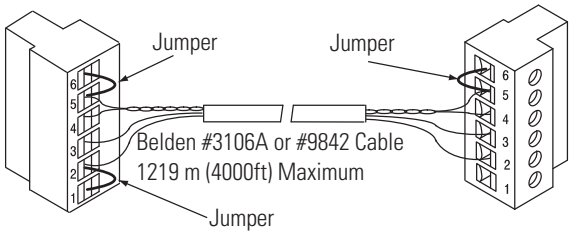
(1) To prevent confusion when installing the communication cable, cut back the white with blue stripe wire immediately after the insulation jacket is removed. This wire is not used by DH-485.

Grounding and Terminating the DH-485 Network

Only one connector at the end of the link must have Terminals 1 and 2 jumpered together. This provides an earth ground connection for the shield of the communication cable.

Both ends of the network must have Terminals 5 and 6 jumpered together, as shown below. This connects the termination impedance (of 120 ohm) that is built into each AIC+ or the 1763-NC01 cable as required by the DH-485 specification.

End-of-Line Termination



MicroLogix 1400 Channel 0 to DH-485 Communication Cable Pinout

When connecting MicroLogix 1400 Channel 0 to DH-485 communication cable pinout using an RS-232 cable, the maximum that the cable length may be extended is 15.24 m (50 ft). Refer to the following typical pinout:

DTE Device (MicroLogix 1400 Channel 0)

8-Pin

7	TXD
4	RXD
2	GND
1	B(+)
8	A(-)
5	DCD
6	CTS
3	RTS

DCE Device (DH-485 connector)

6-pin

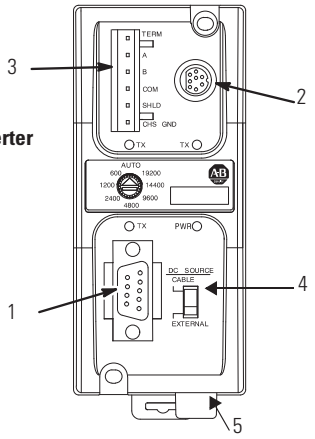
6	Termination
5	A
4	B
3	Common
2	Shield
1	ChassisGround

Connecting the AIC+

You can connect a MicroLogix 1400 controller to a DH-485 network via Channel 0 directly without using an optical isolator, such as AIC+, catalog number 1761-NET-AIC, because Channel 0 is isolated. However, you need to use an AIC+ to connect your PC or other MicroLogix Family products, such as MicroLogix 1200, to a DH-485 network.

The following figure shows the external wiring connections and specifications of the AIC+.

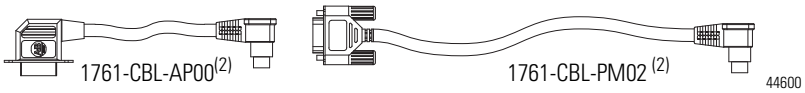
AIC+ Advanced Interface Converter (1761-NET-AIC)



Item	Description
1	Port 1 - DB-9 RS-232, DTE
2	Port 2 - mini-DIN 8 RS-232 DTE
3	Port 3 - RS-485 Phoenix plug
4	DC Power Source selector switch (cable = port 2 power source, external = external power source connected to item 5)
5	Terminals for external 24V DC power supply and chassis ground

For additional information on connecting the AIC+, refer to the Advanced Interface Converter (AIC+) User Manual, publication 1761-UM001.

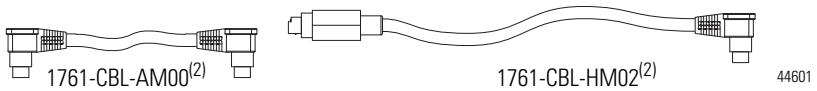
Cable Selection Guide



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
1761-CBL-AP00(2) 1761-CBL-PM02(2)	45 cm (17.7 in.) 2 m (6.5 ft)	SLC 5/03 or SLC 5/04 processors, ch 0	port 2	yes	external
		MicroLogix 1000, 1200, or 1500 ch 0	port 1	yes	external
		MicroLogix 1400 ch 2	port 2	yes	external
		PanelView 550 through NULL modem adapter	port 2	yes	external
		DTAM Plus / DTAM Micro	port 2	yes	external
		PC COM port	port 2	yes	external

(1) External power supply required unless the AIC+ is powered by the device connected to port 2, then the selection switch should be set to *cable*.

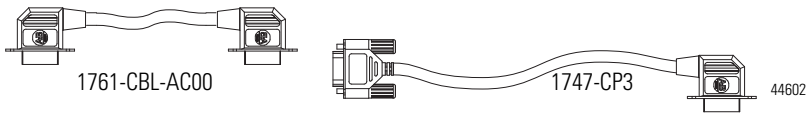
(2) Series C or later cables are required.



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting
1761-CBL-AM00(2) 1761-CBL-HM02(2)	45 cm (17.7 in.) 2 m (6.5 ft)	MicroLogix 1000, 1200, or 1500 ch 0	port 2	no	cable
		to port 2 on another AIC+	port 2	yes	external

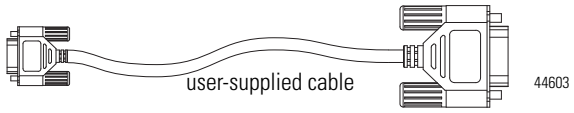
(1) External power supply required unless the AIC+ is powered by the device connected to port 2, then the selection switch should be set to *cable*.

(2) Series C or later cables are required.



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
1747-CP3 1761-CBL-AC00(1)	3 m (9.8 ft) 45 cm (17.7 in.)	SLC 5/03 or SLC 5/04 processor, channel 0	port 1	yes	external
		PC COM port	port 1	yes	external
		PanelView 550 through NULL modem adapter	port 1	yes	external
		DTAM Plus / DTAM Micro™	port 1	yes	external
		Port 1 on another AIC+	port 1	yes	external
		MicroLogix 1400 ch 2	port 2	yes	external

(1) External power supply required unless the AIC+ is powered by the device connected to port 2, then the selection switch should be set to *cable*.



Cable	Length	Connections from	to AIC+	External Power Supply Required(1)	Power Selection Switch Setting(1)
straight 9-25 pin	—	modem or other communication device	port 1	yes	external

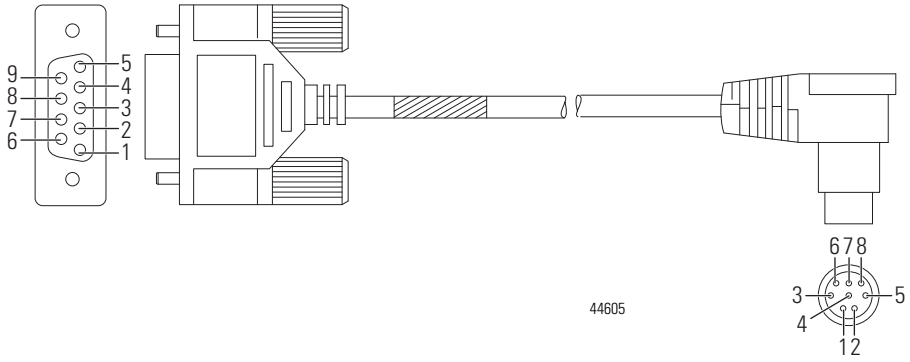
(1) External power supply required unless the AIC+ is powered by the device connected to port 2, then the selection switch should be set to *cable*.



Cable	Length	Connections from	to AIC+	External Power Supply Required[1]	Power Selection Switch Setting[1]
1761-CBL-AS03 1761-CBL-AS09	3 m (9.8 ft) 9.5 m (31.17 ft)	SLC 500 Fixed, SLC 5/01, SLC 5/02, and SLC 5/03 processors	port 3	yes	external
		PanelView 550 RJ45 port	port 3	yes	external

(1) External power supply required unless the AIC+ is powered by the device connected to port 2, then the selection switch should be set to *cable*.

1761-CBL-PM02 Series C (or equivalent) Cable Wiring Diagram



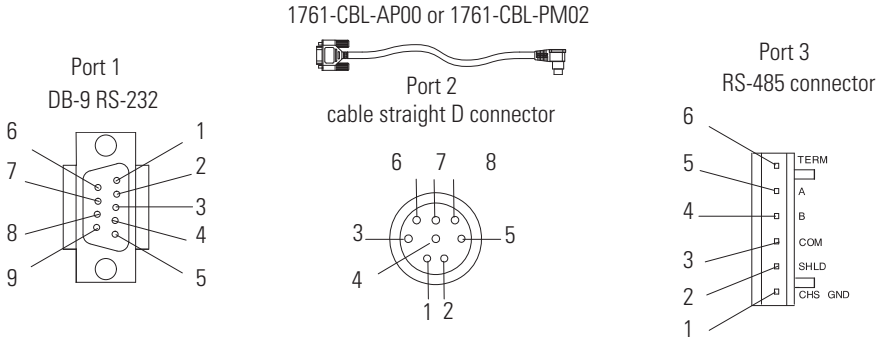
Programming Device 9-Pin D-Shell		Controller 8-Pin Mini Din	
9	RI		
8	CTS	GND	2
7	RTS	RTS	3
6	DSR	RXD	4
5	GND	DCD	5
4	DTR	CTS	6
3	TXD	TXD	7
2	RXD	A(-)	8
1	DCD		
		B(+)	1

Recommended User-Supplied Components

These components can be purchased from your local electronics supplier.

User Supplied Components

Component	Recommended Model
external power supply and chassis ground	power supply rated for 20.4...28.8V dc
NULL modem adapter	standard AT
straight 9-25 pin RS-232 cable	see table below for port information if making own cables



Pin	Port 1: DB-9 RS-232	Port 2[2]: (1761-CBL-PM02 cable)	Port 3: RS-485 Connector
1	received line signal detector (DCD)	24V dc	chassis ground
2	received data (RxD)	ground (GND)	cable shield
3	transmitted data (TxD)	request to send (RTS)	signal ground
4	DTE ready (DTR)[1]	received data (RxD)[3]	DH-485 data B
5	signal common (GND)	received line signal detector (DCD)	DH-485 data A
6	DCE ready (DSR)[1]	clear to send (CTS)[3]	termination
7	request to send (RTS)	transmitted data (TxD)	not applicable
8	clear to send (CTS)	ground (GND)	not applicable
9	not applicable	not applicable	not applicable

(1) On port 1, pin 4 is electronically jumpered to pin 6. Whenever the AIC+ is powered on, pin 4 will match the state of pin 6.

(2) An 8-pin mini DIN connector is used for making connections to port 2. This connector is not commercially available. If you are making a cable to connect to port 2, you must configure your cable to connect to the Allen-Bradley cable shown above.

(3) In the 1761-CBL-PM02 cable, pins 4 and 6 are jumpered together within the DB-9 connector.

Safety Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only.



WARNING: EXPLOSION HAZARD
AIC+ must be operated from an external power source.
This product must be installed in an enclosure. All cables connected to the product must remain in the enclosure or be protected by conduit or other means.

See Safety Considerations on page 9 for additional information.

Install and Attach the AIC+

1. Take care when installing the AIC+ in an enclosure so that the cable connecting the MicroLogix controller to the AIC+ does not interfere with the enclosure door.
2. Carefully plug the terminal block into the RS-485 port on the AIC+ you are putting on the network. Allow enough cable slack to prevent stress on the plug.
3. Provide strain relief for the Belden cable after it is wired to the terminal block. This guards against breakage of the Belden cable wires.

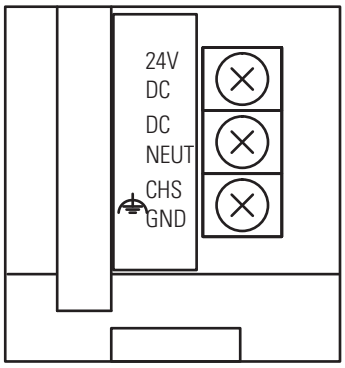
Powering the AIC+

MicroLogix 1000, 1200, and 1500 programmable controllers support 24V DC communication power on Channel 0. When connected to the 8 pin mini-DIN connector on the 1761-NET-AIC, 1761-NET-ENI, and the 1761-NET-ENIW, these controllers provide the power for the interface converter modules. The MicroLogix 1400 does not provide 24V DC communication power through communication ports. Instead these pins are used to provide RS-485 communications directly. Any AIC+, ENI, or ENIW not connected to a MicroLogix 1000, 1200, or 1500 controller requires a 24V DC power supply.

If both the controller and external power are connected to the AIC+, the power selection switch determines what device powers the AIC+.

ATTENTION: If you use an external power supply, it must be 24V DC (-15%/+20%). Permanent damage results if a higher voltage supply is used.

Set the DC Power Source selector switch to EXTERNAL before connecting the power supply to the AIC+. The following illustration shows where to connect external power for the AIC+.



Bottom View

ATTENTION: Always connect the CHS GND (chassis ground) terminal to the nearest earth ground. This connection must be made whether or not an external 24V DC supply is used.

Power Options

Below are two options for powering the AIC+:

- Use the 24V DC user power supply built into the MicroLogix 1000, 1200, or 1500 controller. The AIC+ is powered through a hard-wired connection using a communication cable (1761-CBL-HM02, or equivalent) connected to port 2.
- Use an external DC power supply with the following specifications:
  - operating voltage: 24V DC (-15%/+20%)
  - output current: 150 mA minimum

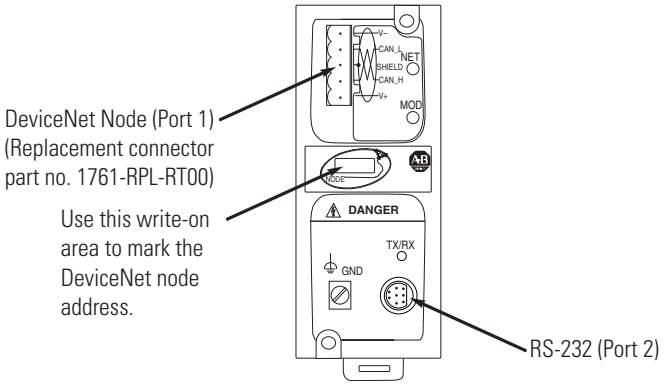
– rated NEC Class 2

Make a hard-wired connection from the external supply to the screw terminals on the bottom of the AIC+.

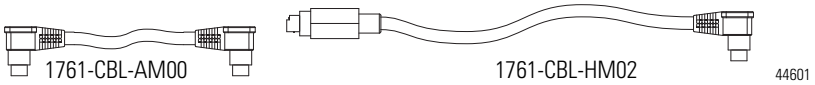
ATTENTION: If you use an external power supply, it must be 24V DC (-15%/+20%). Permanent damage results if miswired with the wrong power source.

Connecting to DeviceNet

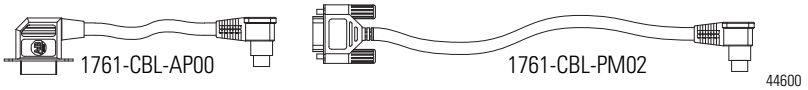
You can connect a MicroLogix 1400 as a slave to a DeviceNet network using the DeviceNet Interface (DNI), catalog number 1761-NET-DNI. For additional information on using the DNI, refer to the *DeviceNet Interface User Manual*, publication 1761-UM005. The following figure shows the external wiring connections of the DNI.



Cable Selection Guide(1)



Cable	Length	Connections from	to DNI
1761-CBL-AM00 1761-CBL-HM02	45 cm (17.7 in.) 2 m (6.5 ft)	MicroLogix 1000	port 2
		MicroLogix 1100/1400 channel 0	port 2
		MicroLogix 1200	port 2
		MicroLogix 1500	port 2

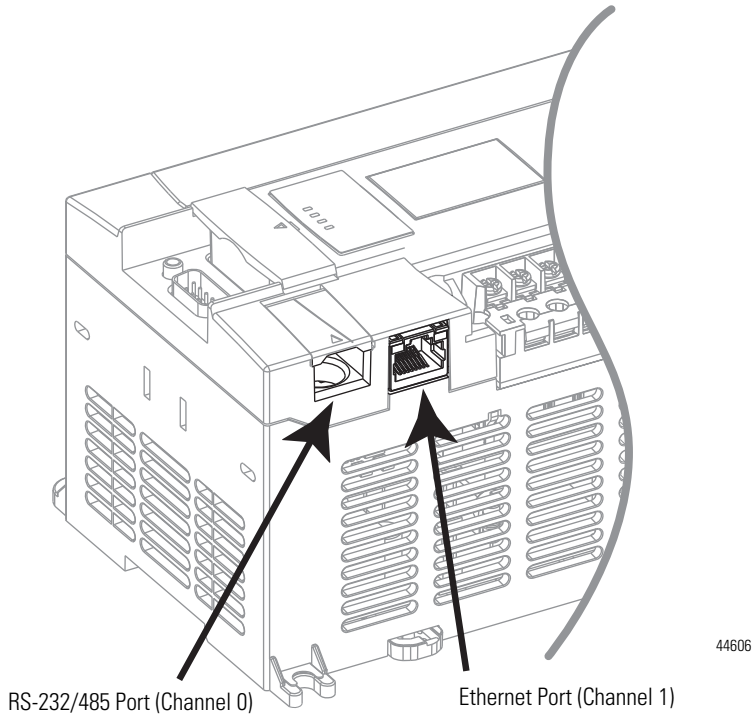


(1) Series C (or later) cables are required.

Cable	Length	Connections from	to DNI
1761-CBL-AP00 1761-CBL-PM02	45 cm (17.7 in.) 2 m (6.5 ft)	SLC 5/03 or SLC 5/04 processors, channel 0	port 2
		PC COM port	port 2
		1764-LRP processor, channel 1	port 2
		MicroLogix 1400 channel 2	port 2

Connecting to Ethernet

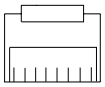
You can connect directly a MicroLogix 1400 to an Ethernet network via the Ethernet port (Channel 1). You do not need to use an Ethernet interface card, such as the Ethernet Interface (ENI) and (ENIW), catalog number 1761-NET-ENI and 1761-NET-ENIW, to connect your MicroLogix 1400 controller to an Ethernet network. For additional information on connecting to an Ethernet network, see Connecting to Networks via Ethernet Interface on page 327.

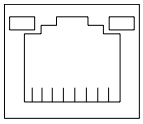


Ethernet Connections

The Ethernet connector, Channel 1, is an RJ45, 10/100Base-T connector. The pin-out for the connector is shown below.

Pin	Pin Name
1	Tx+
2	Tx-
3	Rx+
4	not used by 10/100Base-T
5	not used by 10/100Base-T
6	Rx-
7	not used by 10/100Base-T
8	not used by 10/100Base-T

End view of RJ 45 Plug 



Looking into a RJ45 Jack

TIP For more information on using ethernet cables with MicroLogix 1400, see.

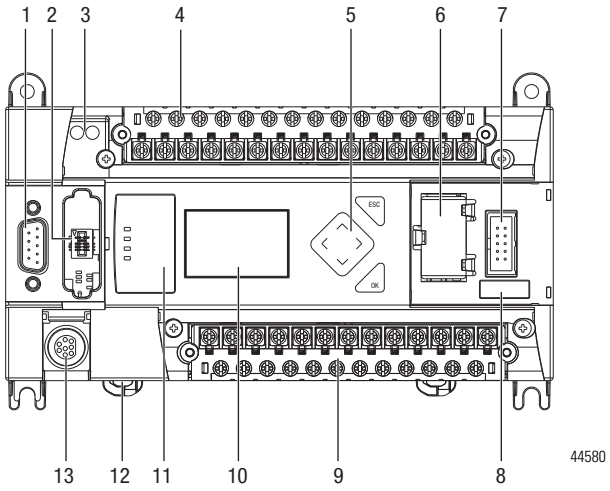
Notes:

Using the LCD

This chapter describes how to use the LCD and keypad on the MicroLogix 1400 controller. Topics include:

- operating principles
- I/O status display
- monitoring user defined target files
- using the mode switch
- using a user defined LCD screen
- changing key in mode
- using communications toggle functionality
- configuring Ethernet port configuration
- using trim pots
- viewing system information
- viewing fault code
- using communication EEPROM
- configuring LCD Setup
- viewing/changing protocol configuration

The LCD and keypad are shown below.

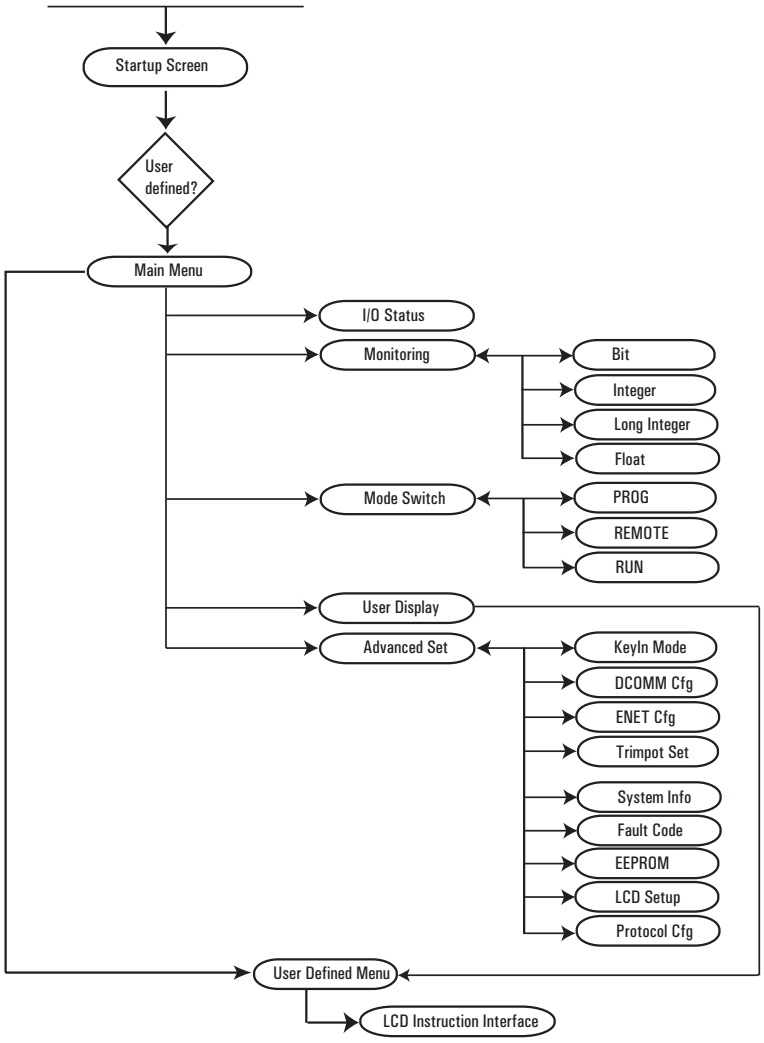


LCD and Keypad

Feature	Description
10	LCD
5	LCD Screen Keypad (ESC, OK, Up, Down, Left, and Right Buttons)

Operating Principles

MicroLogix 1400 LCD Menu Structure Tree



Startup Screen

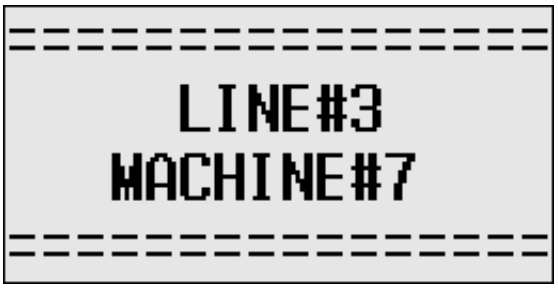
The Startup screen is displayed whenever the controller is powered up.

LCD Default Startup Screen



You can customize this Startup screen in your application program by defining a ASCII data file that contains the bitmap format image to display on the Startup screen and specifying the CBL element of the LCD Function File to the address of this ASCII file.

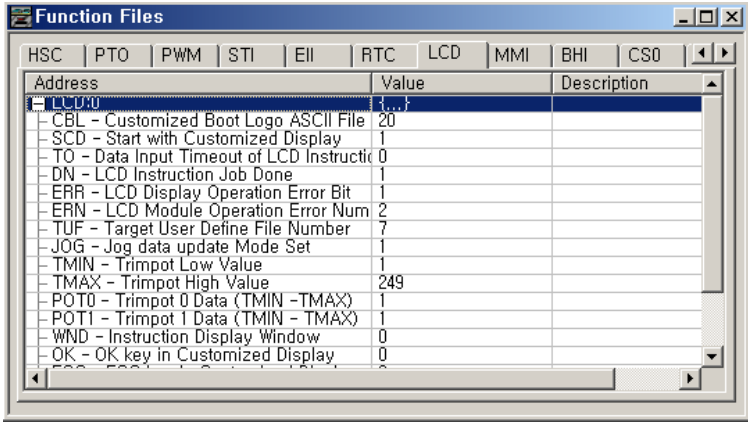
The screen shown below is an example of a customized Startup screen.



Your imported Bitmap file format should meet the following criteria:

- image resolution : 128 x 64 pixels (black/white image)
- image size : 1088 bytes
  (consisting of image header = 62 bytes
  + raw image data size = 1024 bytes
  + padding data : 2 bytes)

To load a customized boot logo image to your controller, the CBL (Customized Boot Logo ASCII File) element in the LCD Function File should be configured properly. If the CBL element is set to 0 (default) or if the indexed ASCII file does not exist, the embedded default logo will be displayed.



TIP Once a valid bitmap file is imported successfully, you should be able to see the data in ASCII data files.

Make sure that the second element (file size) in the first ASCII data file is 0x0440 (1088 bytes) in hexadecimal value.
After a power cycle, you should be able to see the customized boot logo on your LCD display.

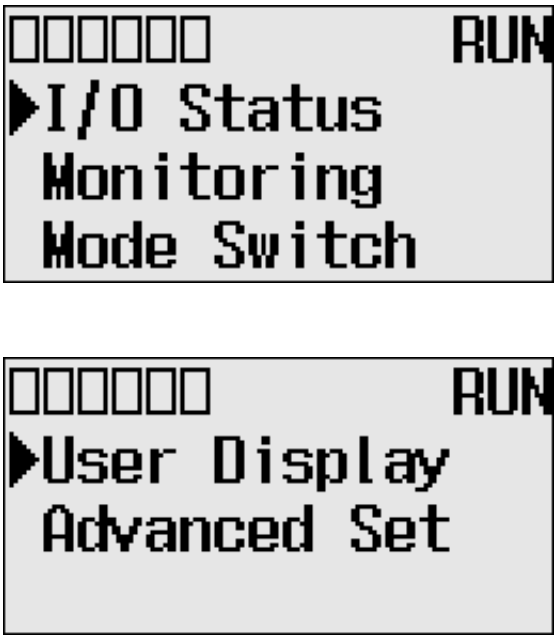
For more information on how to create and use a customized Startup screen, refer to the LCD Function File described in the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

After the default Startup screen or your customized Startup screen is displayed for 3 seconds, either the default screen (the I/O Status screen) is displayed by default, or a user defined screen is displayed if your application uses a custom default screen.

Main Menu and Default Screen

The Main menu consists of five menu items: I/O Status, Monitoring, Mode Switch, User Display, and Advanced Set.

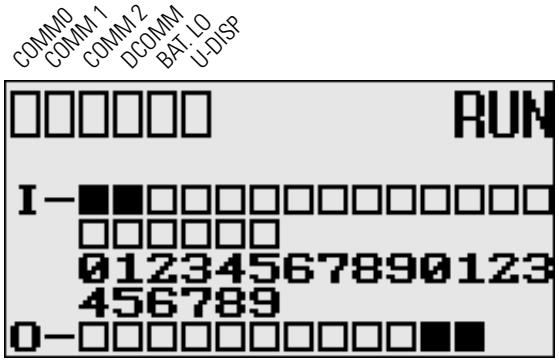
LCD Main Menu



Main Menu Items

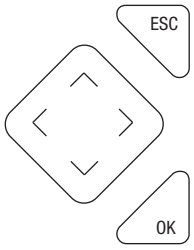
Menu Item	Description	For details, refer to
I/O Status	Displays the I/O Status screen, which shows the I/O status of the embedded digital I/O.	I/O Status on page 67
Monitoring	Allows you to view and change the data value of a bit and an integer file.	Monitor User Defined Target Files on page 69 Monitoring Integer Files on page 74
Mode Switch	Allows you to change the mode switch selection.	Using the Mode Switch on page 86
User Display	Displays the user defined LCD screen	Using a User Defined LCD Screen on page 89
Advanced Set	Allows you to configure or view the following:	
	• Change the key in mode for value entry for a trim pot.	• Changing Key In Mode on page 92
	• Use the communications toggle functionality.	• Using Communications Toggle Functionality on page 94
	• View and change the Ethernet network configuration.	• Viewing Ethernet Status on page 94
	• Change the data value of trim pots.	• Using Trim Pots on page 105
	• View system information, such as OS series and firmware version.	• I/O Status on page 67
	• User communication EEPROM functionality.	• Saving/Loading Communication EEPROM on page 110
	• Change LCD contrast and backlight option.	• LCD setup on page 113
	• Modbus RTU Slave Node Address	• See Protocol Configuration on page 116

LCD Default Screen – I/O Status Screen



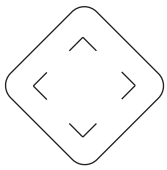
This is the default screen of the display, allowing you to monitor controller and I/O Status. For more information on the I/O Status screen, see I/O Status on page 67.

Operating Buttons

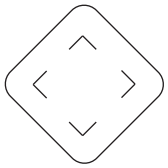


Button	Function
Cursor Buttons	Move cursor
	Select menu item
	Choose file numbers, values, etc.
OK	Next menu level, store your entry, apply the changes
ESC	Previous menu level, cancel your entry

Using Menus to Choose Values

Press	To
 44613	• Go to next menu level. • Store your entry. • Apply the changes.
 44614	• Go to previous menu level. • Cancel your entry since the last *Ok*. • Press repeatedly to go to the main menu.
 44615	• Change menu item. • Change value. • Change position.

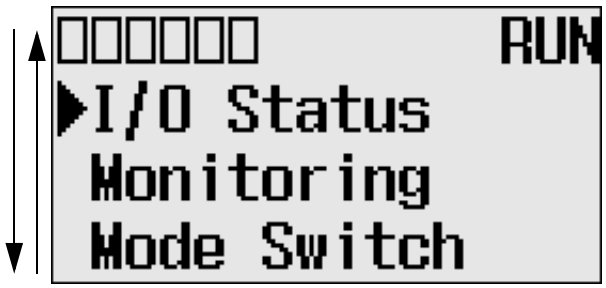
Selecting Between Menu Items



Cursor up or down

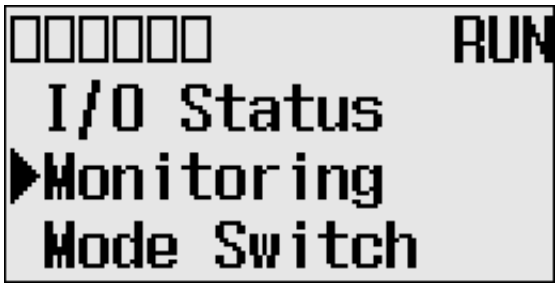


Apply or Enter



The symbol " ▶ " is used as the cursor.

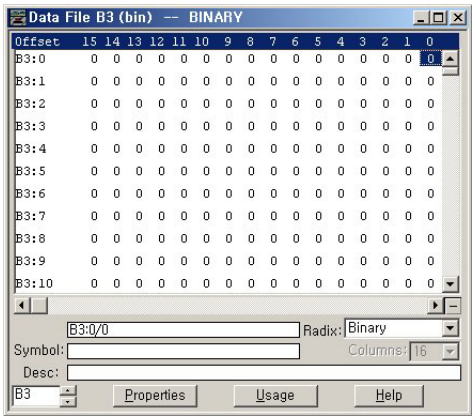
Cursor Display



There are two different cursor types:

Selection cursor (the symbol "▶") is displayed left to the selected item.

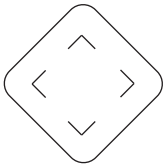
- Move cursor with the up/down arrows



Full block navigation is shown as a flashing block:

- Change position with left/right arrows
- Change values with up/down arrows

Setting Values



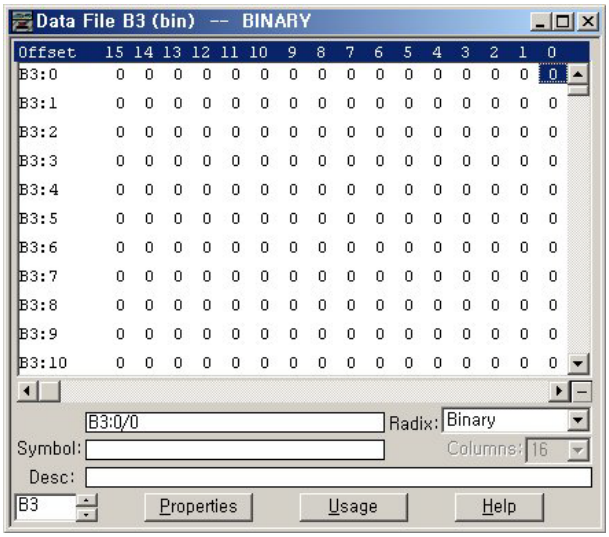
Change value = up/down arrows
Move cursor between digits = left/right arrows



Stores Entries



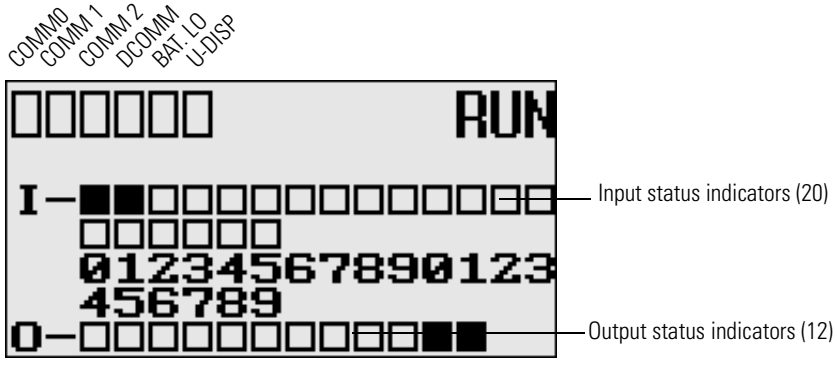
Retain previous value



Left/right arrow moves the cursor between the digits of the value .
Up/down arrow changes the value.
Up arrow = increment
Down arrow = decrement

I/O Status

The MicroLogix 1400 provides I/O status indicators on the LCD screen. You can view the status of inputs and outputs on the I/O Status screen on the LCD, as shown below. The I/O status indicators on this screen are updated every 100 ms to reflect the current I/O status in real time, regardless of controller scan time.



A solid rectangle is displayed when the input or output is energized. An empty rectangle is displayed when the input or output is not energized.

IMPORTANT If no user defined LCD screen is used, the I/O Status screen is displayed,

- 5 seconds after the controller has powered-up.
- When the user enters the I/O Status screen from other screen using the LCD menu. If you are at other screen and want to view I/O status, you have to enter the I/O Status screen manually using the menu. Otherwise, the current screen will be displayed continuously.

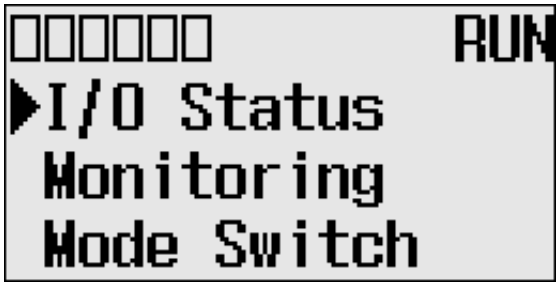
IMPORTANT If a user defined LCD screen is used, the I/O S sctatus sreen is displayed,

- When the user holds down the ESC key for more than 3 seconds.
- When time out is enabled, that is, the time out period is set to a positive value, and the time out period is passed. You can enable and disable time out and set the time out period using the TO element in the LCD Function File. For more information, refer to the LCD Function File described in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001.
- If time out is disabled, that is, the time out period is set to zero (0), and a custom LCD screen is displayed, it will be displayed continuously until the user gives an input to change to other screen. For more information, see Using a User Defined LCD Screen on page 89.

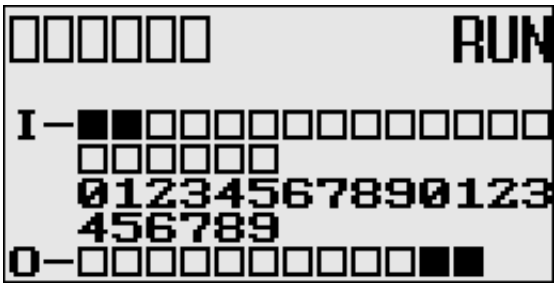
Viewing I/O Status

Follow these steps to view the status of inputs and outputs on the LCD.

1. On the Main Menu screen, select I/O Status by using the Up and Down keys on the LCD keypad, as shown below.



2. Then, press the OK key on the LCD keypad. The I/O Status screen is displayed, as shown below.



3. If you have finished viewing I/O status, press the ESC key to return to the Main Menu screen, as shown in step 1.

Monitor User Defined Target Files

The LCD allows you to view and change the data values of 256 bits, words or double integers in a user defined file. You can access to this functionality via the Monitoring screen of the LCD.

To monitor the bit file on the LCD, you have to specify its file number in the Target User Defined File Number (TUF) element of the LCD Function File and download your application program to the controller. The TUF element can only be changed by a program download.

Target User Defined File Number (TUF)

Feature	Address	Data Format	Type	User Program Access
Target User Defined File Number	LCD:0.TUF	Word (int)	Control	Read Only

The value stored in the TUF element identifies the bit file with which the LCD will interface. Valid bit files are B3, and B10 through B255. When the LCD reads a valid bit file number, it can access up to 256 bits (0 to 255) on the LCD screen. The protection bit (LCD edit disable) in the data file properties of target bit file are used to define the read-only or read/write privileges for its file.

The file type that the LCD interfaces with is bit, integer, double integer or float file specified in the TUF element.

IMPORTANT Use your programming software to ensure that the bit file you specify in the TUF element, as well as the appropriate number of elements, exist in the MicroLogix 1400 user program.

The data protection for a file depends on the LCD edit disable setting. When LCD Edit Disable is set (1: Checked) in file properties, the corresponding data file is considered read-only by and the “Protected!” message is displayed. When

LCD Edit Disable is clear (0: Unchecked), the "UnProtected!" message is displayed and the corresponding data file is editable from the LCD keypad.

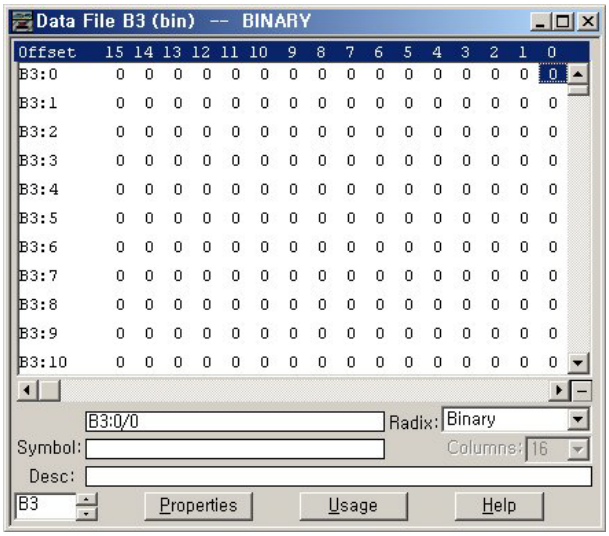
IMPORTANT	Although you cannot change protected data from the LCD keypad, the control program or other communication devices do have access to this data. The Protection bit (LCD Edit Disable) only provides write protection from the LCD keypad. This does not provide any overwrite protection from ladder logic, HMI, or programming software. It is the user's responsibility to ensure that data is not inadvertently overwritten.

TIP	The LCD always starts at bit 0 of a data file. It cannot start at any other address within the file.

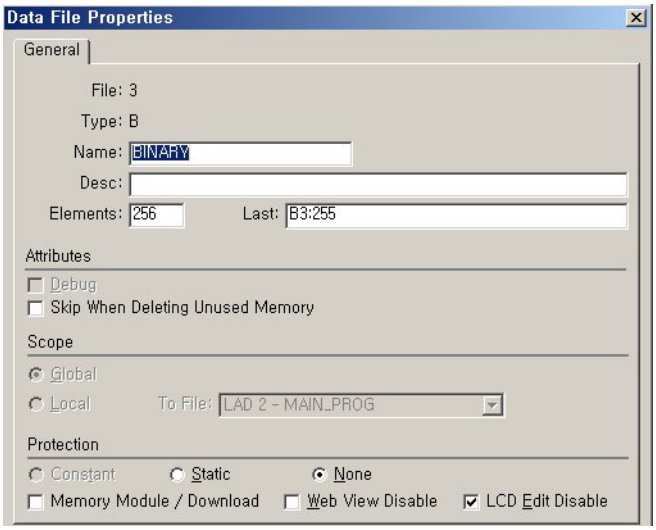
Monitoring a Bit File

For explanations in this section, we assume the following in the application program:

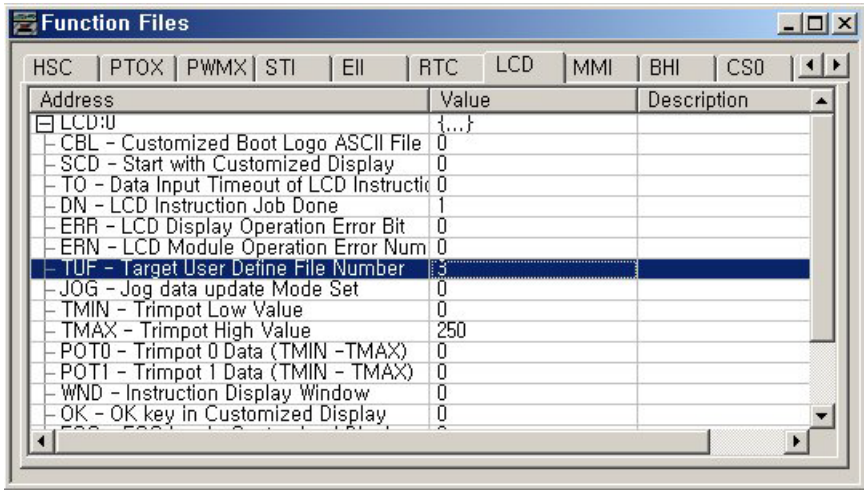
- A bit file B3, which is 256 elements long (256 words = 4096 bits), is defined with the preset data, as shown in the screen capture below.



- LCD Edit Disable is set to unchecked(disable)



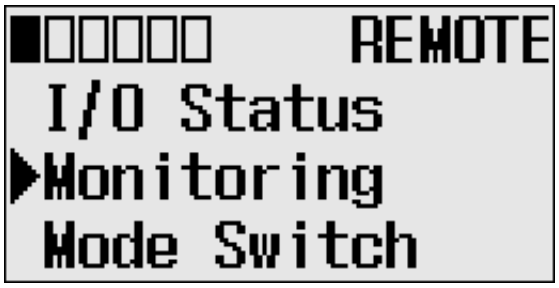
- The TUF element of the LCD Function File is set to 3 to specify the bit file B3 as the target bit file to monitor on the LCD, as shown in the screen capture below.



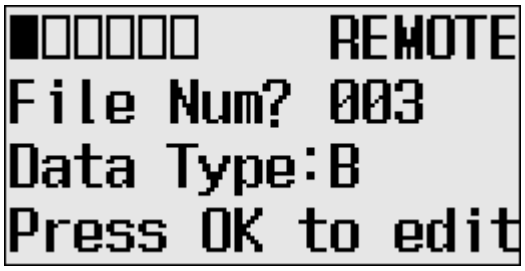
- The controller mode is set to REMOTE RUN.

Follow these steps to view and change the data values of the bit file B3.

1. On the Main Menu screen, select Monitoring by using the Up and Down keys on the LCD keypad.



2. Press the OK key on the LCD keypad. The File Number prompt is displayed.



3. If number 3 is selected, as shown in step 2, press the OK key. If not selected, press the Up or Down key to select it and then press the OK key.
4. The current data value (ON) of the B3:0/0 bit is displayed, as shown below. Note that "0/0" is flashing, which means the cursor is at the target bit position.

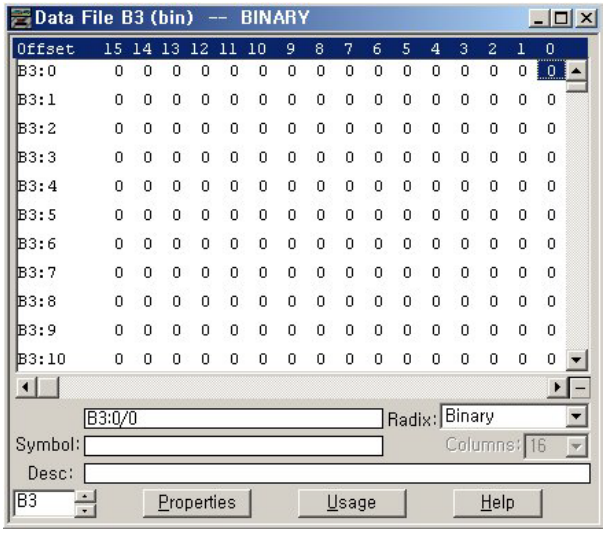


5. We will change the data value of the B3:0/0 bit to OFF (0).
   First, press OK to select the displayed address and move the cursor to the data value position. Then, "ON" will flash, which means the cursor is at the data value position.
6. Press the Down key. Then, the data value will be represented as "OFF". Note that "OFF" is still flashing, which means the cursor is still at the data value position.

7. Press OK to apply the changes. Then, the new value OFF (0) is applied. Note that the target bit, "0/0" in this example, is flashing. The cursor is moved automatically to the target bit position.



You can identify this change of data value is reflected to your RSLogix 500/RSLogix Micro programming software.



TIP

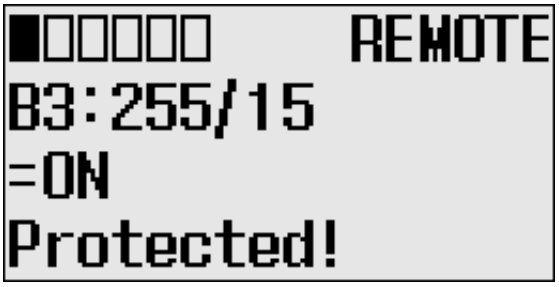
When the cursor is at the data value position, press the Down key to change the data value of a bit from ON (1) to OFF (0). Press the Up key to change from OFF (0) to ON (1).

After changing the data value of a target bit, press the OK key to apply the changes or press the ESC key to discard the changes.

8. Now, we will view an example of the data value of a protected property. If LCD Edit Disable is set to checked (enable), the “Protected!” message will be displayed and this data file cannot be edited from the LCD.



9. Try to move the cursor to the data value position by pressing the OK key. Because the B3:0/0 bit is a protected bit, you will find that the cursor does not move to the data value position.
10. Hold down the Up key until the target bit becomes “255/15”, as shown below. The maximum range of bits you can monitor with the LCD is 256 words of specified target bit file.



11. If you have finished monitoring the bit file, B3, press the ESC key to return to the Bit/Integer File Select screen, as shown in step 2.

Monitoring Integer Files

The LCD allows you to view and change the data value of an integer file. You can access to this functionality via the Monitoring screen of the LCD.

To monitor an integer file on the LCD, you have to specify its file number in the Target User Defined File Number (TUF) element of the LCD Function File and download your application program to the controller. The TUF element can only be changed by a program download.

The value stored in the TUF element identifies the integer file with which the LCD will interface. Valid integer files are N7, and N10 through N255. When the LCD reads a valid integer file number, it can access up to 256 bits (0...255) on the LCD screen. The protection bit (LCD edit disable) in the data file properties of the target integer file are used to define the read-only or read/write privileges for its file.

Valid file type include Bit, Integer, Double integer or Float, as specified in the TUF element.

IMPORTANT	Use your programming software to ensure that the integer file you specify in the TUF element, as well as the appropriate number of elements, exists in the MicroLogix 1400 user program.

The example table below shows how the LCD uses the configuration information with integer file number 7 (LCD:0.TUF=7).

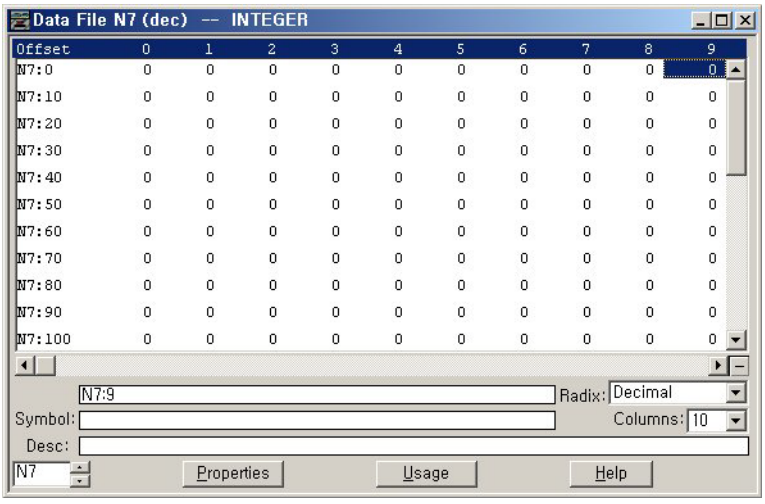
The data protection for its file depends on the setting for LCD Edit Disable. If LCD Edit Disable is set to 1 in file properties, the corresponding data file is considered read-only by the LCD and the "Protected!" message is displayed.

IMPORTANT	Although you cannot change protected data from the LCD keypad, the control program or other communication devices have access to protected data. Protection bits do not provide any overwrite protection to data within the target integer file. It is entirely the user's responsibility to ensure that data is not inadvertently overwritten.

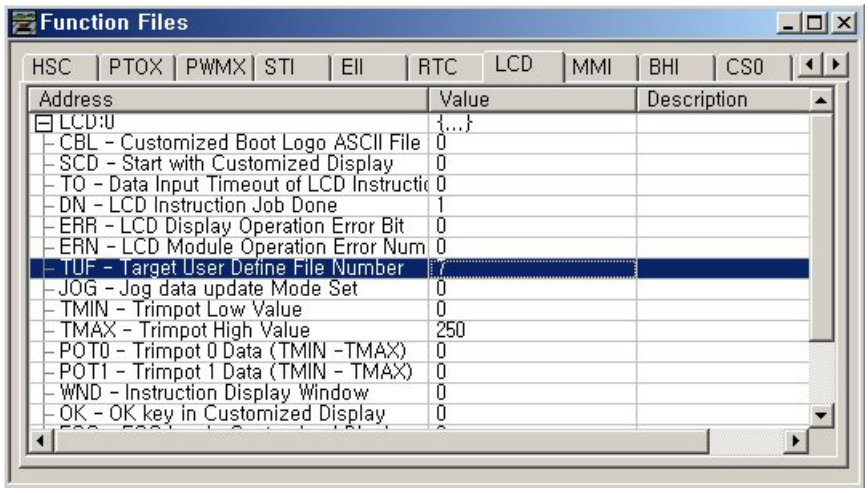
TIP	The LCD always starts at word 0 of a data file. It cannot start at any other address within the file.

For explanations in this section, we assume the following in the application program:

- An integer file N7, which is 256 elements long (256 words), is defined with the preset data, as shown in the screen capture below.



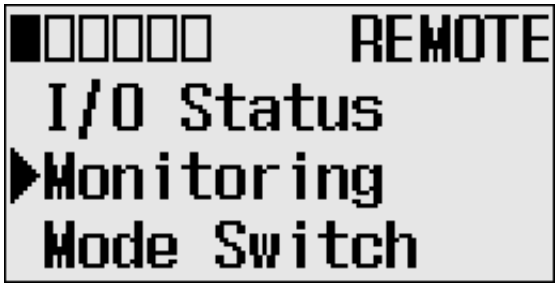
- The TUF element of the LCD Function File is set to 7 to specify the integer file N7 as the target integer file to monitor on the LCD, as shown in the screen capture below.



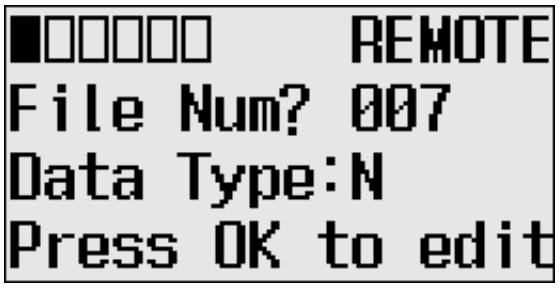
- The controller mode is set to REMOTE RUN.

Follow these steps to view and change the data values of the integer file N7.

1. On the Main Menu screen, select Monitoring by using the Up and Down keys on the LCD keypad.



2. Press the OK key on the LCD keypad. The File Number prompt is displayed.



3. If Integer is selected, as shown in step 2, press the OK key.
   If not selected, press the Down key to select it and then press the OK key.

4. The current data value (ON) of the N7:0 word is displayed. Note that the target word "0", which is right next to "N7:", is flashing, which means the cursor is at the target word position.



5. We will change the data value of the N7:0 word to the negative decimal value -1300. First, press OK to move the cursor to the data value position. Then, the last digit of "+00000" will be flashing, which means the cursor is at the data value position.
6. Press the Left key twice. Then, the cursor will position at the third digit. Press the Up key three times to change the third digit to 3.



7. Press the Left key once. Then, press the Up key once. The second digit will change to "1". Note that "1" is still flashing, which means the cursor is still at the data value position.

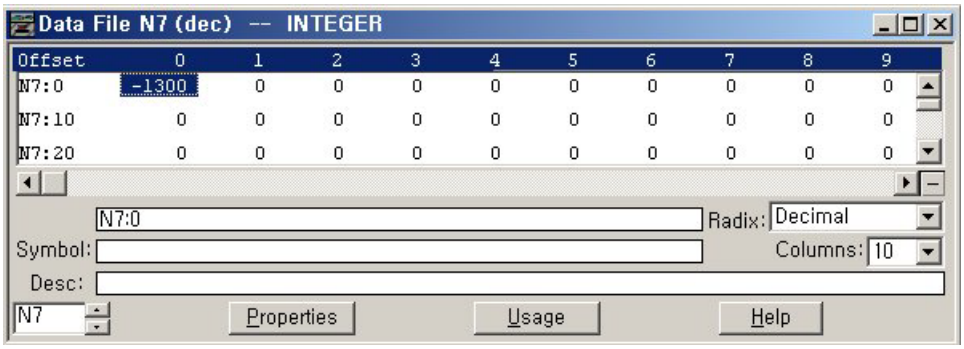


8. Press the Left key once. Then, press the Down key once. The sign digit will change to "-", as shown below. Note that "-" is still flashing, which means the cursor is still at the data value position.



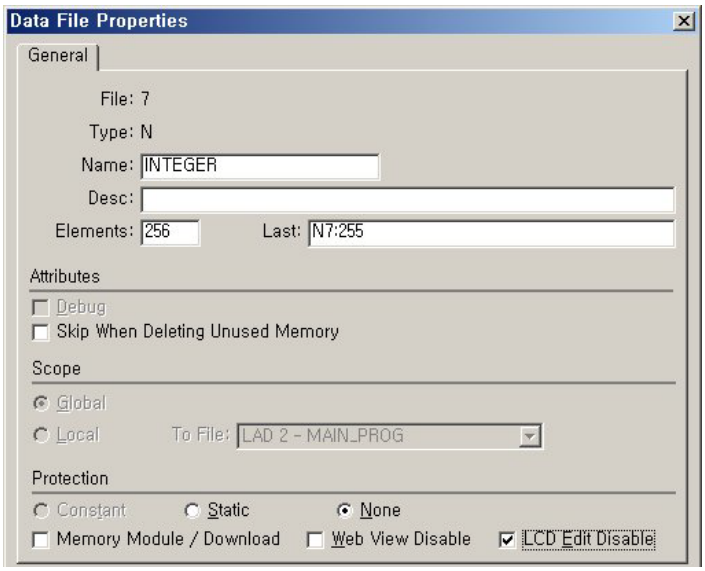
9. Press OK to apply the changes. Then, the new value -1300 is applied. Note that the target word "0", which is right next to "N7:", is flashing. The cursor is moved automatically to the target word position.

   You can identify this change of data value is reflected to your RSLogix 500/RSLogix Micro programming software, as shown below.



TIP After changing the data value of a target word, press the OK key to apply the changes or press the ESC key to discard the changes.

10. Now, we will view an example of the data value of a protected property. If LCD Edit Disable is set to checked (enable), the “Protected!” message will be displayed and this data file cannot be edited by the LCD.





11. Try to move the cursor to the data value position by pressing the OK key. Because the N7:0 word is protected, you will find that the cursor even does not move to the data value position.

IMPORTANT The maximum range of words you can monitor with the Integer File Monitoring functionality on the LCD is the first 256 words (0…255) of the target integer file.

12. If you have finished monitoring the integer file N7, press the ESC key to return to the Main Menu screen, as shown in step 2.

Monitoring Double Integer files

The LCD allows you to view and change the data value of a double integer file. You can access to this functionality via the Monitoring screen of the LCD.

To monitor a double integer file on the LCD, you have to specify its file number in the Target User Defined File Number (TUF) element of the LCD Function

File and download your application program to the controller. The TUF element can only be changed by a program download.

The value stored in the TUF element identifies the double integer file with which the LCD will interface. Valid double integer files are L9, and L10 through L255. When the LCD reads a valid double integer file number, it can access up to 256 words (0 to 255) on the LCD screen. The protection bit (LCD edit disable) in the data file properties of target integer file are used to define the read-only or read/write privileges for its file.

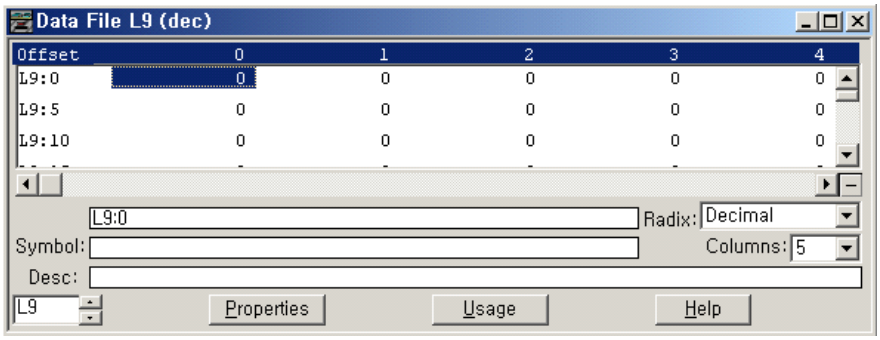
Valid file type include Bit, Integer, Double integer or Float, as specified in the TUF element.

The data protection for its file depends on the setting for LCD Edit Disable. If LCD Edit Disable is set to 1 in file properties, the corresponding data file is considered read-only by the LCD and the "Protected!" message is displayed.

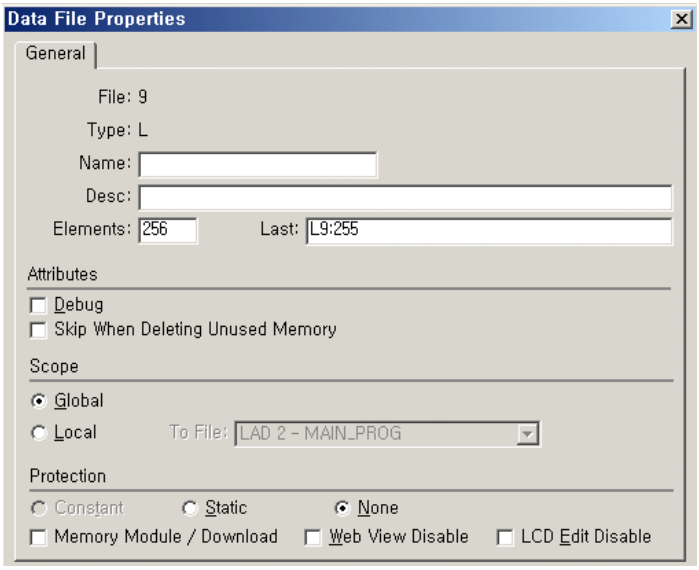
IMPORTANT Although you cannot change protected data from the LCD keypad, the control program or other communication devices do have access to this data. The Protection bit (LCD Edit Disable) only provides write protection from the LCD keypad. This does not provide any overwrite protection from ladder logic, HMI, or programming software. It is the user's responsibility to ensure that data is not inadvertently overwritten.

For explanations in this section, we assume the following in the application program:

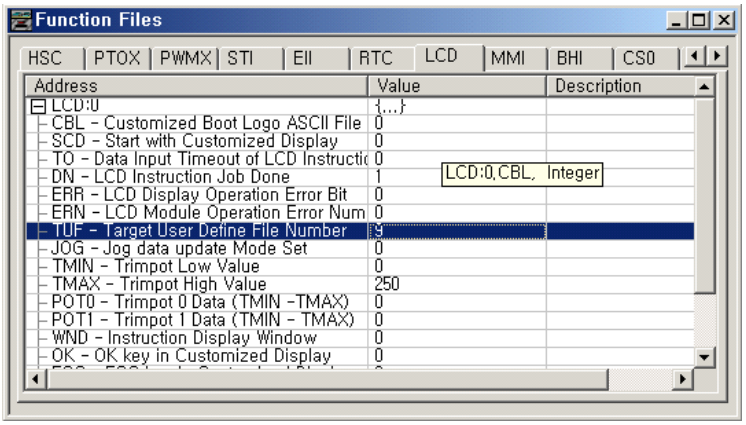
- A bit file L9, which is 256 elements long (256 words), is defined with the preset data, as shown in the screen capture below.



- LCD Edit Disable is set to unchecked(disable)

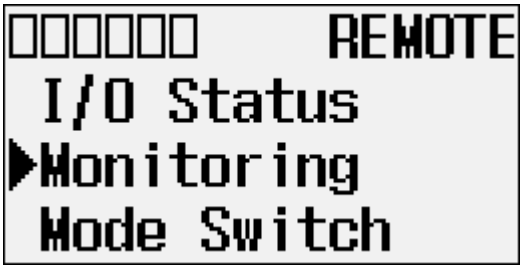


- The TUF element of the LCD Function File is set to 9 to specify the integer file L9 as the target file to monitor on the LCD, as shown in the screen capture below.
  The controller mode is set to REMOTE RUN.

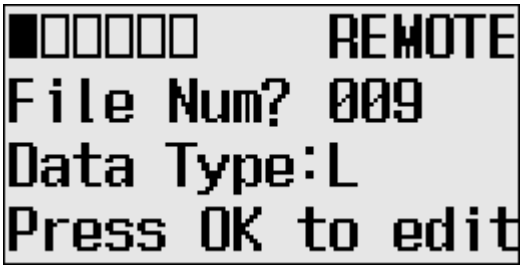


Follow these steps to view and change the data values of the double integer file L9.

1. On the Main Menu screen, select Monitoring by using the Up and Down keys on the LCD keypad.



2. Then, press the OK key on the LCD keypad. The File Number prompt is displayed.



3. If Integer is selected, as shown in step 2, press the OK key. If not selected, press the Down key to select it and then press the OK key.
4. The current data value (ON) of the L9:0 word is displayed. Note that the target word "0", which is at the right "L9:", is flashing, which means the cursor is at the target word position.



5. We will change the data value of the L9:0 word to the negative decimal value -1300. First, press OK to move the cursor to the data value position. Then, the last digit of "+0000000000" will be flashing, which means the cursor is at the data value position.

6. Press the Left key twice. Then, the cursor will position at the third digit. Press the Up key three times to change the third digit to 3.



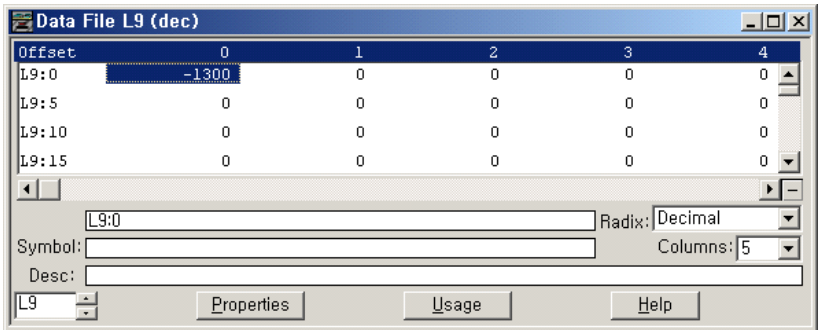
7. Press the Left key once. Then, press the Up key once. The second digit will change to "1". Note that "1" is still flashing, which means the cursor is still at the data value position.
8. Press the Left key once. Then, press the Down key once. The sign digit will change to "-", as shown below. Note that "-" is still flashing, which means the cursor is still at the data value position.



9. Press OK to apply the changes. The new value -1300 is applied. Note that the target word "0", which is to the right of "L9:", is flashing. The cursor is moved automatically to the target word position.

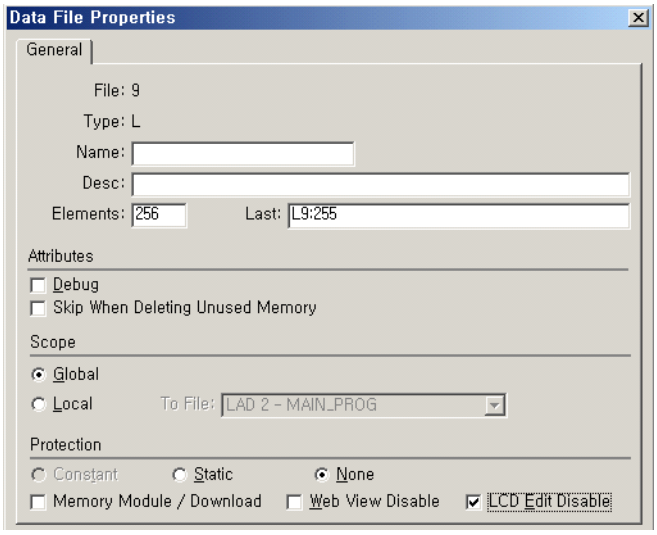


10. You can identify this change of data value is reflected to your RSLogix 500/RSLogix Micro programming software.



TIP After changing the data value of a target double word, press the OK key to apply the changes or press the ESC key to discard the changes.

11. Now, we will view an example of the data value of a protected property. If LCD Edit Disable is set to checked (enable), the "Protected!" message will be displayed and this data file cannot be edited by the LCD.





12. Try to move the cursor to the data value position by pressing the OK key. Because this double integer file is protected, you will find that the cursor even does not move to the data value position.

13. If you have finished monitoring the double integer file, L9, press the ESC key to return to the File Number question screen, as shown in step 2.

Monitor Floating point Files

In this section, this assumption regarding the application program is made:

- The TUF element of the LCD Function File is set to 8. This specifies the floating point file F8 as the target file to monitor via the LCD.

Most of the steps outlined in this section are similar to those found in Monitoring Double Integer files on page 79. However, you will not be able to edit floating point files from the LCD.



The Protected! message is displayed on the LCD for floating point files.

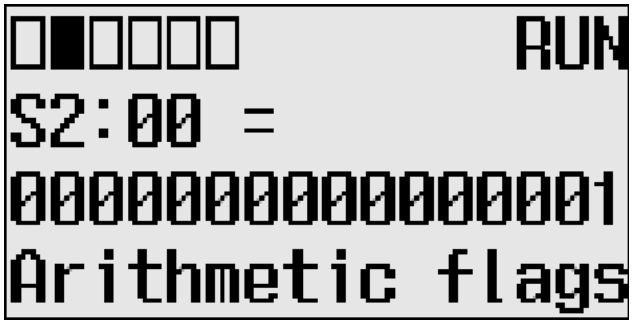
TIP MicroLogix 1400 Series A controllers display an "Unprotected!" message but you will not be able to edit the corresponding data file.

Monitor System Status Files

In this section, this assumption regarding the application program is made:

- The TUF element of the LCD Function File is set to 2. This specifies the system status file S2 as the target file to monitor via the LCD.

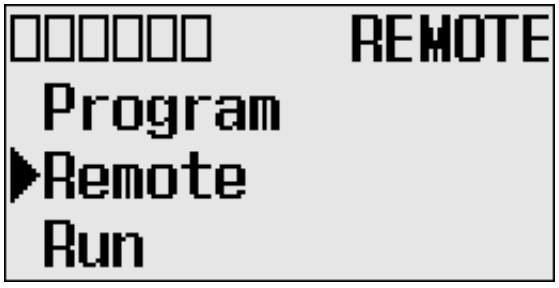
The format string on the third line is displayed as decimal, hexadecimal or binary for each word element, depending on what each elements means.



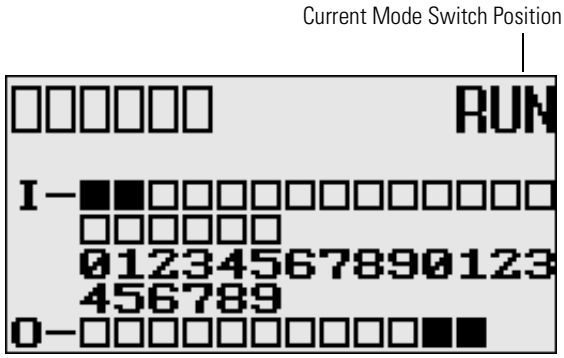
For more information, see the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

Using the Mode Switch

The MicroLogix 1400 provides the controller mode switch on the LCD. The possible positions of the mode switch are PROGRAM, REMOTE, and RUN. You can change mode switch position using the Mode Switch screen on the LCD, as shown below. In this example, the mode switch position is set to REMOTE.



All the built-in LCD screens except the Boot Message screen display *the current mode switch position*, at their top right portion, as shown below. In this example, the mode switch position is set to RUN.



Controller Modes

The table below shows the possible controller modes when the mode switch positions at PROGRAM, REMOTE, or RUN. For example, if the Mode Switch is at RUN and you want to test a control program with running it for a single scan, you have to first change mode switch position to REMOTE before you run the control program in the remote test single scan mode with your RSLogix 500/RSLogix Micro programming software.

Possible Controller Modes by Mode Switch Position

When the Mode Switch Positions at	Possible Controller Modes are
PROGRAM	download in progress
	program mode
	suspend mode (operation halted by execution of the SUS instruction)
REMOTE	remote download in progress
	remote program mode
	remote suspend mode (operation halted by execution of the SUS instruction)
	remote run mode
	remote test continuous mode
	remote test single scan mode
RUN	run mode

Changing Mode Switch Position

Mode Switch position can be changed at two different times using LCD keypad. One is when the controller is powered up, and the other is while the controller is powered on.

Mode Switch position can be set to either PROG or RUN when the controller is powered up. This allows the controller operation which is different from the previous mode, that is, any program under RUN before can be stopped or any new program can be run when the controller is powered up.

- How to forcibly set Mode Switch to RUN when the controller is powered up:

  Press OK key for 5 seconds when the controller is powered up. The following LCD screen appears if it's successfully done.



- How to forcibly set Mode Switch to PROG when the controller is powered up:

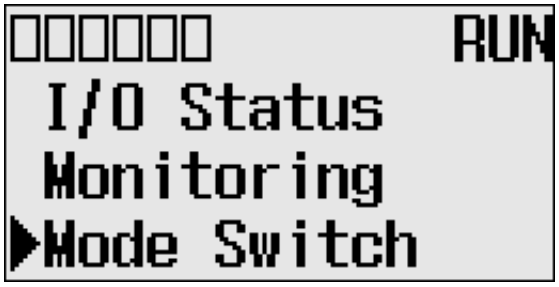
  Press ESC key for 5 seconds when the controller is powered up. The following LCD screen appears if it's successfully done.



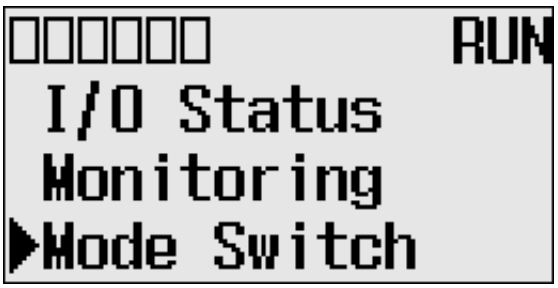
Note that I/O output status may be changed for some programs.

While the controller is powered on, follow these steps to change the position of the Mode Switch.

1. On the Main Menu screen, select Mode Switch by using the Up and Down keys on the LCD keypad.



2. Then, press the OK key on the LCD keypad. The Mode Switch screen is displayed, as shown below.



   The arrow indicates current Mode Switch position.

3. When the Up or Down key is pressed, the mode indicated by the arrow starts to blink if the mode is different from the current mode of controller. Press OK key to set the controller to the mode indicated by the arrow.
4. If you have finished changing mode switch position, press the ESC key to return to the Main Menu screen, as shown in step 1.

Using a User Defined LCD Screen

The MicroLogix 1400 controller allows you to use user defined LCD screens instead of the default built-in screens.

To use a user defined screen, you need to create a group of appropriate instructions using the LCD instruction in your application program. For more information on how to create a user defined LCD screen, refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

By using the User Display menu item, you can change from the default built-in screens to a user defined screen and back on the LCD.

User Defined LCD Screen

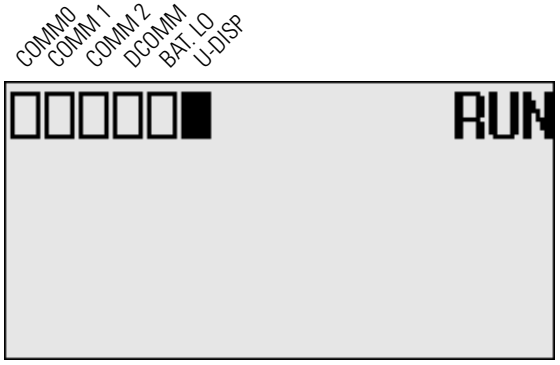
Follow these steps to display the user defined screen implemented in your application program.

1. On the Main Menu screen, select User Display by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



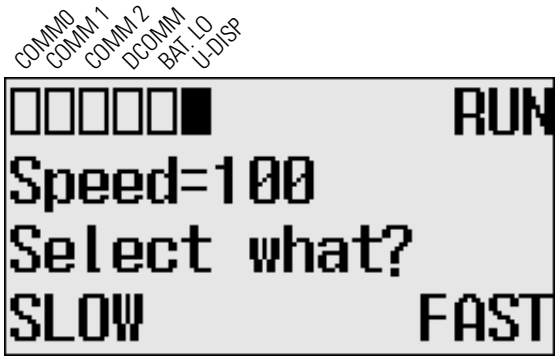
2. Then, press the OK key on the LCD keypad.

   If no user defined screen is used in your application program, the screen is displayed, as shown below.

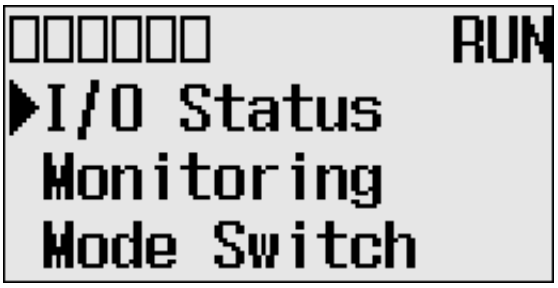


   Note that the U-DISP indicator on the top of the LCD is displayed in solid rectangle. It means the LCD is in User Defined LCD mode.

If a user defined screen is used in your application program, the LCD screen is displayed, as shown below, according to the specific instructions used in your program.



3. Hold down the ESC key **more than 3 seconds** to return to the Main Menu screen, as shown below.

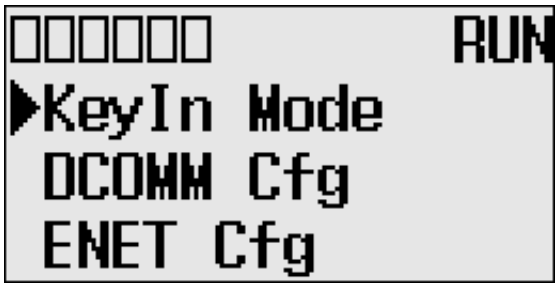


Configuring Advanced Settings

With the Advanced Set menu, which is a sub-menu under the main menu of the LCD, you can use the following features:

- changing Key In mode
- using communications toggle functionality
- configuring Ethernet Network Configuration
- using trim pots
- viewing system information
- viewing fault code
- saving/loading Communication EEPROM
- changing LCD contrast and backlight
- viewing/changing the Modbus RTU Slave Node address

You can access to the Advanced Set Menu screen, as shown below, by selecting Advanced Set on the Main Menu screen.



Changing Key In Mode

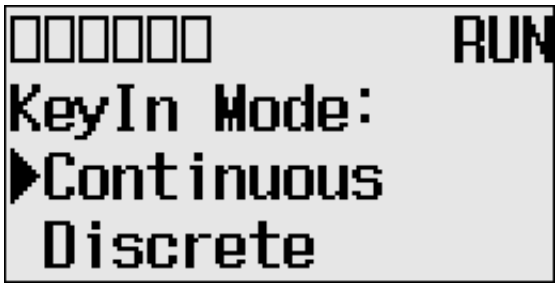
Key In Modes

There are two Key In modes, Continuous and Discrete.

TIP The Key In mode has an effect only when you change the data value of a trim pot on a trim pot screen, either Trim Pot 0 or Trim Pot 1 screen. For more information on how to change the data value of a trim pot, see Changing Data Value of a Trim Pot on page 106.

The current Key In mode determines how the value changes are applied when you press the Up and Down keys to change the data value for a trim pot. When set to Continuous, the changes are applied immediately whenever you press the Up and Down keys. When set to Discrete, the changes are applied only when you press the OK key after you have changed the value using the Up and Down keys.

By using the Key In Mode screen, as shown below, you can change the Key In mode to use.



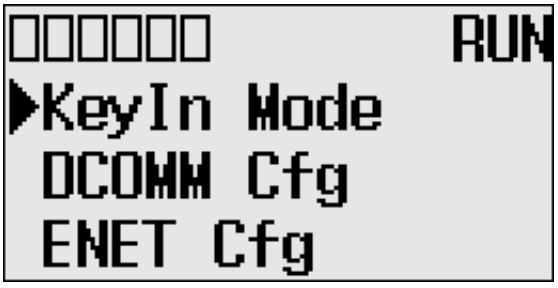
Changing Key In Mode

Follow these steps to change the current Key In mode.

1. On the Main Menu screen, select Advance Set by using the Up and Down keys on the LCD keypad. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



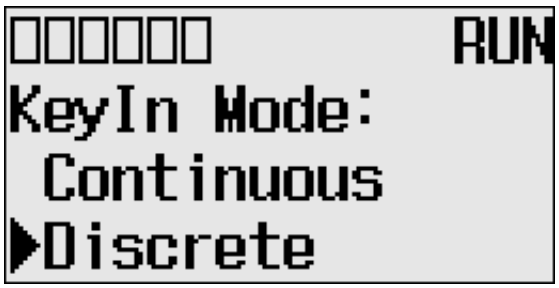
2. Then, press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed.



3. Select KeyIn Mode using the Up and Down keys, and then press the OK key.
4. The Key In Mode screen is displayed. The current mode, Continuous in this example, is selected marked up with the symbol "▶".



5. Press the Up or Down key to select the different mode, Discrete in this example. Press the OK key.



6. The Key In Mode Change Notification screen is displayed, as shown below.



7. Press the ESC key to return to the Advanced Set Menu screen, as shown in step 2.

Using Communications Toggle Functionality

The MicroLogix 1400 provides the Communications Toggle Functionality, which allows you to change from the user-defined communication configuration to the default communications mode and back to the user defined communication configuration on Channel 0. See Using the Communications Toggle Functionality on page 60 for more information on this feature.

Ethernet Network Configuration

Viewing Ethernet Status

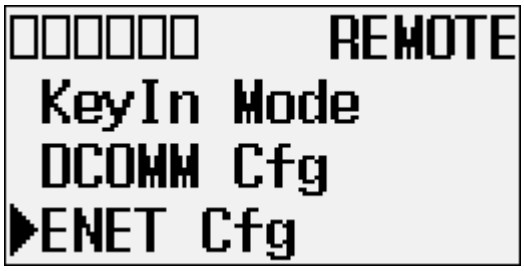
The Ethernet configuration screen of the LCD displays the MAC and IP addresses assigned to the controller.

Follow these steps to view the Ethernet configuration for your controller.

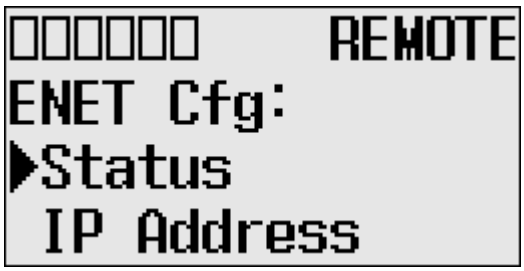
1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



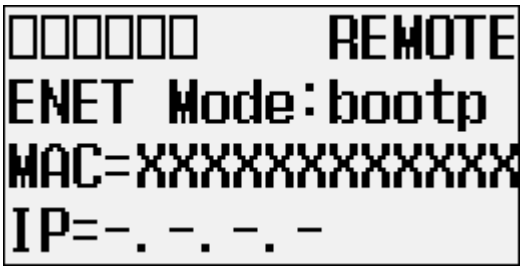
2. Press the OK key on the LCD keypad. The Advanced Set Menu screen is displayed, as shown below.



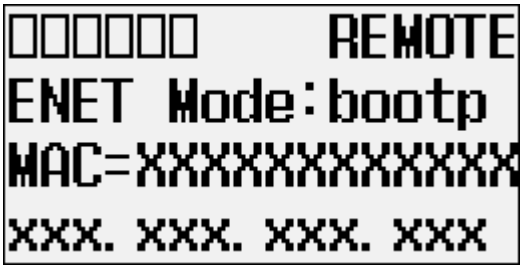
3. If ENET Cfg is selected, press the OK key. Otherwise, select ENET Cfg using the Up and Down keys, and then press the OK key.
4. The Ethernet Configuration screen is displayed. Press the OK key on the LCD Status menu.



5. When an IP address is not yet assigned to your controller, only the MAC address that is assigned to your controller, represented as XXXXXXXXXXXX below, is displayed. A MAC address is a 12-digit hexadecimal number. Your controller ships with a unique MAC address assigned in the factory. You can identify the MAC address of your controller by opening the expansion module cover on your controller.



6. When an IP address is assigned to your controller, both the MAC and IP addresses of your controller are displayed, as shown below. In this example, the MAC address is represented as XXXXXXXXXXXX. The IP address is represented as xxx.xxx.xxx.xxx, where each xxx is a decimal number between 0...255.



7. Press the ESC key to return to the Advanced Set Menu screen, as shown in step 2.

Configuring the IP Address

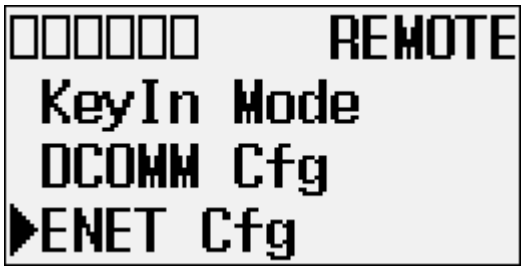
The IP Address screen of the LCD displays Ethernet network configuration assigned to the controller.

Follow these steps to edit the Ethernet network configuration for your controller.

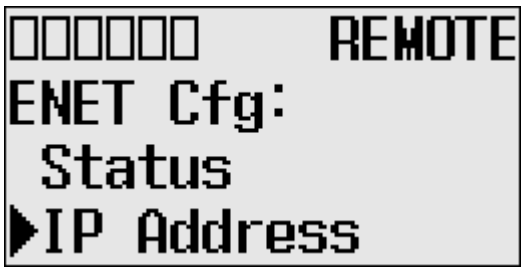
1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



2. Press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed, as shown below. If ENET Cfg is selected, press the OK key. Otherwise, select ENET Cfg using the Up and Down keys, and then press the OK key.



3. If IP Address is selected, press the OK key, If not, select IP Address using the Up and Down keys, and then press the OK key.



4. The password screen is displayed. Press Up, Down, Left and Right keys to enter the Master password up to a maximum of 10 digits. In this example, the current Master password is allocated as "1234".



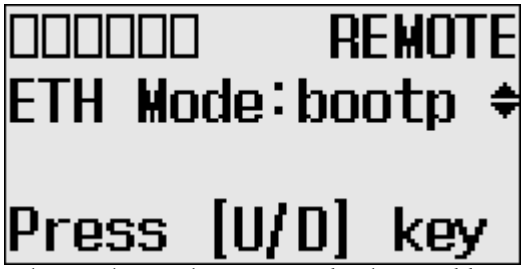
5. After entering the Master password, press the OK key on the LCD keypad.



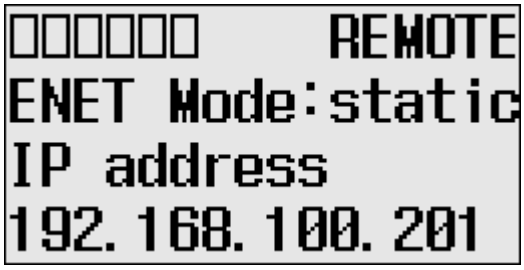
6. If the Master password is incorrect, an error message will be displayed.



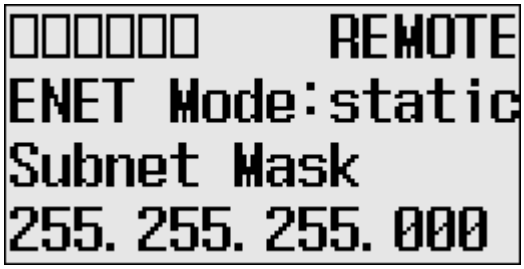
7. If the password is correct, the Ethernet network type screen is displayed as below. Press Up or Down key to select the appropriate Ethernet mode.



If you press the OK key at the static mode, the IP address flashes.



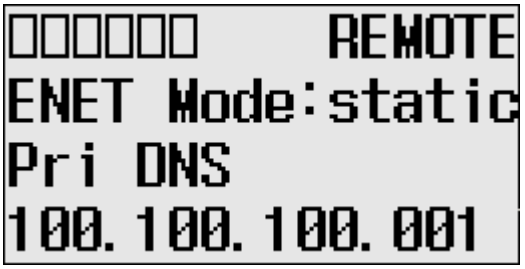
8. After configuring the IP address, press the OK key. The Subnet Mask screen is displayed.



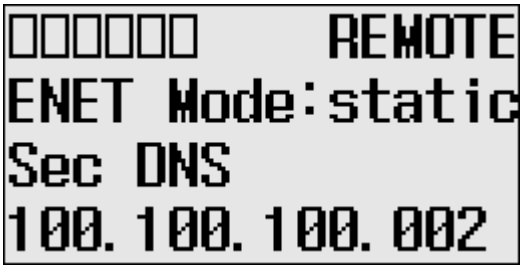
9. After configuring the Subnet Mask, press the OK key. The Gateway address is displayed.



10. After configuring the Gateway address, press the OK key. The Primary DNS is displayed.



11. After configuring the Primary DNS, press the OK key. The Secondary DNS is displayed.



TIP To exit the Network configuration Menu, press the ESC key on the LCD keypad at any time.

Configuring the Ethernet Port

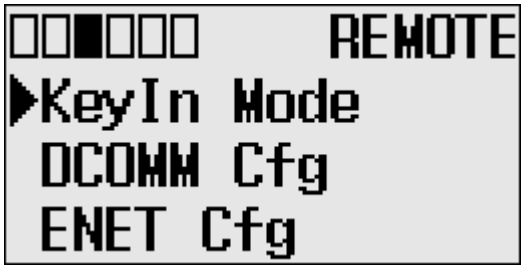
The Port Settings screen of the LCD displays the Ethernet port settings assigned to the controller.

Follow these steps to edit the Ethernet port settings for your controller.

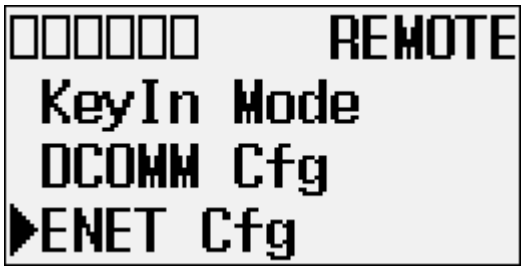
1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



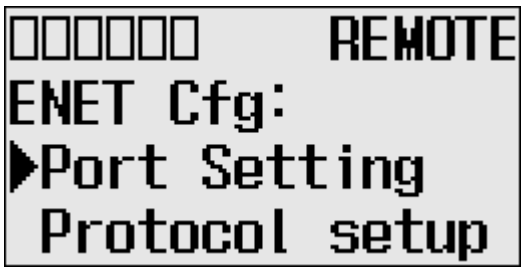
2. Press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed.



3. If ENET Cfg is selected, press the OK key. If not, select ENET Cfg using the Up and Down keys, and then press the OK key.



4. If Port Setting is selected, press the OK key, If not, select Port Setting using the Up and Down keys, and then press the OK key.

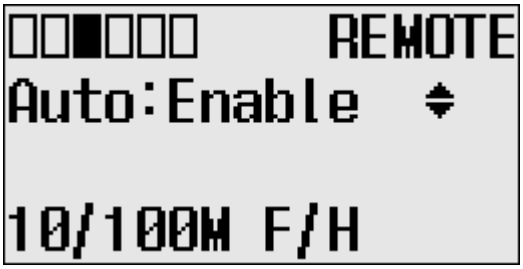


5. The password screen is displayed. Press Up, Down, Left and Right keys to enter Master password with maximum 10 digits. In this example, the current Master password is allocated as "1234".

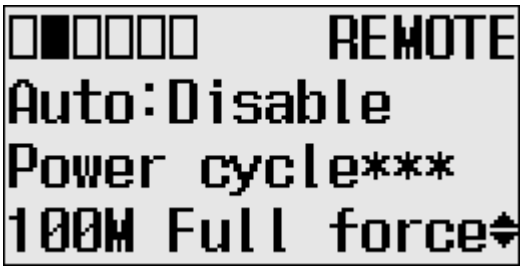


After entering the Master password, press the OK key on the LCD keypad.

6. If the Master password is correct, the last configuration is displayed. In this example, the auto negotiation function is enabled and the 10/100Mbps link configuration is shown.



7. Press Up and Down key to select auto disable menu, then press the OK key. The fourth line on the LCD flashes. Press the Up and Down keys to configure the Ethernet port to 100Mbps Full-duplex forced.



TIP Any change to this feature's configuration does not take effect until after the next power cycle.

Configuring Ethernet Protocol Setup

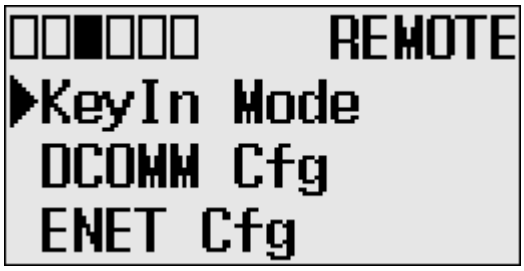
The Ethernet Protocol Setup screen of the LCD displays Ethernet Protocol settings assigned to the controller.

Follow these steps to edit the Ethernet Protocol settings for your controller.

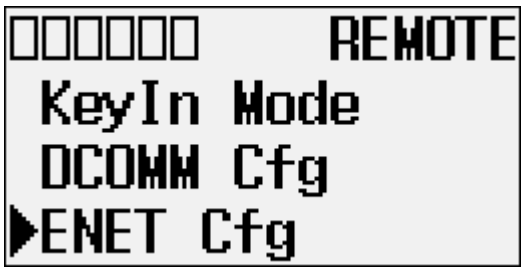
1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



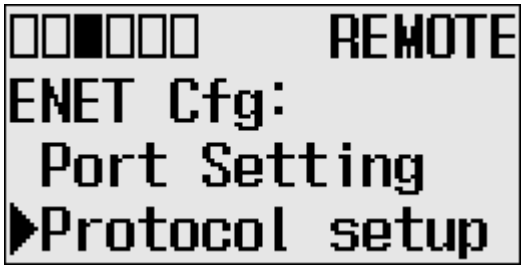
2. Press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed, as shown below.



3. If ENET Cfg is selected, press the OK key. If not, select ENET Cfg using the Up and Down keys, and then press the OK key.



4. If Protocol setup is selected, press the OK key. If not, select Protocol setup using the Up and Down keys, and then press the OK key.

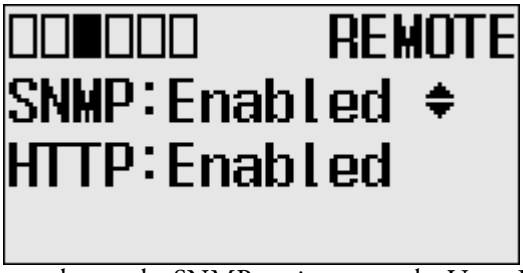


5. The password screen is displayed. Press Up, Down, Left and Right keys to enter a Master password up to a maximum of 10 digits. In this example, the current Master password is allocated as "1234".

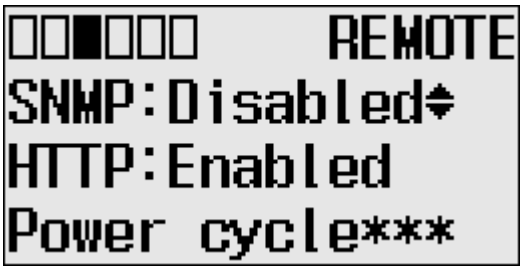


After entering the Master password, press the OK key on the LCD keypad.

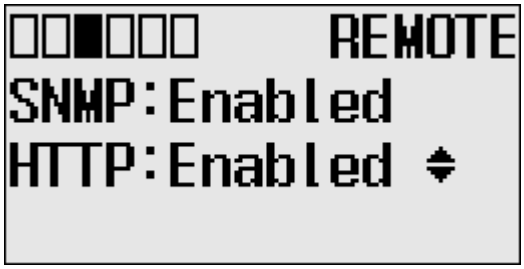
6. The following menu is displayed.

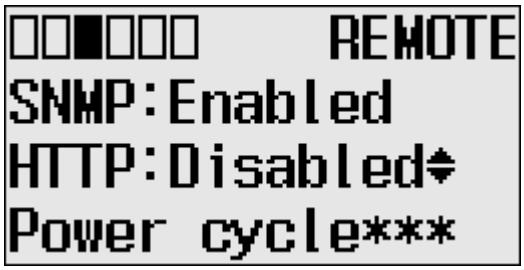


If you want to change the SNMP setting, press the Up or Down key and press the OK key to apply the change.



7. To change the HTTP setting, press the Up or Down key and press the OK key to apply the change.





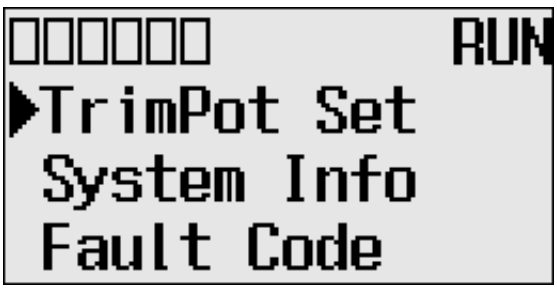
TIP To exit the Protocol Setup Menu, press the ESC key on the LCD keypad at any time.

Using Trim Pots

Trim Pot Operation

The MicroLogix 1400 controller provides two trimming potentiometers (trim pots, POT0 and POT1) which allow modification of integer data within the controller. The data value of each trim pot can be used throughout the control program for timers, counters, analog presets, depending upon the requirements of the application.

You can change the data value of each trim pot using the trim pot screens provided by the LCD. To access to the Trim Pot Set screen, which is the top screen for the trim pot functionality, select trim pot Set on the LCD default menu screen, as shown below, and press the OK key on the LCD keypad.

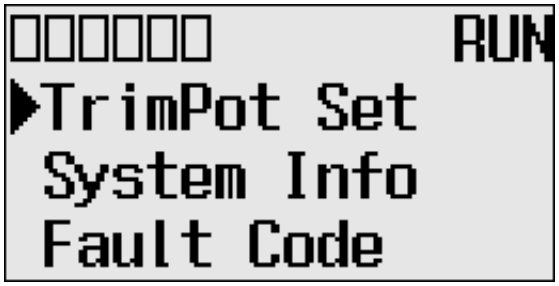


Trim pot data is updated continuously whenever the controller is powered-up.

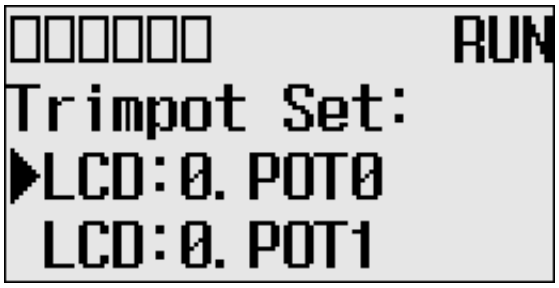
Changing Data Value of a Trim Pot

Follow these steps to change the data value of a trim pot, either POT0 or POT1.

1. On the Main Menu screen, select trim pot Set by using the Up and Down keys on the LCD keypad.



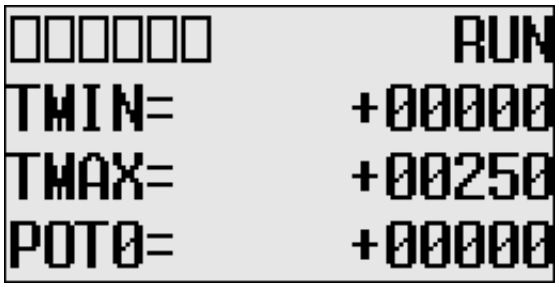
2. Then, press the OK key on the LCD keypad. The Trim Pot Select screen is displayed, as shown below.



   The last trim pot whose data value you changed is selected by default. If you are accessing to this screen for the first time, POT0 is selected by default.

3. Select a trim pot, either POT0 or POT1, whose data value you want to change using the Up and Down keys on the LCD keypad. In this example, we will select POT0.

4. Then, press the OK key on the LCD keypad. The Trim Pot 0 screen is displayed, as shown below.



TMIN and TMAX indicate the range of data value for the trim pots, both POT0 and POT1. The factory default for TMIN, TMAX, and POT0 values are 0, 250, and 0 in decimal, respectively. TMIN and TMAX on this screen are read only, but you can change them using the LCD Function File in your application program. The TMIN and TMAX elements can only be changed by a program download.

For more information on how to change Trim Pot configuration including TMIN and TMAX, refer to the LCD Function File described in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001.

IMPORTANT The same TMIN and TMAX values are used for both trim pots, POT0 and POT1. This behavior is intended by design for simplicity in Trim Pot configuration.

When you enter this screen, the last digit of the POT0 value is flashing. It indicates the current digit. Press the Up and Down keys on the LCD keypad to change the value of the current digit. Press the Left and Right keys to select a different digit as the current digit.

If the Key In mode is set to Continuous, the changes are applied immediately after you press the Up and Down keys. While, if it is set to Discrete, you have to press the OK key to apply the changes after you change the data value. For more information on how to set the Key In mode, see Changing Key In Mode on page 92.

TIP The Key In mode has an effect only when you change the data value of a trim pot on a Trim Pot screen, either the Trim Pot 0 or Trim Pot 1 screen.

5. If you have finished changing the data value of the selected trim pot, POT0 in this example, press the ESC key to return to the Trim Pot Select screen, as shown in step 2.

Trim Pot Configuration in LCD Function File

The configuration for Trim Pots in the LCD Function File, including trim pot low and high values for data value range, is described in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001.

Error Conditions

Error conditions regarding the Trim Pot functionality are described in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001.

Viewing System Information

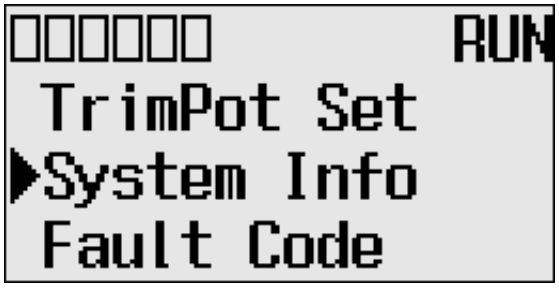
The System Information screen of the LCD allows you to identify the system information for your controller.

Follow these steps to view the system information for your controller.

1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.

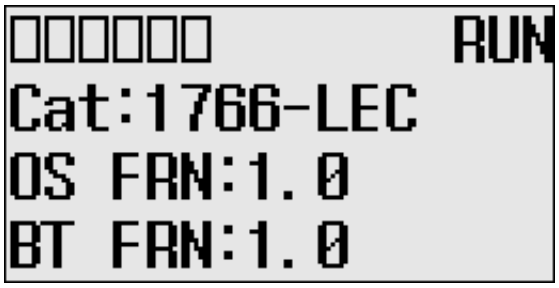


2. Then, press the OK key on the LCD keypad. The Advanced Set Menu screen is displayed, as shown below.



3. If System Info is selected, press the OK key.
   If not, select System Info using the Up and Down keys, and then press the OK key.
4. The System Information screen is displayed.

   You can identify the catalog number, operating system firmware revision number, and boot firmware revision number of your controller.



5. Press the ESC key to return to the Advanced Set Menu screen, as shown in step 3.

Viewing Fault Code

The Fault Code screen of the LCD displays the fault code when a fault occurs.

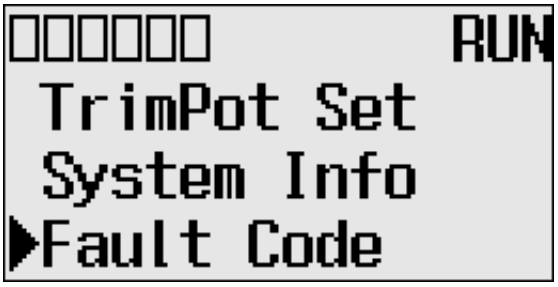
When a fault occurs, the Fault Code screen is not displayed automatically. Only the FAULT LED on the controller flashes in red light. Therefore, you need to navigate into the Fault Code screen to identify the fault code on the LCD.

Follow these steps to view the fault code when a fault occurs.

1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad, as shown below. If the menu items shown in the figure below are not displayed on the Main Menu screen, you need to scroll down the screen by pressing the Down key.



2. Then, press the OK key on the LCD keypad. The Advanced Set Menu screen is displayed, as shown below.



3. If Fault Code is selected, press the OK key.
   If not, select Fault Code using the Up and Down keys, and then press the OK key.
4. The Fault Code screen is displayed.

   If no fault occurred, “0000h” is displayed, as shown below.



If a fault is occurred, its fault code is displayed, as shown below.



TIP For more information on a specific fault code, refer to the *Online Help* of your RSLogix 500/RSLogix Micro programming software.

5. Press the ESC key to return to the Advanced Set Menu screen, as shown in step 2.

Saving/Loading Communication EEPROM

At the communication EEPROM screen, you can load/save user programs and data to/from the Memory module.

Saving Communication EEPROM

Follow these steps to save user program and data from controller's memory to memory module.

1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad.
   If the menu items shown are not displayed on the Main Menu screen, scroll down by pressing the Down key.

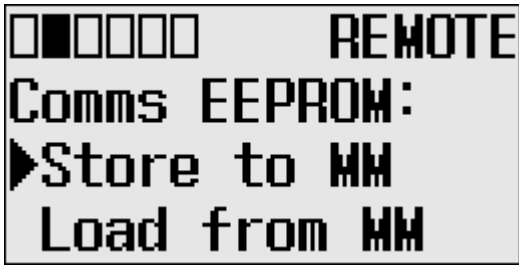


2. Press the OK key on the LCD keypad.

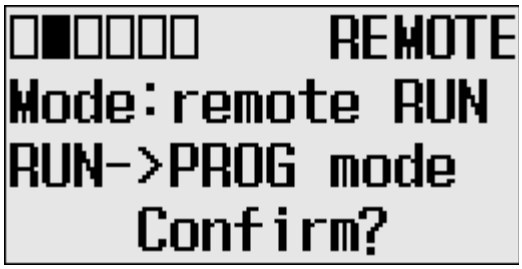
3. Select Comms EEPROM using the Down key, and then press the OK key.



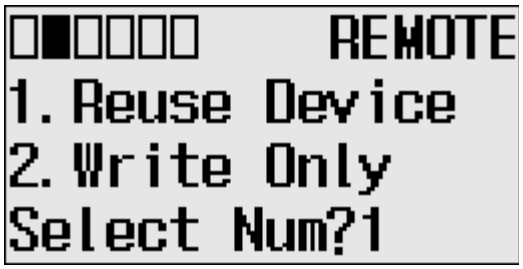
4. Select Store to MM to save user program and data, and then press the OK key.



5. If your controller is in a non-executing mode, skip to the next step. Otherwise switch your controller to a non-executing mode.



6. The usual method for using a memory module is to reuse the device. Select Reuse Device or Write Only by pressing the Up or Down keys.



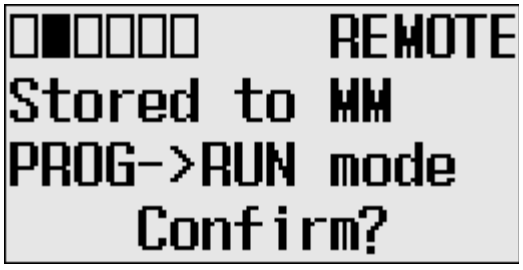
IMPORTANT

Once set to Write Only mode, write protection cannot be removed. If a change is required, use a different memory module. For more information on this, refer to the chapter of Memory Module operation.

Once Write Only is set, write protection cannot be removed. A change cannot be made to the control program stored in a write protected memory module. If a change is required, use a different memory module.

For more information on transferring data to and from memory modules, see Memory Module Operation on page 120.

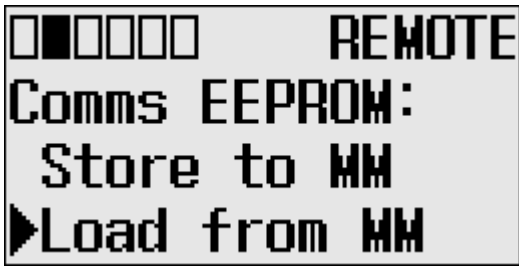
7. This screen appears if the save is complete. Press the OK key to go back to executing mode.



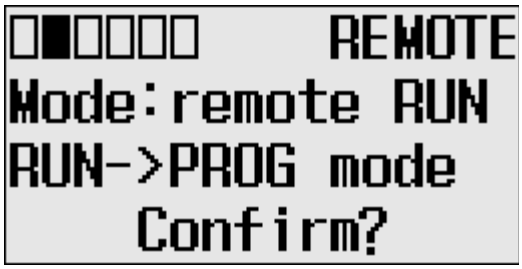
Loading communication EEPROM

Follow these steps to load user programs and data from the memory module to the controller's memory.

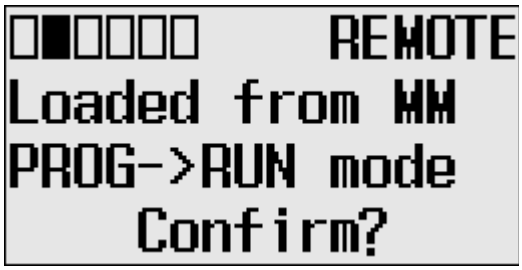
1. Select Load from MM to load user programs and data.



2. If your controller is in a non-executing mode, skip to the next step. Otherwise switch your controller to a non-executing mode.



3. This screen appears if the load from the memory module is complete. Press the OK key to go back to executing mode.



TIP For more information on transferring data to and from memory modules, see Memory Module Operation on page 159.

LCD setup

In the LCD Setup screen, you can configure the contrast value and backlight for the LCD.

Configuring contrast value

1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad.
   If the menu items shown are not displayed on the Main Menu screen, scroll down by pressing the Down key.



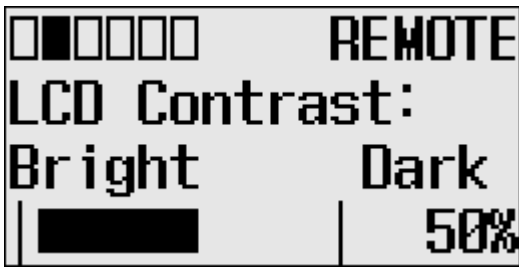
2. Press the OK key on the LCD keypad.
3. Select LCD Setup, using the Up and Down keys on the LCD keypad. When the LCD Setup menu screen is displayed, press the OK key.



4. Select Contrast to adjust the contrast of LCD.



5. Adjust the contrast value using the Left and Right keys on the LCD keypad.



Configuring the backlight

1. On the Main Menu screen, select Advanced Set by using the Up and Down keys on the LCD keypad.
   If the menu items shown are not displayed on the Main Menu screen, scroll down by pressing the Down key.



2. Press the OK key on the LCD keypad.
3. Select LCD Setup, using the Up and Down keys on the LCD keypad. When the LCD Setup menu screen is displayed, press the OK key.



4. Select Back Light to adjust backlighting options for the LCD.



5. The default value for the backlight is 30 seconds. You can adjust backlight time using the Up and Down keys on the LCD keypad.



Protocol Configuration

The following section provides a step-by-step guide on how to change the Modbus Node address.

Modbus RTU Slave Node Address

The user can set the Modbus RTU Slave Node address for Channel 0 or 2.

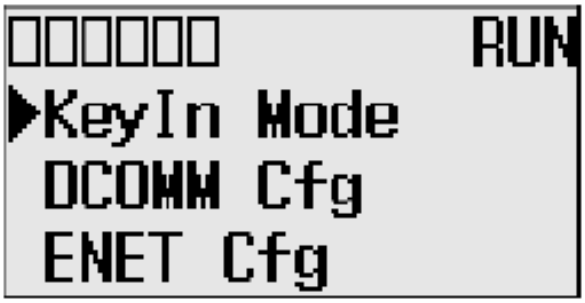
TIP The node address change will only be applicable after a power cycle.

Changing the Modbus RTU Slave Node address

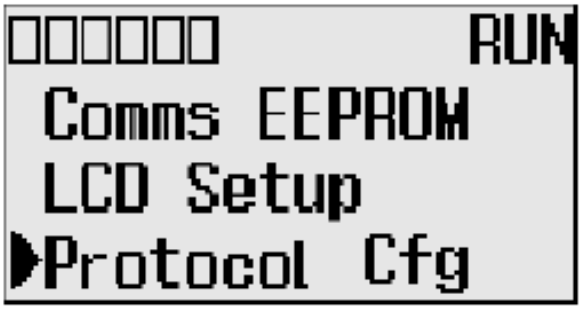
1. On the Main Menu screen, select Advanced Set by using the Up or Down arrow key on the LCD keypad. If the menu items shown in the figure are not displayed on the Main Menu screen below, you need to scroll down the screen by pressing the Down arrow key.



2. Then, press the OK key on the LCD keypad. The Advanced Settings Menu screen is displayed.



3. Select the Protocol Cfg using the Up and Down arrow keys, and then press the OK key.



4. Select the Modbus RTU Sl and then press the OK key.



5. The Modbus RTU Slave screen is displayed. Channel 0 is selected below.



6. Press the Up or Down arrow key to select a different channel, Channel 2 in this example. Press the OK key.



7. If the channel selected is not configured with the Modbus RTU Slave driver, then Modbus Not Configured is displayed, as shown below.



8. If channel 0 is configured with the Modbus RTU Slave driver with node address 100, the following screen will appear as shown.



9. If channel 2 is configured with the Modbus RTU Slave driver with node address 100, the following screen will appear as shown.



10. The user can configure the node address for either channel by using the Up and Down arrow keys. Once the address is changed, press OK to confirm the change. The following screen appears.



Using Real-Time Clock and Memory Modules

The MicroLogix 1400 controller has a built-in real-time clock (RTC). You can order a memory module as an accessory.

TIP For more information on "Real-Time Clock Function File" and "Memory Module Information File", refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001.

One type of memory module is available for use with the MicroLogix 1400 controller.

Catalog Number	Function	Memory Size
1766-MM1	Memory Module	384 KB

Real-Time Clock Operation

Operation at Power-up and Entering a Run or Test Mode

At power-up and when the controller enters a run or test mode, the values (date, time and status) of the RTC are written to the RTC Function File in the controller.

The following table indicates the accuracy of the RTC for various temperatures.

RTC Accuracy

Ambient Temperature	Accuracy[1]
0 °C (32 °F)	-13...-121 seconds/month
25 °C (77 °F)	54...-5 seconds/month
40 °C (104 °F)	29...-78 seconds/month
55 °C (131 °F)	-43...-150 seconds/month

(1) These numbers are maximum worst case values over a 31-day month.

Writing Data to the Real-Time Clock

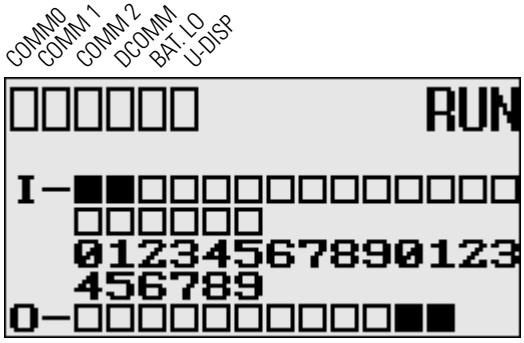
When valid data is sent to the real-time clock from the programming device or another controller, the new values take effect immediately.

The real-time clock does not allow you to load or store invalid date or time data.

RTC Battery Operation

The real-time clock uses the same replaceable battery that the controller uses. The RTC Function File features a battery low indicator bit (RTC:0/BL), which shows the status of the replacement battery. When the battery is low, the indicator bit is set (1). This means that the battery wire connector could be disconnected or if the battery is connected, the battery may be ready to fail in the next two weeks. In the latter case, the replacement battery needs to be replaced with a new one. When the battery low indicator bit is clear (0), the battery level is acceptable.

The Battery Low (BAT.LO) indicator on the LCD display of the controller also shows the status of the replaceable battery. When the battery is low, the indicator is displayed as a solid rectangle (■). When the battery level is acceptable, the indicator is displayed as an empty rectangle (□), as shown below.



If the RTC battery is low and the controller is powered, the RTC operates normally. If the controller power is removed and the RTC battery is low, RTC data is lost.

ATTENTION: Operating with a low battery indication for more than 2 weeks may result in invalid RTC data unless power is on continuously.

Memory Module Operation

The memory module supports the following features:

- User Program, User Data, Datalog and Recipe Back-up
- User Program Compare
- Data File Download Protection
- Memory Module Write Protection
- Removal/Insertion Under Power

ATTENTION: Electrostatic discharge can damage the Memory Module. Do not touch the connector pins or other sensitive areas.

User Program , User Data, Datalog and Recipe Back-up

The memory module provides a simple and flexible program, data, DataLog, and Recipe transport mechanism, allowing the user to transfer the program, data, DataLog and Recipe to the controller without the use of a personal computer and programming software.

The memory module can store one user program at a time.

During program transfers to or from the memory module, the controller's RUN LED flashes.

Program Compare

The memory module can also provide application security, allowing you to specify that if the program stored in the memory module does not match the program in the controller, the controller will not enter an executing (run or test) mode. To enable this feature, set the S:2/9 bit in the system status file. See "Status System File" in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, Publication 1766-RM001 for more information.

Data File Download Protection

The memory module supports data file download protection. This allows user data to be saved (not overwritten) during a download.

TIP Data file download protection is only functional if the processor does not have a fault, size of all protected data files in the memory module exactly match the size of protected data files within the controller, and all protected data files are of the same type. See "Protecting Data Files During Download" in the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, Publication 1766-RM001.

Memory Module Write Protection

The memory module supports write-once, read-many behavior. Write protection is enabled using your programming software.

IMPORTANT Once set, write protection cannot be removed. A change cannot be made to the control program stored in a write protected memory module. If a change is required, use a different memory module.

Removal/Insertion Under Power

The memory module can be installed or removed without risk of damage to either the memory module or the controller, except during a data transaction. If the memory module is removed during a data transaction, data corruption can occur.
If a memory module is installed while the MicroLogix 1400 is executing, the memory module is not recognized until either a power cycle occurs, or until the controller is placed in a non-executing mode (program mode, suspend mode or fault condition).

Memory Module Information File

The controller has a Memory Module Information (MMI) File which provides status from the attached memory module. At power-up or on detection of a memory module being inserted, the catalog number, series, revision, and type are identified and written to the MMI file. If a memory module is not attached, zeros are written to the MMI file. Refer to the *MicroLogix 1400 Instruction Set Reference Manual*, publication 1766-RM001, for more information.

Program /Data Download

To download the program and data from a memory module to the controller's memory, on the "Comms" menu in your RSLogix 500/RSLogix Micro programming software, point "EEPROM" and then click "Load from EEPROM".

TIP With MicroLogix 1400, you can also use the LCD and the LCD buttons on the module to transfer applications to or from the controller.

For more information on program/data download, refer to your RSLogix 500/RSLogix Micro programming software documentation.

Program /Data Upload

To upload the program and data from the controller's memory to a memory module, on the "Comms" menu in your RSLogix 500/RSLogix Micro programming software, point "EEPROM" and then click "Store to EEPROM".

TIP With MicroLogix 1400, you can also use the LCD and the LCD buttons on the module to transfer applications to or from the controller.

For more information on program/data upload, refer to your RSLogix 500/RSLogix Micro programming software documentation.

Online Editing

Directions and Cautions for MicroLogix 1400 Online Editing User

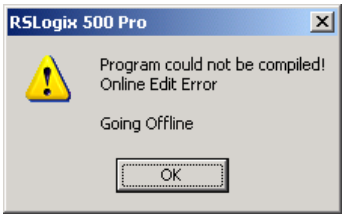
A Download is Required Before Starting Online Editing

At least one download is required before you can start online editing.

If you are using a MicroLogix 1400 from out-of-box state or after clearing processor memory or a firmware upgrade, at least one download is required before starting online edits. If not, an error occurs and programming software will go offline due to a default image mismatch between programming software (RSLogix500) and the MicroLogix 1400. You can also see the fault code 1Fh which is a user defined fault code.

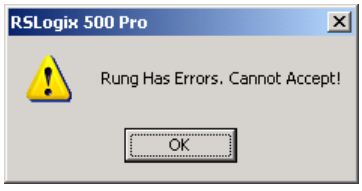
In order to prevent this error, you need to download the program to the MicroLogix 1400, although the program is empty.

This problem happens only in out-of-box state or after clear processor memory.





ATTENTION: PTO and PWM instructions may not be deleted during runtime online edit. This is because if the PTO or PWM instructions were deleted during runtime online edit, outputs could stop in an unpredictable state, causing unexpected equipment operation.
If you attempt to insert or modify a rung with MSG, PTO, and PWM instruction, the following error message will be generated by programming software "Error: Online editing of PTO, PWM and MSG are not allowed on ML1400 RUN mode." And, the rung with MSG, PTO, and PWM instruction will not be accepted.



In online edit during PROGRAM mode (program online edit), there are no restrictions. For example, a user can insert MSG instruction if related MG file or MG/RI file is already defined in data file.



ATTENTION: When editing a rung that contains an MCR instruction, both the MCR start and MCR end rungs must be edited (whether it be test/assemble/cancel) at the same time. We recommend that you fully understand the possible results of the edit to the system under control. Failure to properly edit a running program could result in unexpected controller operation. Physical injury or equipment damage may result.



ATTENTION: If you use EII or STI interrupts and your application requires a quick interrupt latency, the online edit feature is not recommended. Online editing feature may increase the interrupt latency response time. To ensure minimum interrupt latency, place the mode switch in LCD screen in the RUN mode. This prevents the use of the online editing feature.

Types of Online Editing

The type of online editing is dependent on the MicroLogix 1400 processor's mode switch position in LCD display and the processor's mode. There are two types of online editing:

- Program Online Editing — when the processor is in either PROG mode or REM Program mode
- Runtime Online Editing — when the processor is in either REM Test or REM Run mode

The following table summarizes the MicroLogix 1400 processor mode switch positions in LCD and modes that enable online editing.

mode switch Position	MicroLogix 1400 Processor Mode	Editing Mode
RUN	RUN	Not Available
PROGram	Program	Program Online Editing
REMote	REMote Program	Program Online Editing
REMote	REMote Test	Runtime Online Editing
REMote	REMote Run	Runtime Online Editing

IMPORTANT Online editing is not available when the mode switch in LCD screen is in the RUN position.



ATTENTION: Use the online editing function while in the RUN mode to make minor changes to the ladder program. We recommend developing your program offline since ladder rung logic changes take effect immediately after testing your edits. Improper machine operation may occur, causing personnel injury or equipment damage.

Edit Functions in Runtime Online Editing

During a runtime online editing session, the processor *is executing* ladder logic. The edit zone markers tell the processor that changes exist, but the changes are not executed until you test the edits.

Deleted and replaced (modified) rungs are not removed from the program and inserted rungs are not executed until you assemble or test the edits.

Edit Functions in Program Online Editing

During a program online editing session, the processor *is not executing* ladder logic. This mode is like the offline editing mode. Note that if a runtime online editing session was performed prior to entering the offline editing mode, edit marked rungs (I, R, and D) *appear* in the program.

If you perform a program online edit, once you accept or delete the rung, the edits take effect immediately and the power rail is displayed as a solid line. If you edit a rung with edit zone markers, the markers are removed when the rung is accepted.

Notes:

Specifications

General Specifications

Description	1766-L32AWA/A	1766-L32BWA/A	1766-L32BXB/A
Dimensions HxWxD	90 x 180 x 87 mm 3.5 x 7.08 x 3.43 in.		
Shipping weight	0.9 kg (2.0 lbs)		
Number of I/O	24 inputs (20 digital and 4 analog) and 14 outputs (12 digital and 2 analog)		
Power supply voltage	100…240V AC (-15%, +10%) at 47…63 Hz		24V DC (-15%, +10%) Class 2 SELV
Heat dissipation	See System Loading and Heat Dissipation on page 343.		
Power supply inrush current	120V AC: 25 A for 8 ms 240V AC: 40 A for 4 ms		24V DC: 15 A for 20 ms
Power consumption	100 VA	120 VA	7.5…53W
24V DC sensor power	none	24V DC at 250 mA 400 µF max.	none
Input circuit type	Digital: 120V AC Analog: 0…10V DC	Digital: 24V DC sink/source (standard and high-speed) Analog: 0…0V DC	Digital: 24V DC sink/source (standard and high-speed) Analog: 0…10V DC
Output circuit type	Relay		Relay/FET
Relay life - Electrical	2 x 10^5 operations min. (2.5 A, 250V AC / 30V DC)		
Enclosure type rating	None (open-style)		
Terminal screw torque	0.791 Nm (7.0 lb-in) rated		

Specifications for Inputs

Description	1766-L32AWA/A	1766-L32BWA/A, 1766-L32BXB/A	
		Inputs 0 through 11 (12 high-speed DC inputs)	Inputs 12 and higher (8 standard DC inputs)
On-state voltage range	79…132 V AC	4.5…24V DC (4.5…26.4V DC (+10%) at 60 °C/140 °F (4.5…30V DC (+25%) at 30 °C/86 °F)	10…24V DC (10…26.4V DC(+10%) at 60 °C/140 °F) (10…30V DC (+25%) at 30 °C/86 °F
Off-state voltage range	0…20 V AC	0…1.5V DC	0…5V DC
Operating frequency	47...63 Hz	0 Hz...100 kHz	0 Hz...1 kHz (scan time dependent)
On-state current Mininum Nominal Maximum	 9.0 mA @ 79 V AC 12 mA @ 120 V AC 16.0 mA @ 132 V AC	 7.0 mA @ 4.5V DC 9.5 mA @ 24V DC 10.0 mA @ 30V DC	 3.0 mA @ 10V DC 5.0 mA @ 24V DC 5.5 mA @ 30V DC

Description	1766-L32AWA/A	1766-L32BWA/A, 1766-L32BXB/A	
		Inputs 0 through 11 (12 high-speed DC inputs)	**Inputs 12 and higher (8 standard DC inputs)**
Off-State Leakage Current	2.5 mA max.	0.1 mA max	1.5 mA max.
Nominal Impedance	12 kΩ at 50 Hz 10 kΩ at 60 Hz	2.0 kΩ	5.5 kΩ
Inrush Current (max.) at 120V AC	30 A		

Analog Inputs

Description	1766-L32AWA/A, -L32BWA/A, -L32BXB/A
Voltage input range	0…10.0V DC - 1 LSB
Type of data	12-bit unsigned integer
Input coding (0…10.0V DC - 1 LSB)	0…4095
Voltage input impedance	>199 kΩ
Input resolution	12 bit
Non-linearity	±0.5% of full scale
Overall accurarcy -20…+65 °C (-4…+149 °F)	±1.0% of full scale
Update tim	100/20/16.67/4 ms (selectable)
Voltage input overvoltage protection	10.5 V DC
Field wiring to logic isolation	Non-isolated with internal logic

Analog Outputs

Description	1766-L32AWA/A, -L32BWA/A, -L32BXB/A
Number of inputs	2 single-ended
Voltage output range	0…10 V DC - 1 LSB
Type of data	12 bit unsigned integer
Step response	2.5 ms @ 95%
Load range Voltage output	>1 KΩ
Output coding (0…10V DC)	0…4095
Output resolution	12 bit
Analog output setting time	3 ms (max.)
Overall Accuracy -20…60 °C (-4…140 °F)	±1.0% of full scale
Electrical isolation	Non-isolated with internal logic
Cable length	30 m (98 ft) shielded cable

Specifications for Outputs in Hazardous Locations (Class 1, Division 2, Groups A, B, C, D)

Relay Outputs

Description		1766-L32AWA/A, 1766-L32BWA/A	1766-L32BXB/A
Maximum controlled load		1440 VA	1080 VA
Maximum Continuous Current:			
Current per channel and group common		2.5 A per channel 8A max channel 8...11 common	2.5 A per channel
Current per controller	at 150V max	28 A or total of per-point loads, whichever is less	
	at 240V max	20 A or total of per-point loads, whichever is less	

Relay Outputs

Description	1766-L32AWA/A, 1766-L32BWA/A, 1766-L32BXB/A
Turn On Time/Turn Off Time	10 msec (maximum)(1)
Load current	10 mA (minimum)

(1) Scan time dependent

Maximum Volts	Amperes		Amperes Continuous	Volt-Amperes	
	Make	Break		Make	Break
240V AC	7.5 A	0.75 A	2.5 A	1800 VA	180 VA
120V AC	15.0 A	1.5 A	2.5 A	1800 VA	180 VA
250V DC	0.11 A		1.0 A	28 VA	
125V DC	0.22 A		1.0 A	28 VA	

Specifications for Outputs in (Non-Hazardous) Locations only

Relay Outputs

Description		1766-L32AWA/A, 1766-L32BWA/A	1766-L32BXB/A
Maximum controlled load		1440 VA	1080 VA
Maximum Continuous Current:			
Current per channel and group common		2.5 A per channel 8A max channel 8...11 common	2.5 A per channel
Current per controller	at 150V max	28 A or total of per-point loads, whichever is less	
	at 240V max	20 A or total of per-point loads, whichever is less	

Relay Outputs

Description	1766-L32AWA/A, 1766-L32BWA/A, 1766-L32BXB/A
Turn On Time/Turn Off Time	10 msec (maximum)(1)
Load current	10 mA (minimum)

(1) Scan time dependent

Figure 1 - MicroLogix 1400 DC Input Power Requirements for 1766-L32BXB/A Unit

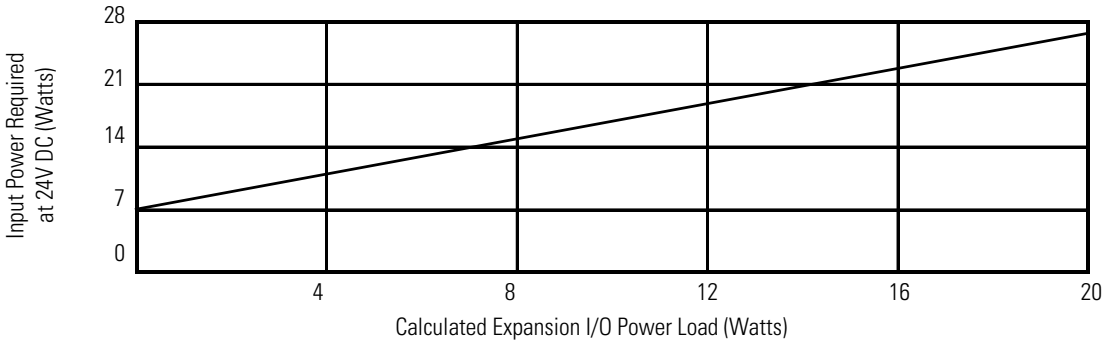
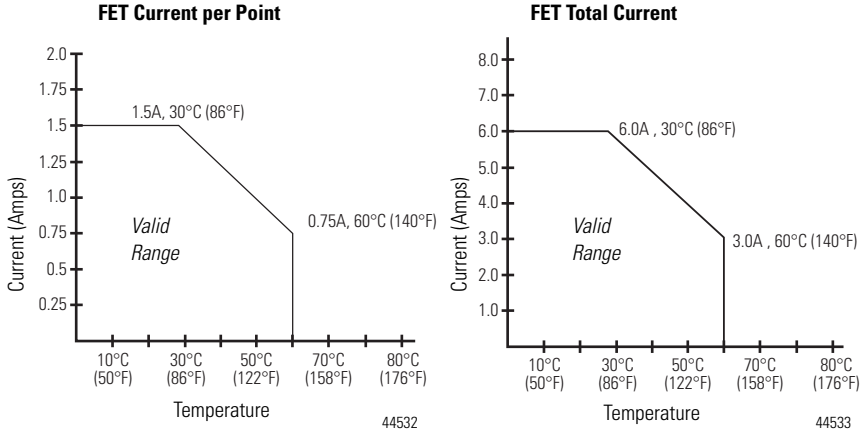


Figure 2 - 1766-L32BXB, 1766-L32BXBA FET Output
Maximum output current (temperature dependent):



Description	General Operation	High Speed Operation[1] (Output 2, 3 and 4 Only)
Power supply voltage	24V DC (-15%, 10%) Class 2	
On-state voltage drop: at max load current at max surge current	 1V DC 2.5V DC	 Not Applicable Not Applicable
Current rating per point max load min load max leakage	 See graphs above 1.0 mA 1.0 mA	 100 mA 20 mA 1.0 mA
Surge current per point: peak current max surge duration max rate of repetition at 30 °C (86 °F) max rate of repetition at 60 °C (140 °F)	 4.0 A 10 ms once every second once every 2 seconds	 Not Applicable Not Applicable Not Applicable Not Applicable
Turn-On Time (maximum)	11 μs	28 ns
Turn-Off Time (maximum)	89 μs	2.3 μs

(1) Output 2, 3 and 4 are designed to provide increased functionality over the other FET outputs. Output 2, 3 and 4 may be used like the other FET transistor outputs, but in addition, within a limited current range, they may be operated at a higher speed. Output 2, 3 and 4 also provide a pulse train output (PTO) or pulse width modulation output (PWM) function.

AC Input Filter Settings

Nominal Filter Setting (ms)	ON Delay (ms)		OFF Delay (ms)	
	Minimum	Maximum	Minimum	Maximum
8	2.3	2.5	11	12

High-Speed DC Input Filter Settings (Inputs 0 to 11)

Nominal Filter Setting (ms)	ON Delay (ms)		OFF Delay (ms)		Maximum Counter Frequency (Hz) 50% Duty Cycle
	Minimum	Maximum	Minimum	Maximum	
0.005	0.001	0.005	0.001	0.005	100.0 kHz
0.008	0.003	0.008	0.003	0.008	60.0 kHz
0.0125	0.0075	0.0125	0.007	0.0115	40.0 kHz
0.025	0.019	0.025	0.018	0.023	20.0 kHz
0.075	0.062	0.072	0.066	0.074	6.7 kHz
0.100	0.089	0.100	0.088	0.098	5.0 kHz
0.250	0.229	0.250	0.228	0.248	2.0 kHz
0.500	0.459	0.500	0.455	0.492	1.0 kHz
1.00	0.918	0.995	0.910	0.979	0.5 kHz
2.000	1.836	1.986	1.820	1.954	250 Hz
4.000	3.672	3.968	3.640	3.904	125 Hz
8.000(1)	7.312	7.868	7.280	7.804	63 Hz
16.000	14.592	15.668	14.560	15.604	31 Hz

(1) This is the default setting.

Standard DC Input Filter Settings (Inputs 4 and higher)

Nominal Filter Setting (ms)	ON Delay (ms)		OFF Delay (ms)		Maximum Frequency (Hz) 50% Duty Cycle
	Minimum	Maximum	Minimum	Maximum	
0.500	0.107	0.439	0.024	0.499	1.0 kHz
1.000	0.597	0.964	0.470	0.978	0.5 kHz
2.000	1.437	1.864	1.415	1.990	250 Hz
4.000	3.397	3.964	3.095	3.790	125 Hz
8.000(1)	6.757	7.564	6.735	7.690	63 Hz
16.000	14.597	15.964	13.455	14.890	31 Hz

(1) This is the default setting.

Analog Input Filter Settings

Analog Input Filter Settings	Filter Bandwidth (-3dB Freq Hz)	Sampling Frequency
250 Hz	250 Hz	1 kHz
60 Hz	60 Hz	1 kHz
50 Hz	50 Hz	1 kHz
10 Hz	10 Hz	1 kHz

Relay Contact Ratings

Maximum Volts	Amperes		Amperes Continuous(1)	Volt-Amperes	
	Make	Break		Make	Break
240V AC	15.0 A	1.5 A	5.0 A(2)/3.0 A	3600 VA	360 VA
120V AC	30.0 A	3.0 A	5.0 A(2)/3.0 A	3600 VA	360 VA
125V AC	0.22 A(3)		1.0 A	28 VA	

(1) 5.0 A for UL 508
3. 0A for UL 1604, Class 1, Division 2, Hazardous Locations, Groups A, B, C, D

(2) 3.0 A above 40 °C.(104 °F)

(3) For DC voltage applications, the make/break ampere rating for relay contacts can be determined by dividing 28 VA by the applied DC voltage. For example, 28 VA/48V DC = 0.58A. For DC voltage applications less than 14V, the make/break ratings for relay contacts cannot exceed 2A.

Working Voltage

Working Voltage for 1766-L32AWA/A

Description	Recommendation
Power Supply Input to Backplane Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (IEC Class 2 reinforced insulation)
Input Group to Backplane Isolation	Verified by one of the following dielectric tests:1517V AC for 1 second or 2145V DC for 1 second
	132V AC Working Voltage (IEC Class 2 reinforced insulation)
Input Group to Input Group Isolation	Verified by one of the following dielectric tests:1517V AC for 1 second or 2145V DC for 1 second
	132V AC Working Voltage (basic insulation)
Output Group to Backplane Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (IEC Class 2 reinforced insulation)
Output Group to Output Group Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1second
	265V AC Working Voltage (basic insulation), 150V AC Working Voltage (IEC Class 2 reinforced insulation)

Working Voltage for 1766-L32BWA/A

Description	Recommendation
Power Supply Input to Backplane Isolation	Verified by one of the following dielectric tests:1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (IEC Class 2 reinforced insulation)
Input Group to Backplane Isolation and Input Group to Input Group Isolation	Verified by one of the following dielectric tests: 1100V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)

Working Voltage for 1766-L32BWA/A

Output Group to Backplane Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (IEC Class 2 reinforced insulation).
Output Group to Output Group Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (basic insulation) 150V Working Voltage (IEC Class 2 reinforced insulation)

Working Voltage for 1766-L16BXB/A

Description	Recommendation
Input Group to Backplane Isolation and Input Group to Input Group Isolation	Verified by one of the following dielectric tests: 1100V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)
FET Output Group to Backplane Isolation	Verified by one of the following dielectric tests: 1100V AC for 1 second or 1697V DC for 1 second
	75V DC Working Voltage (IEC Class 2 reinforced insulation)
Relay Output Group to Backplane Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (IEC Class 2 reinforced insulation)
Relay Output Group to Relay Output Group and FET Output Group Isolation	Verified by one of the following dielectric tests: 1836V AC for 1 second or 2596V DC for 1 second
	265V AC Working Voltage (basic insulation), 150V Working Voltage (IEC Class 2 reinforced insulation)

Expansion I/O Specifications

Digital I/O Modules

General Specifications

Specification	Value
Dimensions	90 mm (height) x 87 mm (depth) x 40.4 mm (width) height including mounting tabs is 110 mm 3.54 in. (height) x 3.43 in. (depth) x 1.59 in. (width) height including mounting tabs is 4.33 in.
Temperature, storage	-40 °C…85 °C (-40…185 °F)
Temperature, operating	-20…65 °C (-4…149 °F)[1]
Operating humidity	5…95% non-condensing
Operating altitude	2000 m (6561 ft)
Vibration	Operating: 10...500 Hz, 5 g, 0.030 in. max. peak-to-peak, 2 hours per axis Relay Operation: 1.5 g
Shock	Operating: 30G panel mounted, 3 pulses per axis Relay Operation: 7 g Non-Operating: 50 g panel mounted, 3 pulses per axis (40G DIN Rail mounted)
Agency Certification	C-UL certified (under CSA C22.2 No. 142) UL 508 listed CE compliant for all applicable directives C-Tick marked for all applicable acts

General Specifications

Specification	Value
Hazardous environment class	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules Hazardous Location, Class I, Division 2 Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213, ANSI/ISA-12.12.01) For all other modules: Hazardous Location, Class I, Division 2 Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213) for all modules
Radiated and conducted emissions	EN50081-2 Class A
Electrical/EMC:	The module has passed testing at the following levels:
ESD immunity	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules IEC61000-4-2: 4 kV contact, 8 kV air, 4 kV indirect For all other modules: IEC1000-4-2: 4 kV contact, 8 kV air, 4 kV indirect
Radiated RF immunity	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules IEC61000-4-3: 10V/m, 80…2700 MHz, 80% amplitude modulation For all other modules: IEC1000-4-3: 10 V/m, 80…1000 MHz, 80% amplitude modulation, +900 MHz keyed carrier for all modules
EFT/B immunity	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules IEC61000-4-4: 2 kV, 5 kHz on signal ports For all other modules IEC1000-4-4: 2 kV, 5 kHz
Surge transient immunity	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules IEC61000-4-5: 2 kV common mode, 1 kV differential mode For all other modules IEC1000-4-5: 2 kV common mode, 1 kV differential mode
Conducted RF immunity	For 1762-IQ32T, 1762-OB32T, and 1762-OV32T modules IEC61000-4-6: 10V, 0.15…80 MHz(2) For all other modules: IEC1000-4-6: 10V, 0.15…80 MHz(2)

(1) For module-specific operating temperature range, refer to the Installation Instructions for the specific module.

(2) Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30…1000 MHz.

Input Specifications

Specification	1762-IA8	1762-IQ8	1762-IQ16	1762-IQ32T	1762-IQ8OW6
Shipping weight, approx. (with carton)	209 g (0.46 lbs.)	200 g (0.44 lbs.)	230 g (0.51 lbs.)	200g (0.44 lbs.)	280g (0.62 lbs.)
Voltage category	100/120V AC	24V DC (sink/source)(1)	24V DC (sink/source)(1)	24V DC (sink/source)(1)	24V DC (sink/source)(1)
Operating voltage range	79V AC…132V AC at 47 Hz…63 Hz	10…30V DC at 30 °C (86 °F) 10…26.4V DC at 55 °C (131 °F)	10…30V DC 10…26.4V DC (3)(2)	10…30V DC (24 points) at 30 °C (86 °F) 10…26.4V DC (23 points)at 60 °C (140 °F)	10…30V DC at 30 °C (86 °F) 10…26.4V DC at 65 °C (149 °F)
Number of inputs	8	8	16	32	8
Bus current draw, max.	50 mA at 5V DC (0.25W)	50 mA at 5V DC (0.25W)	70 mA at 5V DC (0.35W) (3)	170 mA at 5V DC 0 mA at 24V DC	110 mA at 5V DC 80 mA at 24V DC

Input Specifications

Specification	1762-IA8	1762-IQ8	1762-IQ16	1762-IQ32T	1762-IQ8OW6
Heat dissipation, max.	2.0 W	3.7 W	4.3 W at 26.4V 5.4 W at 30V (3)	5.4 W at 26.4V DC 6.8 W at 30V DC	5.0 W at 30V DC 4.4 W at 26.4V DC (The Watts per point, plus the minimum W, with all points energized.)
Signal delay, max.	On delay: 20.0 ms Off delay: 20.0 ms	On delay: 8.0 ms Off delay: 8.0 ms	On delay: 8.0 ms Off delay: 8.0 ms	On delay: 8.0 ms Off delay: 8.0 ms	On delay: 8.0 ms Off delay: 8.0 ms
Off-state voltage, max.	20V AC	5V DC	5V DC	5V DC	5V DC
Off-state current, max.	2.5 mA	1.5 mA	1.5 mA	1.0 mA	1.5 mA
On-state voltage, min.	79V AC (min.) 132V AC (max.)	10V DC	10V DC	10V DC	10V DC
On-state current	5.0 mA (min.) at 79V AC 47 Hz 12.0 mA (nominal) at 120V AC 60 Hz 16.0 mA (max.) at 132V AC 63 Hz	2.0 mA min. at 10V DC 8.0 mA nominal at 24V DC 12.0 mA max. at 30V DC	2.0 mA min. at 10V DC 8.0 mA nominal at 24V DC 12.0 mA max. at 30V DC	1.6 mA min. at 10V DC 2.0 mA min. at 15V DC 5.7 mA max. at 26.4V DC 6.5 mA max. at 30.0V DC	10 mA at 5V DC
Inrush current, max.	250 mA	Not applicable	Not applicable	Not applicable	250 mA
Nominal impedance	12K Ω at 50 Hz 10K Ω at 60 Hz	3K Ω	3K Ω	4.7K Ω	3K Ω
IEC input compatibility	Type 1+	Type 1+	Type 1+	Type 1	Type 1+
Isolated groups	Group 1: inputs 0…7 (internally connected commons)	Group 1: inputs 0…7 (internally connected commons)	Group 1: inputs 0…7; Group 2: inputs 8…15	Group 1: Inputs 0…7; Group 2: Inputs 8…15; Group 3: Inputs 16…23; Group 4: Inputs 24…31	Group 1: inputs 0…3; Group 2: inputs 4…7
Input group to backplane isolation	Verified by one of the following dielectric tests: 1517V AC for 1 s or 2145V DC for 1 s. 132V AC working voltage (IEC Class 2 reinforced insulation)	Verified by one of the following dielectric tests: 1200V ACAC for 1 s or 1697V DC for 1 s 75V DC working voltage (IEC Class 2 reinforced insulation)	Verified by one of the following dielectric tests: 1200V AC for 1 s or 1697V DC for 1 s 75V DC working voltage (IEC Class 2 reinforced insulation)	Verified by one of the following dielectric tests: 1200V AC for 2 s or 1697V DC for 2 s 75V DC working voltage (IEC Class 2 reinforced insulation)	Verified by one of the following dielectric tests: 1200V AC for 1 s or 1697V DC for 1 s 75V DC working voltage (IEC Class 2 reinforced insulation)
Vendor I.D. code	1				
Product type code	7				
Product code	114	96	97	99	98

(1) Sinking/Sourcing Inputs - Sourcing/sinking describes the current flow between the I/O module and the field device. Sourcing I/O circuits supply (source) current to sinking field devices. Sinking I/O circuits are driven by a current sourcing field device. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices.

(2) Refer to Publication 1762-IN10, MicroLogix 1762-IQ16 DC Input Module Installation Instructions, for the derating chart.

(3) Only applicable to Series B I/O modules.

Output Specifications

Specification	1762-OA8	1762-OB8	1762-OB16	1762-OB32T	1762-OV32T
Shipping weight, approx. (with carton)	215 g (0.48 lbs.)	210 g (0.46 lbs.)	235 g (0.52 lbs.)	200 g (0.44 lbs.)	200 g (0.44 lbs.)
Voltage category	100…240V AC	24V DC	24V DC	24V DC source	24V DC sink
Operating voltage range	85…265V AC at 47…63 Hz	20.4…26.4V DC	20.4…26.4V DC	10.2…26.4V DC	10.2…26.4V DC
Number of outputs	8	8	16	32	32
Bus current draw, max.	115 mA at 5V DC (0.575 W)	115 mA at 5V DC (0.575 W)	175 mA at 5V DC (0.88 W)	175 mA at 5V DC 0 mA at 24V DC	175 mA at 5V DC 0 mA at 24V DC
Heat dissipation, max.	2.9 W	1.61 W	2.9 W at 30 °C (86 °F) 2.1 W at 55 °C (131 °F)	3.4 W at 26.4 DC	2.7 W at 26.4V DC
Signal delay, max. – resistive load	On delay: 1/2 cycle Off delay: 1/2 cycle	On delay: 0.1 ms Off delay: 1.0ms	On delay: 0.1 ms Off delay: 1.0 ms	On delay: 0.5 ms Off delay: 4.0 ms	On delay: 0.5 ms Off delay: 4.0 ms
Off-state leakage current, max.	2 mA at 132V, 2.5 mA at 265V	1.0 mA	1.0 mA	0.1 mA at 26.4V DC	0.1 mA at 26.4V DC
On-state current, min.	10 mA	1.0 mA	1.0 mA	1.0 mA	1.0 mA
On-state voltage drop, max.	1.5V at 0.5 A	1.0V DC	1.0V DC	0.3V DC at 0.5 A	0.3V DC at 0.5A
Continuous current per point, max.	0.25 A at 55 °C (131 °F) 0.5 A at 30 °C (86 °F)	0.5 A at 55 °C (131 °F) 1.0 A at 30 °C (86 °F)	0.5 A at 55 °C (131 °F) 1.0 A at 30 °C (86 °F)	0.5 A at 60 °C (140 °F)	0.5A at 60 °C (140 °F)
Continuous current per common, max.	1.0 A at 55 °C (131 °F) 2.0 A at 30 °C (86 °F)	4.0 A at 55 °C (131 °F) 8.0 A at 30 °C (86 °F)	4.0 A at 55 °C (131 °F) 8.0 A at 30 °C (86 °F)	2.0 A at 60 °C (140 °F)	2.0 A at 60 °C (140 °F)
Continuous current per module, max.	2.0 A at 55 °C (131 °F) 4.0 A at 30 °C (86 °F)	4.0 A at 55 °C; 8.0 A at 30 °C	4.0 A at 55 °C (131 °F) 8.0 A at 30 °C (86 °F)	4.0 A at 60 °C (140 °F)	4.0 A at 60 °C (140 °F)
Surge current, max.	5.0 A (Repeatability is once every 2 s for a duration of 25 ms.	2.0 A (Repeatability is once every 2 s at 55 °C (131 °F), once every second at 30 °C (86 °F) for a duration of 10 ms.)	2.0 A (Repeatability is once every 2 s at 55 °C (131 °F), once every second at 30 °C (86 °F) for a duration of 10 ms.)	2.0 A (Repeatability is once every 2 s at 60 °C (140 °F) for 10 ms)	2.0 A (Repeatability is once every 2 s at 60 °C (140 °F) for 10 ms)
Isolated groups	Group 1: Outputs 0 to 3 Group 2: Outputs 4 to 7	Group 1: Outputs 0 to 7	Group 1: Outputs 0 to 15	Group 1: Outputs 0…15 Group 2: Outputs 16…31 (internally connected to common)	
Output group to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s. 265V AC working voltage (IEC Class 2 reinforced insulation)	Verified by one of the following dielectric tests: 1200V AC for 1 s or 1697V DC for 1 s. 75V DC working voltage (IEC Class 2 reinforced insulation)		Verified by one of the following dielectric tests: 1200V AC for 2 s or 1697V DC for 2 s. 75V DC working voltage (IEC Class 2 reinforced insulation)	
Output group to output group isolation	Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s. 265V AC working voltage (IEC Class 2 reinforced insulation)	Not applicable		Verified by one of the following dielectric tests: 1200V AC for 2 s or 1697V DC for 2 s. 75V DC working voltage (IEC Class 2 reinforced insulation)	

Output Specifications

Specification	1762-OA8	1762-OB8	1762-OB16	1762-OB32T	1762-OV32T
Vendor I.D. code	1				
Product type code	7				
Product code	119	101	103	100	102

Output Specifications

Specification	1762-OW8	1762-OW16	1762-OX6I	1762-IQ8OW6
Shipping weight, approx. (with carton)	228 g (0.50 lbs.)	285 g (0.63 lbs.)	220 g (0.485 lbs)	280 g (0.62 lbs.)
Voltage category	AC/DC normally open relay	AC/DC normally open relay	AC/DC Type C Relay	AC/DC normally open relay
Operating voltage range	5…265V AC 5…125V DC	5…265V AC 5…125V DC	5…265V AC 5…125V DC	5…265V AC 5…125V DC
Number of outputs	8	16	6	6
Bus current draw, max.	80 mA at 5V DC (0.40W) 90 mA at 24V DC (2.16W)	140 mA at 5V DC (0.70W)[1] 180 mA at 24V DC (4.32W) [1]	110 mA at 5V DC (0.55W) 110 mA at 24V DC (2.64W)	110 mA at 5V DC 80 mA at 24V DC
Heat dissipation, max.	2.9 W	6.1 W [1]	2.8 W	5.0 W at 30V DC 4.4 W at 26.4V DC (The Watts per point, plus the minimum W, with all points energized.)
Signal delay, max. – resistive load	On Delay: 10 ms Off Delay: 10 ms	On Delay: 10 ms Off Delay: 10 ms	On Delay: 10 ms (max) 6 ms (typical) Off Delay: 20 ms (max) 12 ms (typical)	On-delay: 10 ms (max) Off-delay: 10 ms (max)
Off-state leakage, max.	0 mA	0 mA	0 mA	0 mA
On-state current, min.	10 mA	10 mA	100 mA	10 mA
On-state voltage drop, max.	Not Applicable			
Continuous current per point, max.	2.5 A (Also see “Relay Contact Ratings” on page 139.)		7 A (Also see “Relay Contact Ratings” on page 139.)	2.5 A (Also see “Relay Contact Ratings” on page 139.)
Continuous current per common, max.	8 A	8 A	7 A (Also see “Relay Contact Ratings” on page 133.)	8 A
Continuous current per module, max.	16 A	16 A	30A (Also see Module Load Ratings 1762-OX6I on page 140.)	8A
Surge current, max.	See “Relay Contact Ratings” on page 139.		See “Relay Contact Ratings” on page 139.	See “Relay Contact Ratings” on page 139.
Isolated groups	Group 1: Outputs 0 to 3 Group 2: Outputs 4 to 7	Group 1: Outputs 0 to 7 Group 2: Outputs 8 to 15	All 6 Outputs Individually Isolated.	Group 3: Outputs 0 to 5
Output group to backplane isolation	Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s. 265V AC working voltage (IEC Class 2 reinforced insulation)			

Output Specifications

Specification	1762-OW8	1762-OW16	1762-OX6I	1762-IQ8OW6
Output group to output group isolation	Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s. 265V AC working voltage (basic insulation) 150V AC working voltage (IEC Class 2 reinforced insulation)			
Vendor I.D. code	1			
Product type code	7			
Product code	120	121	124	98

(1) Only applicable to Series B I/O modules.

Relay Contact Ratings (1762-OW8, 1762-OW16, and 1762-IQ8OW6)

Maximum Volts	Amperes Continuous	Amperes		Volt-Amperes	
		Make	Break	Make	Break
240V AC	2.5A(1)	7.5A	0.75A	1800 VA	180 VA
120V AC	2.5A(2)	15A	1.5A	1800 VA	180 VA
125V DC	1.0A	0.22A(2)		28 VA	
24V DC	2.0A	1.2A(3)			

(1) 1.5A above 40 °C (104 °F).

(2) For DC voltage applications, the make/break ampere rating for relay contacts can be determined by dividing 28 VA by the applied DC voltage. For example, 28 VA/48V DC = 0.58A. For DC voltage applications less than 14V, the make/break ratings for relay contacts cannot exceed 2A.

Relay Contact Ratings 1762-OX6I

Volts (max.)	Continuous Amps per Point (max.)(1)	Amperes(3)		Voltamperes	
		Make	Break	Make	Break
240V AC	5.0 A	15 A	1.5 A	3600 VA	360 VA
120V AC	7.0 A(2)	30 A	3.0 A		
125V DC	2.5 A	0.4 A		50 VA(4)	
24V DC	7.0 A(2)	7.0 A		168 VA(4)	

(1) The continuous current per module must be limited so the module power does not exceed 1440VA.

(2) 6 A in ambient temperatures above 40 °C (104.°F)

(3) **Surge Suppression** – Connecting surge suppressors across your external inductive load will extend the life of the relay contacts. For additional details, refer to *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1.

(4) DC Make/Break Voltamperes must be limited to 50 VA for DC voltages between 28V DC and 125V DC. DC Make/Break Voltamperes below 28V DC are limited by the 7 A Make/Break current limit.

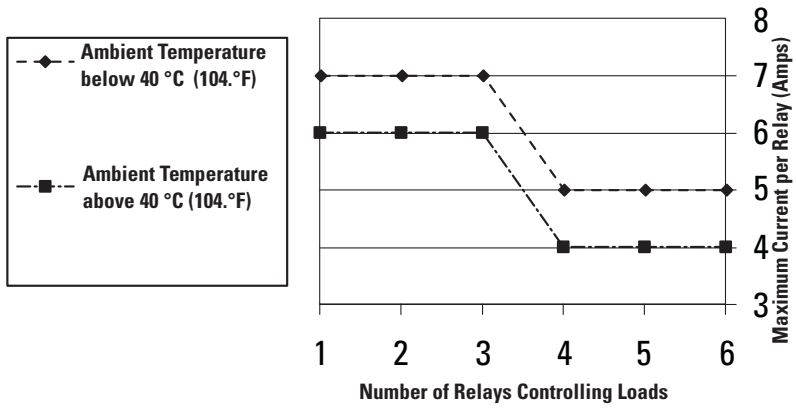
Module Load Ratings 1762-OX6I

Volts (max.)	Controlled Load (Current) per Module (max.)
240V AC	6 A
120V AC	12 A(1)
125V DC	11.5 A
24V DC	30 A(2)

(1) Current per relay limited to 6 A at ambient temperatures above 40 °C (104.°F).

(2) 24 A in ambient temperatures above 40 °C (104.°F). Limited by ambient temperature and the number of relays controlling loads. See below.

Relays Used vs. Maximum Current per Relay (24V DC) 1762-OX6I



Analog Modules

Common Specifications

Specification	1762-IF2OF2, 1762-IF4, 1762-IR4, 1762-IT4 and 1762-OF4
Dimensions	90 mm (height) x 87 mm (depth) x 40 mm (width) height including mounting tabs is 110 mm 3.54 in. (height) x 3.43 in. (depth) x 1.58 in. (width) height including mounting tabs is 4.33 in.
Temperature, storage	-40…85 °C (-40…185 °F)
Temperature, operating	-20…65 °C (-4…149 °F) (1)
Operating humidity	5…95% non-condensing
Operating altitude	2000 m (6561 ft)
Vibration	Operating: 10…500 Hz, 5 g, 0.030 in. max. peak-to-peak
Shock	Operating: 30 g
Module power LED	On: indicates power is applied.
Recommended cable	Belden 8761 (shielded) (For 1762-IT4, Shielded thermocouple extension wire for the specific type of thermocouple you are using. Follow thermocouple manufacturer's recommendations.)
Agency certification	C-UL certified (under CSA C22.2 No. 142) UL 508 listed CE compliant for all applicable directives C-Tick marked for all applicable acts (1762-IR4 and 1762-IT4)
Hazardous environment class	Class I, Division 2, Hazardous Location, Groups A, B, C, D (UL 1604, C-UL under CSA C22.2 No. 213)
Noise immunity	NEMA standard ICS 2-230
Radiated and conducted emissions	EN50081-2 Class A
Electrical /EMC:	The module has passed testing at the following levels:
ESD immunity (IEC1000-4-2)	4 kV contact, 8 kV air, 4 kV indirect
Radiated RF immunity (IEC1000-4-3)	10 V/m, 80…1000 MHz, 80% amplitude modulation, +900 MHz keyed carrier
EFT/B immunity (IEC1000-4-4)	2 kV, 5 kHz
Surge transient immunity (IEC1000-4-5)	1 kV galvanic gun
Conducted immunity (IEC1000-4-6)	10V, 0.15…80 MHz(2) (3)

(1) Refer to the module's Installation Instruction for exact operating temperature range.

(2) Conducted Immunity frequency range may be 150 kHz to 30 MHz if the Radiated Immunity frequency range is 30…1000 MHz.

(3) For grounded thermocouples, the 10V level is reduced to 3V.

General Specifications

Specification	1762-IF2OF2	1762-IF4	1762-OF4	1762-IR4	1762-IT4
Shipping weight, approx. (with carton)	240 g (0.53 lbs.)		235 g (0.517 lbs.)	260 g (0.57 lbs.)	220 g (0.53 lbs.)
Bus current draw, max.	40 mA at 5V DC 105 mA at 24V DC	40 mA at 5V DC 50 mA at 24V DC	40 mA at 5V DC 165 mA at 24V DC	40 mA at 5V DC 50 mA at 24V DC	40 mA at 5V DC 50 mA at 24V DC
Analog normal operating range	Voltage: 0…10V DC Current: 4…20 mA	Voltage: -10…+10V DC Current: 4…20 mA	Voltage 0…10V DC Current: 4…20 mA	NA	NA
Full scale(1) analog ranges	Voltage: 0…10.5V DC Current: 0…21 mA	Voltage: -10.5…+10.5V DC Current: -21…+21 mA	Voltage: 0…10.5V DC Current: 0…21 mA	NA	NA
Resolution	12 bits (unipolar)	15 bits (bipolar) (4)	12 bits (unipolar)	Input filter and configuration dependent	15 bits plus sign
Repeatability(2)	±0.12% (4)	±0.12% (4)	±0.12% (4)	±0.1 °C (±0.18 °F) for Ni and NiFe ±0.2 °C (±0.36 °F)…±0.2 °C (±0.36 °F) for other RTD inputs ±0.04 ohm for 150 ohm resistances ±0.2 ohm for other resistances	See Table 146
Input and output group to system isolation	30V AC/30V DC rated working voltage(3) (N.E.C. Class 2 required) (IEC Class 2 reinforced insulation) type test: 500V AC or 707V DC for 1 minute		30V AC/30V DC rated working voltage (IEC Class 2 reinforced insulation) type test: 500V AC or 707V DC for 1 minute	30V AC/30V DC working voltage type test: 500V AC or 707V DC for 1 minute	30V AC/30V DC working voltage qualification test: 720V DC for 1 minute
Vendor I.D. code	1	1	1	1	1
Product type code	10	10	10	10	10
Product code	75	67	66	65	64

(1) The over- or under-range flag comes on when the normal operating range (over/under) is exceeded. The module continues to convert the analog input up to the maximum full scale range.

(2) Repeatability is the ability of the module to register the same reading in successive measurements for the same signal.

(3) Rated working voltage is the maximum continuous voltage that can be applied at the terminals with respect to earth ground.

(4) Only applicable to Series B I/O modeles.

Input Specifications

Specification	1762-IF2OF2	1762-IF4	1762-IR4	1762-IT4
Number of inputs	2 differential (unipolar)	4 differential (bipolar)	4	4 input channels plus 1 CJC sensor
Update time (typical)	2.5 ms	130, 250, 290, 450, 530 ms (selectable)	Input filter and cofiguration dependent	NA
A/D converter type	Successive approximation	Successive approximation	Delta-Sigma	Delta-Sigma
Common mode voltage range(1)	±27V	±27V	NA	±10V

Input Specifications

Specification	1762-IF2OF2	1762-IF4	1762-IR4	1762-IT4
Common mode rejection(2)	> 55 dB at 50 and 60 Hz	> 55 dB at 50 and 60 Hz	>110 dB at 50 Hz (with 10 or 50 Hz filter) >110 dB at 60 Hz (with 10 or 60 Hz filter)	>110 dB at 50 Hz (with 10 or 50 Hz filter) >110 dB at 60 Hz (with 10 or 60 Hz filter)
Non-linearity (in percent full scale)	±0.12% (4)	±0.12% (4)	±0.05%	NA
Typical overall accuracy(3)	±0.55% full scale at -20…65 °C(4) ±0.3% full scale at 25 °C	±0.32% full scale at -20…65 °C (4) ±0.24% full scale at 25 °C	±0.5 °C (F °) for Pt 385	NA
Input impedance	Voltage Terminal: 200 KΩ Current Terminal: 250 Ω	Voltage Terminal: 200 KΩ Current Terminal: 275 Ω	>10 MΩ	>10 MΩ
Current input protection	±32 mA	±32 mA	NA	NA
Voltage input protection	±30V	±30V	NA	NA
Channel diagnostics	Over or under range or open circuit condition by bit reporting for analog inputs.	Over or under range or open circuit condition by bit reporting for analog inputs.	Over or under range or open circuit condition by bit reporting for analog inputs.	Over or under range or open circuit condition by bit reporting for analog inputs.

(1) For proper operation, both the plus and minus input terminals must be within ±27V (±10V for 1762-IT4) of analog common.

(2) V_{cm} = 1 V_{pk-pk} AC

(3) V_{cm} = 0 (includes offset, gain, non-linearity and repeatability error terms)

(4) Only applicable to Series B I/O modules.

Input Specifications 1762-IR4

Specification	1762-IR4
Input types	•100 Ω Platinum 385 •200 Ω Platinum 385 •500 Ω Platinum 385 •1,000 Ω Platinum 385 •100 Ω Platinum 3916 •200 Ω Platinum 3916 •500 Ω Platinum 3916 •1,000 Ω Platinum 3916 •10 Ω Copper 426 •120 Ω Nickel 672 •120 Ω Nickel 618 •604 Ω Nickel-Iron 518 •0...150 Ω •0...500 Ω •0...1,000 Ω •0...3,000 Ω
Heat dissipation	1.5 Total Watts (The Watts per point, plus the minimum Watts, with all points enabled.)
Normal mode rejection ratio	70 dB minimum at 50 Hz with the 10 or 50 Hz filter selected 70 dB minimum at 60 Hz with the 10 or 60 Hz filter selected
Typical accuracy [Autocalibration enabled] at 25 ° C (77 °F) ambient with module operating temperature at 25 °C (77 °F) [1]	±0.5 °C (°F) for Pt 385 ±0.4 °C (°F) for Pt 3916 ±0.2 °C (°F) for Ni ±0.3 °C (°F) for NiFe ±0.6 °C (°F) for Cu ±0.15 Ω for 150 Ω range ±0.5 Ω for 500 Ω range ±1.0 Ω for 1,000 Ω range ±1.5 Ω for 3,000 Ω range
Typical accuracy [Autocalibration enabled] at 0…55 ° C (32…131 °F)[1]	±0.9 °C (°F) for Pt 385 ±0.8 °C (°F) for Pt 3916 ±0.4 °C (°F) for Ni ±0.5 °C (°F) for NiFe ±1.1 °C (°F) for Cu ±0.25 Ω for 150 Ω range ±0.8 Ω for 500 Ω range ±1.5 Ω for 1,000 Ω range ±2.5 Ω for 3,000 Ω range
Accuracy drift at 0…55 ° C (32…131 °F)	±0.026 °C/°C (0.026 °F/°F) for Pt 385 ±0.023 °C/°C (0.023 °F/°F) for Pt 3916 ±0.012 °C/°C (0.012 °F/°F) for Ni ±0.015 °C/°C (0.015 °F/°F) for NiFe ±0.032 °C/°C (0.032 °F/°F) for Cu ±0.007 Ω/°C (0.012 Ω/°F) for 150 Ω range ±0.023 Ω/°C (0.041 Ω/°F) for 500 Ω range ±0.043 Ω/°C (0.077 Ω/°F) for 1,000 Ω range ±0.07 2Ω/°C (0.130 Ω/°F) for 3,000 Ω range
Excitation current source	0.5 mA and 1.0 mA selectable per channel
Open-circuit detection time[2]	6…1212 ms
Input channel configuration	Via configuration software screen or the user program (by writing a unique bit pattern into the module's configuration file). Refer to your controller's user manual to determine if user program configuration is supported.
Calibration	The module performs autocalibration on channel enable and on a configuration change between channels. You can also program the module to calibrate every five minutes.

Input Specifications 1762-IR4

Specification	1762-IR4
Maximum overload at input terminals	±35V DC continuous
Cable impedance, max.	25 Ω (Operating with >25 Ω will reduce accuracy.)
Channel to channel isolation	±10V DC

(1) Accuracy is dependent upon the Analog/Digital converter filter rate selection, excitation current selection, data format, and input noise.
(2) Open-circuit detection time is equal to channel update time.

Input Specifications 1762-IT4

Specification	Value
Heat dissipation	1.5 Total Watts (The Watts per point, plus the minimum Watts, with all points energized.)
Response speed per channel	Input filter and configuration dependent.
Rated working voltage(1)	30V AC/30V DC
Normal mode rejection ratio	85 dB (minimum) at 50 Hz (with 10 Hz or 50 Hz filter) 85 dB (minimum) at 60 Hz (with 10 Hz or 60 Hz filter)
Cable impedance, max.	25 Ω (for specified accuracy)
Open-circuit detection time	7 ms…1.515 s(2)
Calibration	The module performs autocalibration upon power-up and whenever a channel is enabled. You can also program the module to calibrate every five minutes.
CJC accuracy	±1.3 °C (±2.34 °F)
Maximum overload at input terminals	±35V DC continuous(3)
Input channel configuration	via configuration software screen or the user program (by writing a unique bit pattern into the module's configuration file).

(1) Rated working voltage is the maximum continuous voltage that can be applied at the input terminal, including the input signal and the value that floats above ground potential (for example, 30V DC input signal and 20V DC potential above ground).
(2) Open-circuit detection time is equal to the module scan time, which is based on the number of enabled channels, the filter frequency of each channel, and whether cyclic calibration is enabled..
(3) Maximum current input is limited due to input impedance.

1762-IT4 Repeatability at 25 °C (77 °F)[1] [2]

Input Type	Repeatability for 10 Hz Filter
Thermocouple J	±0.1 °C [±0.18 °F]
Thermocouple N (-110…1300 °C [-166…2372 °F])	±0.1 °C [±0.18 °F]
Thermocouple N (-210…-110 °C [-346…-166 °F])	±0.25 °C [±0.45 °F]
Thermocouple T (-170…400 °C [-274…752 °F])	±0 .1 °C [±0.18 °F]
Thermocouple T (-270…-170 °C [-454…-274 °F])	±1.5 °C [±2.7 °F]
Thermocouple K (-270…1370 °C [-454 °F…2498 °F])	±0.1 °C [±0.18 °F]
Thermocouple K (-270…-170 °C [-454…-274 °F])	±2.0 °C [±3.6 °F]
Thermocouple E (-220…1000 °C [-364…1832 °F])	±0.1 °C [±0.18 °F]
Thermocouple E (-270…-220 °C [-454…-364 °F])	±1.0 °C [±1.8 °F]
Thermocouples S and R	±0.4 °C [±0.72 °F]
Thermocouple C	±0.2 °C [±0.36 °F]
Thermocouple B	±0.7 °C [±1.26 °F]
±50 mV	±6 µV
±100 mV	±6 µV

(1) Repeatability is the ability of the input module to register the same reading in successive measurements for the same input signal.

(2) Repeatability at any other temperature in the 0...60 °C (32...140 °F) range is the same as long as the temperature is stable.

1762-IT4 Accuracy

Input Type[1]	With Autocalibration Enabled		Without Autocalibration
	Accuracy[2] [3] for 10 Hz, 50 Hz and 60 Hz Filters (max.)		Maximum Temperature Drift[2] [4]
	at 25 °C [77 °F] Ambient	at 0…60 °C [32…140 °F] Ambient	at 0…60 °C [32…140 °F] Ambient
Thermocouple J (-210…1200 °C [-346…2192 °F])	±0.6 °C [± 1.1 °F]	±0.9 °C [± 1.7 °F]	±0.0218 °C/ °C [±0.0218 °F/ °F]
Thermocouple N (-200…1300 °C [-328…2372 °F])	±1 °C [± 1.8 °F]	±1.5 °C [±2.7 °F]	±0.0367 °C/ °C [±0.0367 °F/ °F]
Thermocouple N (-210…-200 °C [-346…-328 °F])	±1.2 °C [±2.2 °F]	±1.8 °C [±3.3 °F]	±0.0424 °C/ °C [±0.0424 °F/ °F]
Thermocouple T (-230…400 °C [-382…752 °F])	±1 °C [± 1.8 °F]	±1.5 °C [±2.7 °F]	±0.0349 °C/ °C [±0.0349 °F/ °F]
Thermocouple T (-270…-230 °C [-454…-382 °F])	±5.4 °C [± 9.8 °F]	±7.0 °C [±12.6 °F]	±0.3500 °C/ °C [±0.3500 °F/ °F]
Thermocouple K (-230…1370 °C [-382…2498 °F])	±1 °C [± 1.8 °F]	±1.5 °C [±2.7 °F]	±0.4995 °C/ °C [±0.4995 °F/ °F]
Thermocouple K (-270…-225 °C [-454…-373 °F])	±7.5 °C [± 13.5 °F]	±10 °C [± 18 °F]	±0.0378 °C/ °C [±0.0378 °F/ °F]
Thermocouple E (-210…1000 °C [-346…1832 °F])	±0.5 °C [± 0.9 °F]	±0.8 °C [±1.5 °F]	±0.0199 °C/ °C [±0.0199 °F/ °F]
Thermocouple E (-270…-210 °C [-454…-346 °F])	±4.2 °C [± 7.6 °F]	±6.3 °C [±11.4 °F]	±0.2698 °C/ °C [±0.2698 °F/ °F]
Thermocouple R	±1.7 °C [± 3.1 °F]	±2.6 °C [± 4.7 °F]	±0.0613 °C/ °C [±0.0613 °F/ °F]
Thermocouple S	±1.7 °C [± 3.1 °F]	±2.6 °C [± 4.7 °F]	±0.0600 °C/ °C [±0.0600 °F/ °F]
Thermocouple C	±1.8 °C [±3.3 °F]	±3.5 °C [±6.3 °F]	±0.0899 °C/ °C [±0.0899 °F/ °F]

1762-IT4 Accuracy

Input Type[1]	With Autocalibration Enabled		Without Autocalibration
	Accuracy[2] [3] for 10 Hz, 50 Hz and 60 Hz Filters (max.)		Maximum Temperature Drift[2] [4]
	at 25 °C [77 °F] Ambient	at 0…60 °C [32…140 °F] Ambient	at 0…60 °C [32…140 °F] Ambient
Thermocouple B	±3.0 °C [±5.4 °F]	±4.5 °C [±8.1 °F]	±0.1009 °C/ °C [±0.1009 °F/ °F]
±50 mV	±15 µV	±25 µV	±0.44µV/ °C [±0.80µV/ °F]
±100 mV	±20 µV	±30 µV	±0.69µV/ °C [±01.25µV/ °F]

(1) The module uses the National Institute of Standards and Technology (NIST) ITS-90 standard for thermocouple linearization.
(2) Accuracy and temperature drift information does not include the affects of errors or drift in the cold junction compensation circuit.
(3) Accuracy is dependent upon the analog/digital converter output rate selection, data format, and input noise.
(4) Temperature drift with autocalibration is slightly better than without autocalibration.

TIP For more detailed 1762-IT4 accuracy information, see publication 1762-UM002.

Output Specifications

Specification	1762-IF2OF2	1762-OF4
Number of outputs	2 single-ended (unipolar)	4 single-ended (unipolar)[2]
Update time (typical)	4.5 ms	
D/A converter type	Resistor string	R-2R Ladder Voltage Switching
Resistive load on current output	0...500 Ω (includes wire resistance)	0...500 Ω (includes wire resistance)
Load range on voltage output	> 1kΩ	> 1KΩ
Reactive load, current output	< 0.1 mH	< 0.1 mH
Reactive load, voltage output	< 1 µF	< 1 µF
Typical overall accuracy[1]	±1.17% full scale at -20...65 °C [2] ±0.5% full scale at 25 °C	±1.17% full scale at -20...65 °C [2] ±0.5% full scale at 25 °C
Output ripple range 0…500 Hz (referred to output range)	< ±0.1%	< ±0.1%
Non-linearity (in percent full scale)	< ±0.59% [2]	< ±0.59% [2]
Open and short-circuit protection	Continuous	Continuous
Output protection	±32 mA	±32 mA

(1) Includes offset, gain, non-linearity and repeatability error terms.

(2) Only applicable to Series B I/O modules.

Valid Input/Output Data Word Formats/Ranges for 1762-IF2OF2

Normal Operating Range	Full Scale Range	RAW/Proportional Data	Scaled-for-PID
0…10V DC	10.5V DC	32760	16380
	0.0V DC	0	0

Valid Input/Output Data Word Formats/Ranges for 1762-IF2OF2

Normal Operating Range	Full Scale Range	RAW/Proportional Data	Scaled-for-PID
4…20 mA	21.0 mA	32760	16380
	20.0 mA	31200	15600
	4.0 mA	6240	3120
	0.0 mA	0	0

Replacement Parts

This chapter contains the following information:

- a table of MicroLogix 1400 replacement parts
- procedure for replacing the lithium battery

MicroLogix 1400 Replacement Kits

The table below provides a list of replacement parts and their catalog number.

Description	Catalog Number
Lithium Battery (See page 151.)	1747-BA

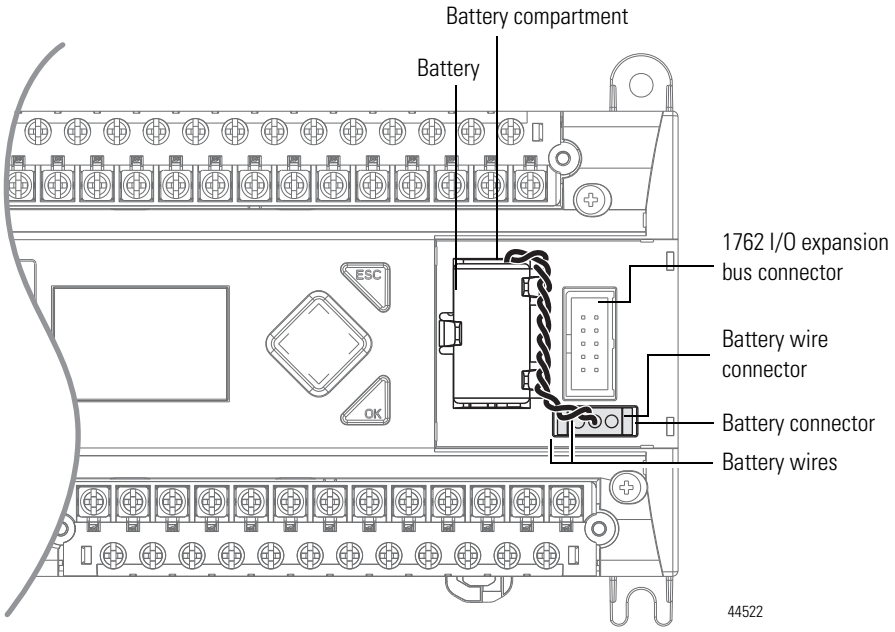
Lithium Battery (1747-BA)

IMPORTANT When the controller's Battery Low indicator is lit, check whether the battery wire connector is connected correctly or replace the replaceable battery with a new one immediately. When the indicator turns on, it means that either the battery is disconnected, or that the battery requires replacement. The controller is designed to operate for up to 2 weeks, from the time that the indicator first turns on. We recommend that you replace the battery immediately when the indicator turns on.

Installation

Follow the procedure below to ensure proper replaceable battery installation.

1. Insert a battery into the battery pocket with wires facing up.
2. Insert the battery wire connector into the battery connector.
3. Secure the battery connector wires around the 1762 expansion bus connector as shown below.


Battery compartment
Battery
1762 I/O expansion bus connector
Battery wire connector
Battery connector
Battery wires
ESC
OK
44522

Battery Handling

Follow the procedure below to ensure proper battery operation and reduce personnel hazards.

- Use only for the intended operation.
- Do not ship or dispose of cells except according to recommended procedures.
- Do not ship on passenger aircraft.



ATTENTION:

- Do not charge the batteries. An explosion could result or the cells could overheat causing burns.
- Do not open, puncture, crush, or otherwise mutilate the batteries. A possibility of an explosion exists and/or toxic, corrosive, and flammable liquids would be exposed.
- Do not incinerate or expose the batteries to high temperatures. Do not attempt to solder batteries. An explosion could result.
- Do not short positive and negative terminals together. Excessive heat can build up and cause severe burns.

Storage

Store lithium batteries in a cool, dry environment, typically 20 °C...2 5°C (68°F...77°F) and 40%...60% humidity. Store the batteries and a copy of the battery instruction sheet in the original container, away from flammable materials.

Transportation

One or Two Batteries

Each battery contains 0.23 g of lithium. Therefore, up to two batteries can be shipped together within the United States without restriction. Regulations governing shipment to or within other countries may differ.

Three or More Batteries

Procedures for the transportation of three or more batteries shipped together within the United States are specified by the Department of Transportation (DOT) in the Code of Federal Regulations, CFR49, “Transportation.” An exemption to these regulations, DOT - E7052, covers the transport of certain hazardous materials classified as flammable solids. This exemption authorizes transport of lithium batteries by motor vehicle, rail freight, cargo vessel, and

cargo-only aircraft, providing certain conditions are met. Transport by passenger aircraft is not permitted.

A special provision of DOT-E7052 (11th Rev., October 21, 1982, par. 8-a) provides that:

> "Persons that receive cell and batteries covered by this exemption may reship them pursuant to the provisions of 49 CFR 173.22a in any of these packages authorized in this exemption including those in which they were received."

The Code of Federal Regulations, 49 CFR 173.22a, relates to the use of packaging authorized under exemptions. In part, it requires that you must maintain a copy of the exemption at each facility where the packaging is being used in connection with shipment under the exemption.

Shipment of depleted batteries for disposal may be subject to specific regulation of the countries involved or to regulations endorsed by those countries, such as the IATA Articles Regulations of the International Air Transport Association, Geneva, Switzerland.

IMPORTANT	Regulations for transportation of lithium batteries are periodically revised. Refer to http://www.dot.gov for the latest shipping information.

Disposal



ATTENTION: Do not incinerate or dispose of lithium batteries in general trash collection. Explosion or violent rupture is possible. Batteries should be collected for disposal in a manner to prevent against short-circuiting, compacting, or destruction of case integrity and hermetic seal.

For disposal, batteries must be packaged and shipped in accordance with transportation regulations, to a proper disposal site. The U.S. Department of Transportation authorizes shipment of "Lithium batteries for disposal" by motor vehicle only in regulation 173.1015 of CFR 49 (effective January 5, 1983). For additional information contact:

U.S. Department of Transportation
Research and Special Programs Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Although the Environmental Protection Agency at this time has no regulations specific to lithium batteries, the material contained may be considered toxic, reactive, or corrosive. The person disposing of the material is responsible for any hazard created in doing so. State and local regulations may exist regarding the disposal of these materials.

For a lithium battery product safety data sheet, contact the manufacturer:

Sanyo Energy Corporation
2001 Sanyo Avenue
San Diego, CA 92173
(619) 661-4801

Tadarand U.S. Battery Division
2 Seaview Blvd.
Port Washington, NY 11050
(516) 621-4980

Notes:

Troubleshooting Your System

This chapter describes how to troubleshoot your controller. Topics include:

- understanding the controller status indicators
- controller error recovery model
- analog expansion I/O diagnostics and troubleshooting
- calling Rockwell Automation for assistance

Understanding the Controller Status Indicators

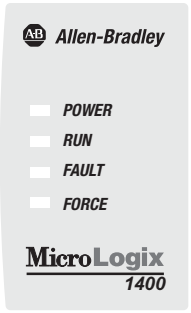
The MicroLogix 1400 provides three groups of status indicators:

- the status LEDs on the top of the controller,
- the status indicators on the LCD
- the I/O status indicators on the LCD.

Together they provide a mechanism to determine the current status of the controller if a programming device is not present or available.

Controller Status LED Indicators

Figure 3 - Controller LED Location



Controller LED Indicators

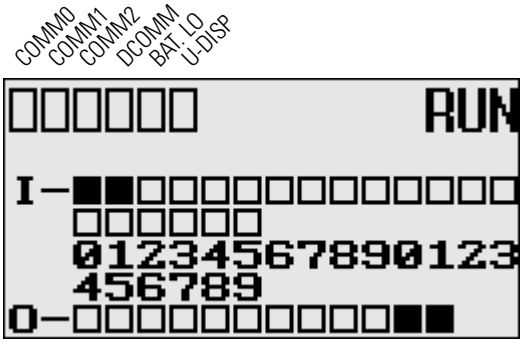
LED	Color	Indicates
POWER	off	No input power, or power error condition
	green	Power on
RUN	off	Not executing the user program
	green	Executing the user program in run mode
	green flashing	Memory module transfer occurring

Controller LED Indicators

LED	Color	Indicates
FAULT	off	No fault detected
	red flashing	Application fault detected
	red	Controller hardware faulted
FORCE	off	No forces installed
	amber	Forces installed
	amber flashing	Forces installed in force files but forcing is disabled.

Status Indicators on the LCD

Figure 4 - Status Indicators on the LCD



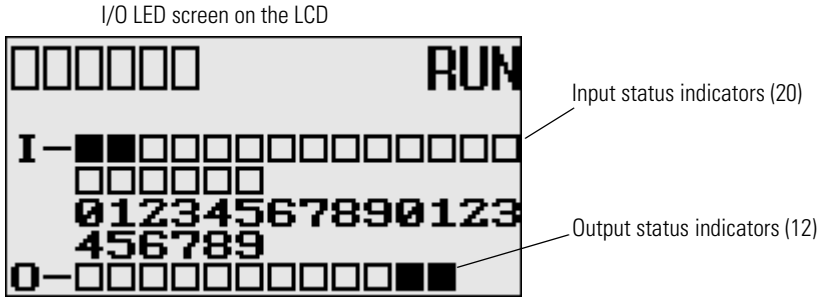
Status Indicators on the LCD

Indicator	Color	Indicates
COMM 0	off (empty rectangle)	Not transmitting via RS-232/485 port (Channel 0)
	on (solid rectangle)	Transmitting via RS-232/485 port (Channel 0)
COMM 1	off (empty rectangle)	Not transmitting via Ethernet port (Channel 1)
	on (solid rectangle)	Transmitting via Ethernet port (Channel 1)
COMM 2	off (empty rectangle)	Not transmitting via RS-232 port (Channel 2)
	on (solid rectangle)	Transmitting via RS-232 port (Channel 2)
DCOMM[1]	off (empty rectangle)	Configured communications (Channel 0)
	on (solid rectangle)	Default communications (Channel 0)
BAT. LO	off (empty rectangle)	Battery level is acceptable
	on (solid rectangle)	Battery low
U-DISP	off (empty rectangle)	Default display mode
	on (solid rectangle)	Customized display mode

(1) When using a MicroLogix 1400 controller, the DCOMM LED applies only to Channel 0.

I/O Status Indicators on the LCD

Figure 5 - I/O Status Indicators on the LCD



I/O Status Indicators on the LCD

Indicator	Color	Indicates
INPUTS[1]	off (empty rectangle)	Input is not energized
	on (solid rectangle)	Input is energized (terminal status)
OUTPUTS	off (empty rectangle)	Output is not energized
	on (solid rectangle)	Output is engerized (logic status)

(1) To view the status of inputs and outputs on the LCD, you need to enter the I/O LED mode screen using the LCD menu. See I/O Status on page 5-67 for more information.

Normal Operation

The POWER and RUN LEDs are On. If forcing is enabled and forces are installed in I/O force files, the FORCE LED turns on and remains on until all forces are removed. And if forcing is disabled and forces are installed in I/O force files, the FORCE LED flashes and remains flashing until forces are removed from I/O force files.

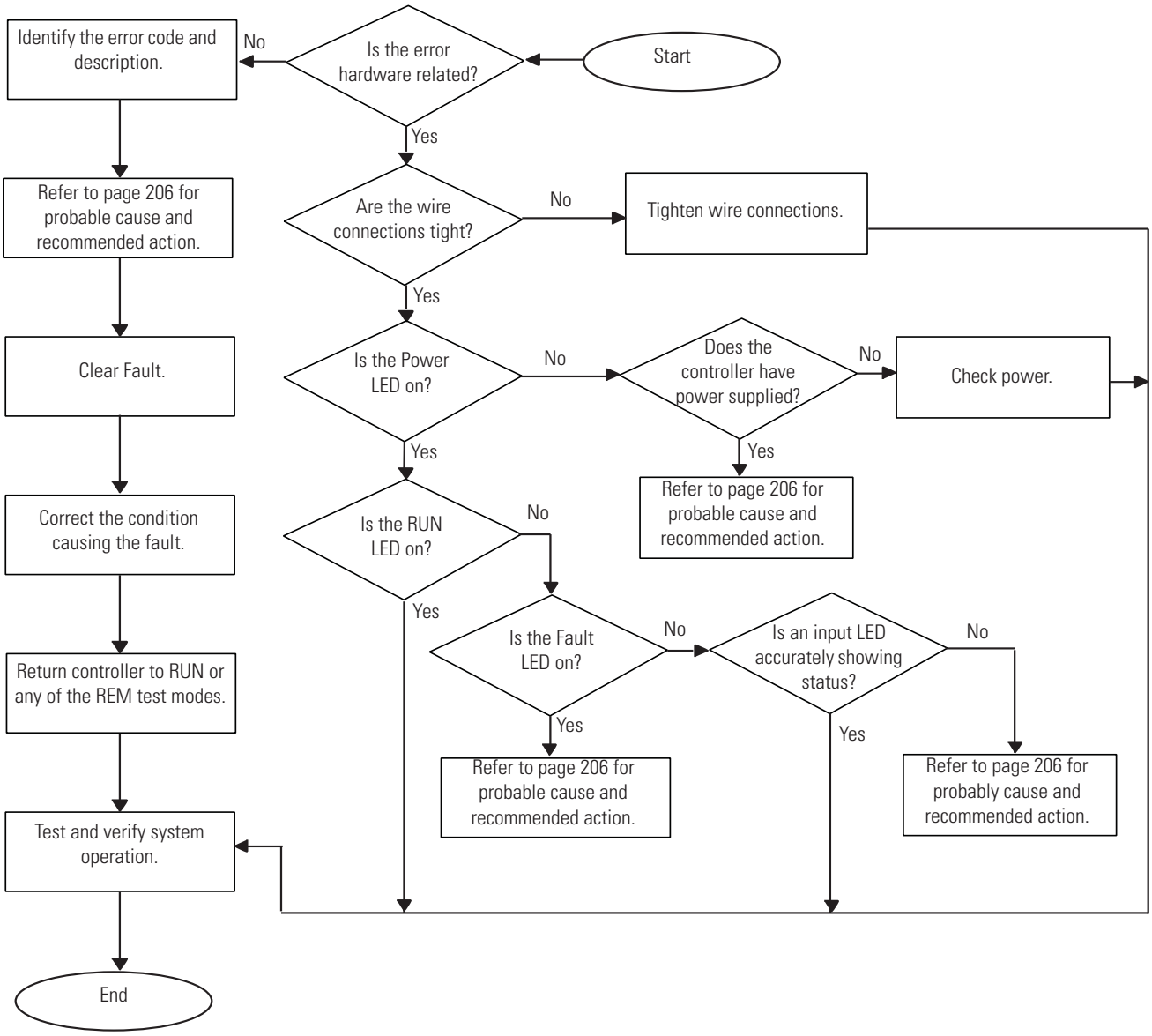
Error Conditions

If an error exists within the controller, the controller LEDs operate as described in the following table.

If the LEDS indicate:	The Following Error Exists	Probable Cause	Recommended Action
All LEDs off	No input power or power supply error	No line Power	Verify proper line voltage and connections to the controller.
		Power Supply Overloaded	This problem can occur intermittently if power supply is overloaded when output loading and temperature varies.
Power and FAULT LEDs on solid	Hardware faulted	Processor Hardware Error	Cycle power. Contact your local Allen-Bradley representative if the error persists.
		Loose Wiring	Verify connections to the controller.
Power LED on and FAULT LED flashing	Application fault	Hardware/Software Major Fault Detected	For error codes and Status File information, see *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, Publication 1766-RM001.
RUN FORCE FAULT LEDs all flashing	Operating system fault	Missing or Corrupt Operating System	See Recovering from Missing or Corrupt OS State on page D-182.

Controller Error Recovery Model

Use the following error recovery model to help you diagnose software and hardware problems in the micro controller. The model provides common questions you might ask to help troubleshoot your system. Refer to the recommended pages within the model for further help.


Start
Is the error hardware related?
No
Identify the error code and description.
Refer to page 206 for probable cause and recommended action.
Yes
Are the wire connections tight?
No
Tighten wire connections.
Yes
Is the Power LED on?
No
Does the controller have power supplied?
No
Check power.
Yes
Refer to page 206 for probable cause and recommended action.
Yes
Is the RUN LED on?
No
Is the Fault LED on?
No
Is an input LED accurately showing status?
No
Yes
Refer to page 206 for probable cause and recommended action.
Yes
Refer to page 206 for probably cause and recommended action.
Yes
Clear Fault.
Correct the condition causing the fault.
Return controller to RUN or any of the REM test modes.
Test and verify system operation.
End

Analog Expansion I/O Diagnostics and Troubleshooting

Module Operation and Channel Operation

The module performs operations at two levels:

- module level
- channel level

Module-level operations include functions such as power-up, configuration, and communication with the controller.

Internal diagnostics are performed at both levels of operation. Both module hardware and channel configuration error conditions are reported to the controller. Channel over-range or under-range conditions are reported in the module's input data table. Module hardware errors are reported in the controller's I/O status file. Refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001 for more information.

When a fault condition is detected, the analog outputs are reset to zero.

Power-up Diagnostics

At module power-up, a series of internal diagnostic tests are performed.

Module Status LED State Table

If module status LED is	Indicated condition	Corrective action
On	Proper Operation	No action required.
Off	Module Fault	Cycle power. If condition persists, replace the module. Call your local distributor or Allen-Bradley for assistance.

Critical and Non-Critical Errors

Non-critical module errors are recoverable. Channel errors (over-range or under-range errors) are non-critical. Non-critical error conditions are indicated in the module input data table. Non-critical configuration errors are indicated by the extended error code. See Extended Error Codes for 1762-IF2OF2 on page 164.

Critical module errors are conditions that prevent normal or recoverable operation of the system. When these types of errors occur, the system leaves the run mode of operation. Critical module errors are indicated in Extended Error Codes for 1762-IF2OF2 on page 164.

Module Error Definition Table

Analog module errors are expressed in two fields as four-digit Hex format with the most significant digit as “don’t care” and irrelevant. The two fields are “Module Error” and “Extended Error Information”. The structure of the module error data is shown below.

Module Error Table

“Don’t Care” Bits				Module Error			Extended Error Information								
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hex Digit 4				**Hex Digit 3**			**Hex Digit 2**					**Hex Digit 1**			

Module Error Field

The purpose of the module error field is to classify module errors into three distinct groups, as described in the table below. The type of error determines what kind of information exists in the extended error information field. These types of module errors are typically reported in the controller's I/O status file. Refer to the *MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual*, publication 1766-RM001 for more information.

Module Error Types

Error Type	Module Error Field Value Bits 11 through 09 (Binary)	Description
No Errors	000	No error is present. The extended error field holds no additional information.
Hardware Errors	001	General and specific hardware error codes are specified in the extended error information field.
Configuration Errors	010	Module-specific error codes are indicated in the extended error field. These error codes correspond to options that you can change directly. For example, the input range or input filter selection.

Extended Error Information Field

Check the extended error information field when a non-zero value is present in the module error field. See Extended Error Codes for 1762-IF2OF2 on page 164.

TIP If no errors are present in the module error field, the extended error information field is set to zero.

Hardware Errors

General or module-specific hardware errors are indicated by module error code 2.

Configuration Errors

If you set the fields in the configuration file to invalid or unsupported values, the module ignores the invalid configuration, generates a non-critical error, and keeps operating with the previous configuration.

The table below lists the configuration error codes defined for the module.

Error Codes

Extended Error Codes for 1762-IF2OF2

Error Type	Hex Equivalent[1]	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
No Error	X000	000	0 0000 0000	No error
General Common Hardware Error	X200	001	0 0000 0000	General hardware error; no additional information
	X201	001	0 0000 0001	Power-up reset state

Extended Error Codes for 1762-IF2OF2

Error Type	Hex Equivalent[1]	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
Hardware-Specific Error	X210	001	0 0001 0000	Reserved
Configuration Error	X400	010	0 0000 0000	General configuration error; no additional information
	X401	010	0 0000 0001	Invalid input data format selected (channel 0)
	X402	010	0 0000 0010	Invalid input data format selected (channel 1)
	X403	010	0 0000 0011	Invalid output data format selected (channel 0)
	X404	010	0 0000 0100	Invalid output data format selected (channel 1)

(1) X represents "Don't Care".

Extended Error Codes for 1762-IF4 and 1762-OF4

Error Type	Hex Equivalent[1]	Module Error Code	Extended Error Information Code	Error Description
		Binary	Binary	
No Error	X000	000	0 0000 0000	No error
General Common Hardware Error	X200	001	0 0000 0000	General hardware error; no additional information
	X201	001	0 0000 0001	Power-up reset state
Hardware-Specific Error	X300	001	1 0000 0000	Reserved
Configuration Error	X400	010	0 0000 0000	General configuration error; no additional information
	X401	010	0 0000 0001	Invalid range select (Channel 0)
	X402	010	0 0000 0010	Invalid range select (Channel 1)
	X403	010	0 0000 0011	Invalid range select (Channel 2)
	X404	010	0 0000 0100	Invalid range select (Channel 3)
	X405	010	0 0000 0101	Invalid filter select (Channel 0) – *1762-IF4 only*
	X406	010	0 0000 0110	Invalid filter select (Channel 1) – *1762-IF4 only*
	X407	010	0 0000 0111	Invalid filter select (Channel 2) – *1762-IF4 only*
	X408	010	0 0000 1000	Invalid filter select (Channel 3) – *1762-IF4 only*
	X409	010	0 0000 1001	Invalid format select (Channel 0)
	X40A	010	0 0000 1010	Invalid format select (Channel 1)
	X40B	010	0 0000 1011	Invalid format select (Channel 2)
	X40C	010	0 0000 1400	Invalid format select (Channel 3)

(1) X represents "Don't Care".

Calling Rockwell Automation for Assistance

If you need to contact Rockwell Automation or local distributor for assistance, it is helpful to obtain the following (prior to calling):

- controller type, series letter, revision letter, and firmware (FRN) number of the controller
- controller indicator status

- controller error codes (Refer to MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, Publication 1766-RM001 for error code information.)

Using ControlFLASH to Upgrade Your Operating System

The operating system (OS) can be upgraded through the Ethernet port of the controller. In order to download a new operating system, you must have the following:

- ControlFLASH Upgrade Kit containing the new OS
  Go to
  http://www.ab.com/programmablecontrol/plc/micrologix/downloads.html
  to download the upgrade kit.
- a Windows 7, Windows 2000, Windows NT, Windows XP, or Windows Vista based computer to run the download software.

The ControlFLASH Upgrade Kit includes:

- the operating system upgrade to be downloaded.
- the ControlFLASH programming tool, along with its support drivers and on-line help.

Preparing for Firmware Upgrade

Before upgrading the controller's operating system (OS), you must:

- install ControlFLASH software on your personal computer.
- prepare the controller for updating.

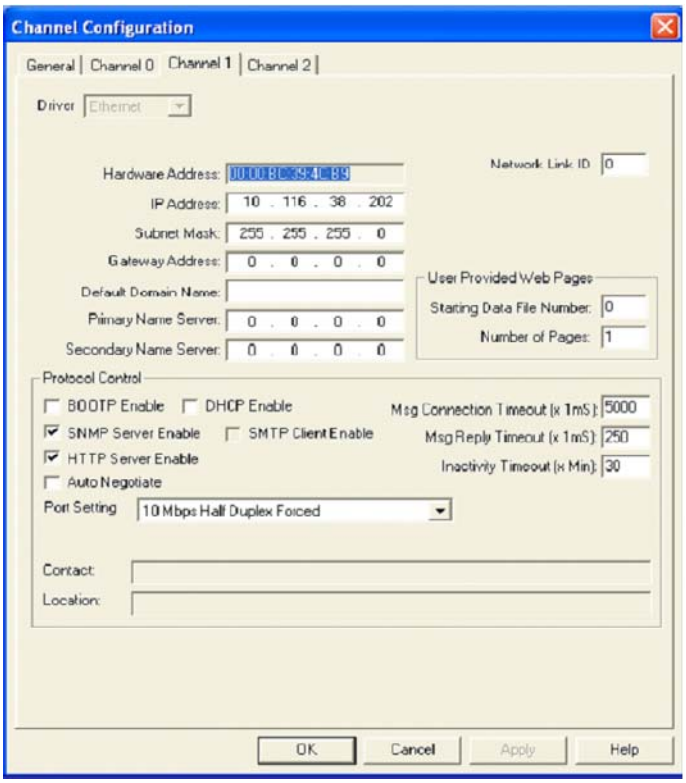
Install ControlFLASH Software

Double click the ControlFLASH.msi file to install the operating system upgrade.

If a ControlFLASH directory does not already exist, one is created in your Program Files directory.

Prepare the Controller for Firmware Upgrade

1. It is important that the SNMP server is enabled before the firmware upgrade begins. You can check if the SNMP server is enabled by looking at the Channel Configuration page for Channel 1 in RSLogix 500/RSLogix Micro. If the SNMP server is not enabled, you can still enable it in the channel configuration page.



IMPORTANT	The user program is cleared as part of the operating system upgrade process. You must restore your program after successfully loading the operating system upgrade. The Ethernet communication configuration parameters are retained and the SNMP is enabled by default after a successful firmware upgrade.

IMPORTANT	A power cycle is needed in order for the changes in the Channel Configuration page to be applied.

2. Ensure that you complete the IP configuration for the OS firmware upgrade. Note the assigned IP address of the controller.
   If the IP address is not configured you can still perform the IP configuration using Static, BOOTP or DHCP settings. Once the IP configuration is done, it is used throughout the firmware upgrade process. If the IP configuration has been done, the IP address may be read from the processor when online with RSLogix 500/RSLogix Micro. In the Channel Configuration dialog box select the Chan. 1 - System tab or use the LCD. If BOOTP/DHCP Enable is selected and if the IP Address is 0.0.0.0, then note the Ethernet Hardware Address which begins with 00:00:BC.
3. The controller should be in Program mode before you start the firmware upgrade (access the Mode Switch from the LCD).

See Using the Mode Switch on page 86 for information about controller modes and how to use the Mode Switch.

See Viewing Ethernet Status on page 94 to find how to browse for the controller's IP address.

Using ControlFLASH for Firmware Upgrade



ATTENTION: Do not interrupt the flash procedure once you have begun to download the firmware. If the flash procedure is interrupted, the controller will be in a Missing or Corrupt OS state on the next power up.
To recover the controller from a missing/corrupt OS state, see Missing or Corrupt OS state on page 181.

1. Launch the ControlFLASH application under Programs>Flash Programming Tools.
   If the Ethernet connection (IP configuration) has not been established, attach an Ethernet cable to the controller from your computer (or a hub), and ensure that the Ethernet connection is intact throughout the upgrade process.

IMPORTANT If you are connecting to the controller through a hub, you can use a standard Ethernet patch cable.
If you are connecting to the controller directly from your computer, you need to use an Ethernet crossover cable.

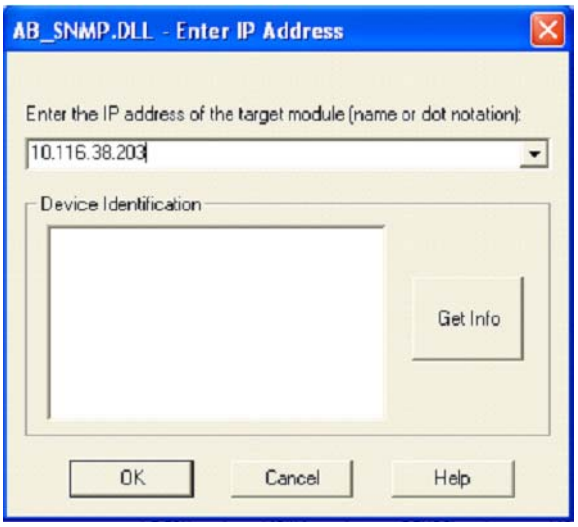
The Welcome to ControlFLASH dialog box is displayed.



2. Click the Next button.
3. Select the appropriate catalog number from the Catalog Number dialog box and click the Next button.



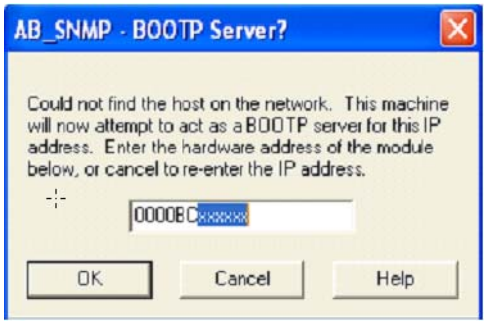
The AB_SNMP.DLL - Enter IP Address dialog box is displayed.



4. Type in the IP address for the processor.

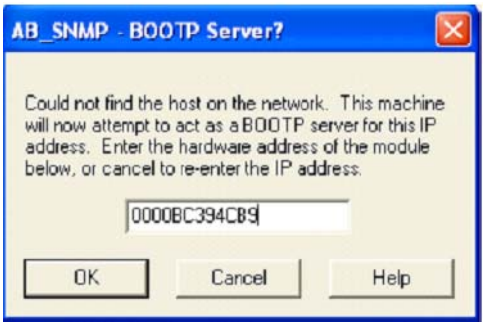
IMPORTANT Use the IP address that was configured earlier, or use an available IP address assigned to by your network administrator.

5. Click the Get Info button. If the IP address was previously configured and the necessary information about the controller is obtained, go to step 9.
6. The AB_SNMP - BOOTP Server dialog box is displayed, indicating that this IP address has not been configured into the processor.

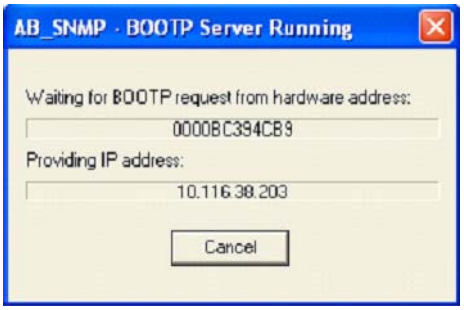


7. Enter the hardware address of the controller that is being upgraded (as noted in step 2 of Prepare the Controller for Firmware Upgrade on page 168) and click the OK button.

For the IP address to be configured using the ControlFLASH BOOTP server, the BOOTP settings should be enabled in the controller, see step 2 of Prepare the Controller for Firmware Upgrade on page 168.

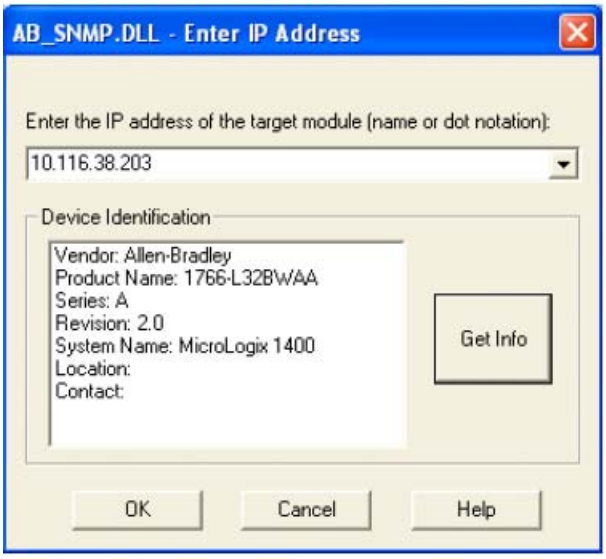


8. The AB_SNMP - BOOTP Server Running dialog box may take several seconds or minutes to appear.

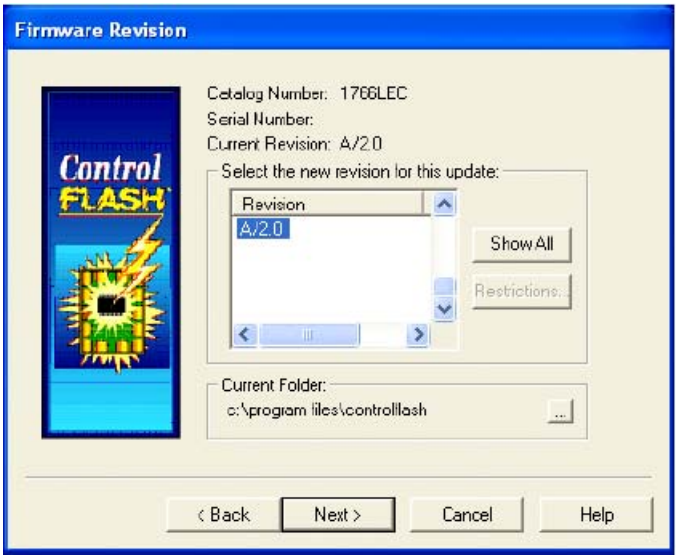


You may need to wait several seconds before you are returned to the AB_SNMP.DLL - Enter IP Address dialog box. Within several seconds, the Device Identification box displays the processor's current revision information.

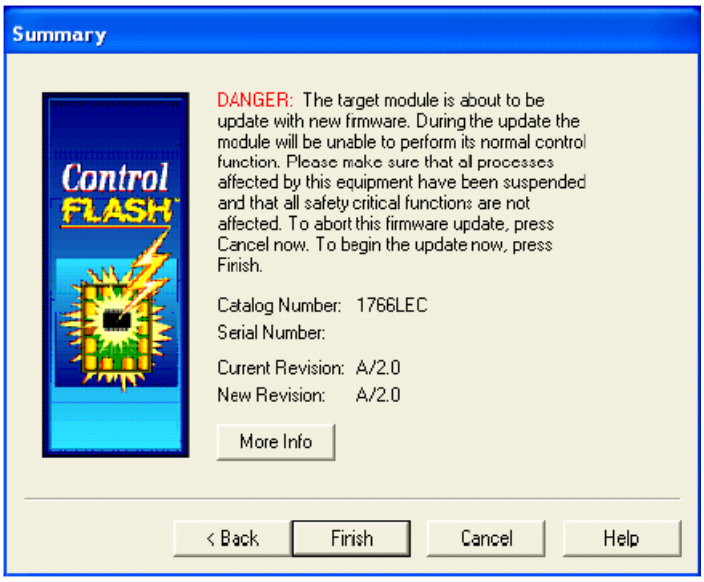
9. Click the OK button.



10. Select the appropriate revision from the Firmware Revision dialog box and click the Next button.



The Summary dialog box is displayed.



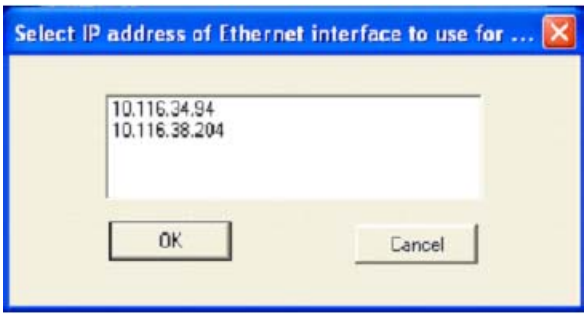
11. Click the Finish button.

    The ControlFLASH dialog box is displayed.



12. Click the Yes button.

    If your computer has more than one Ethernet interface installed, the following dialog box displays the assigned IP addresses of each of the listed Ethernet interfaces. Otherwise, go to step 16.

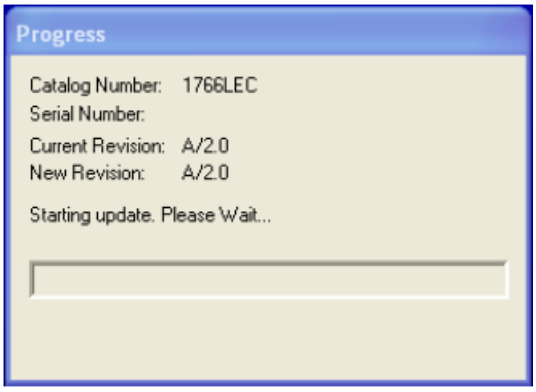


13. Highlight the IP address of the PC Ethernet interface that connects to the Ethernet network hosting the target processor. and click the OK button.

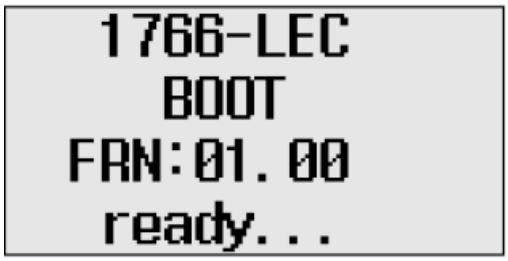
14. You may need to wait several seconds before the Progress dialog box is displayed. (A typical sequence is shown below). While the download is in progress, the RUN LED, FAULT LED and FORCE LED display a Walking Pattern (First RUN LED ON, then FAULT LED ON and then FORCE LED ON in sequence). When the flashing starts the POWER LED and the FORCE LED stay solid ON.

The concurrent ControlFLASH and LCD displays during the Firmware download are shown here.

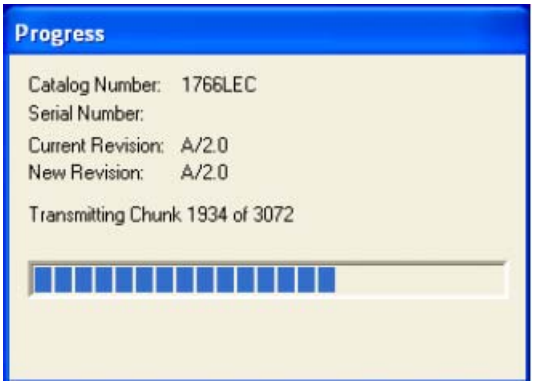
Stage 1



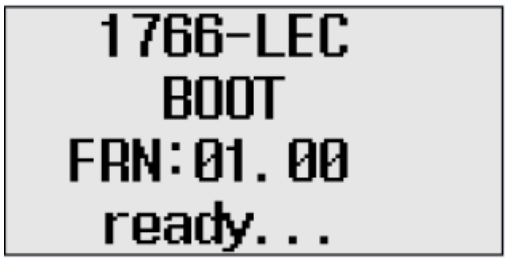
The LCD displays this screen:



Stage 2

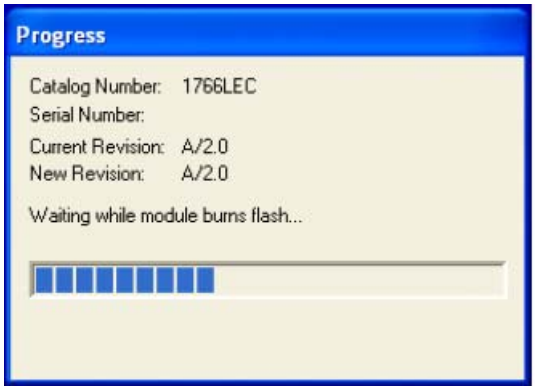


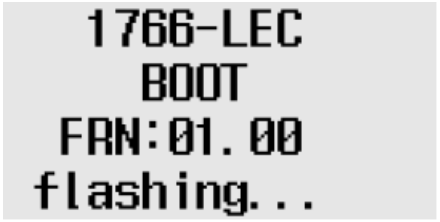
The LCD displays this screen:



The Run, Fault and Force LEDs display a walking Pattern.

Stage 3 The LCD displays this screen:





At this stage the Power and Force LEDs are solid ON.
After flashing of the controller, the LCD shows this screen:

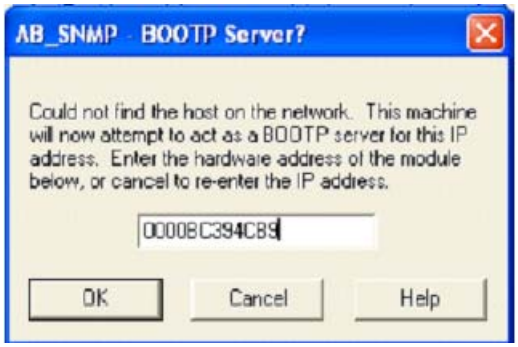


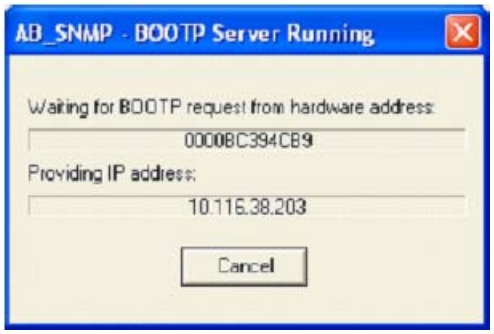
15. After the flashing is complete, the following dialog box prompts you to wait for the controller to reset, verify that the POWER LED is solid GREEN and verify the FAULT LED is turned OFF.



16. Click the OK button.

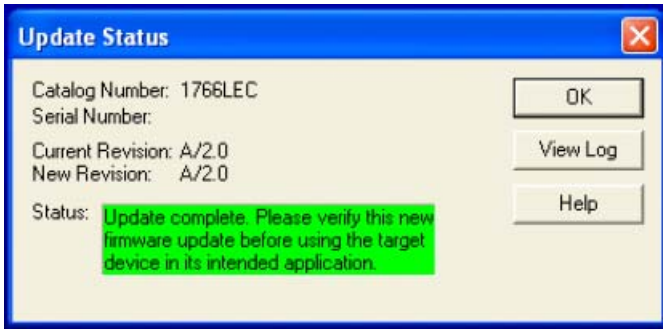
17. Enter the hardware address if prompted. Otherwise, the AB_SNMP - BOOTP Server Running dialog box may appear.



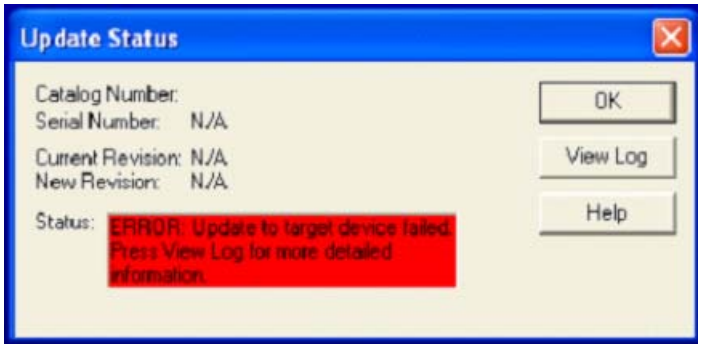


If the AB_SNMP - BOOTP Server Running dialog box appears and if there is no response from the controller for more than 30 seconds, click Cancel.

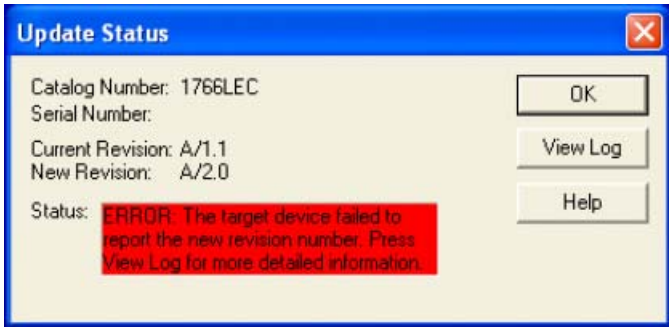
The Update Status dialog box is displayed. If the update was successful, the status text box is green and has an appropriate message.



If the update was not successful, the status text box is red and has an appropriate message.



If the following dialog box appears, it indicates that the controller ended up in a Missing/Corrupt OS state. The current revision number reflects the version of Boot Firmware.
To recover the controller from this state, see Recovering from Missing or Corrupt OS State on page 182.

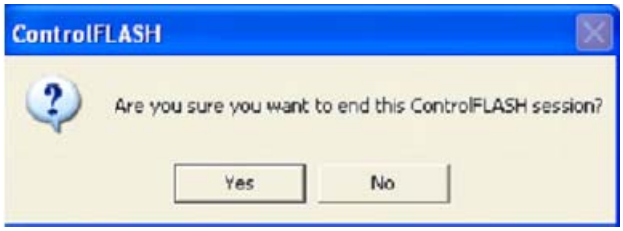


18. Click the OK button. You are returned to the Welcome to ControlFLASH dialog box.



19. You can continue to upgrade additional controllers by clicking the Next button, or exit the program by clicking the Cancel button.

    If you click cancel, you are asked to verify that you want to end the update session.



ControlFLASH Error Messages

The following are error messages you can receive.

- Invalid Catalog Number
- Target Module Not in Proper State for Programming
- Failed to Receive Initial TFTP Request from Target
- Communication error during TFTP transfer

Invalid Catalog Number



This error message is displayed if the ControlFLASH tool is unable to match the processor to the catalog number that was selected in the Catalog Number dialog box.

To clear this error:

1. Click the OK button to go to the Catalog Number dialog box.
2. Select the correct catalog number in the dialog box, and proceed with the update.
3. Restart the firmware upgrade procedure as described in the section Using ControlFLASH for Firmware Upgrade on page 169.

Target Module Not in Proper State for Programming

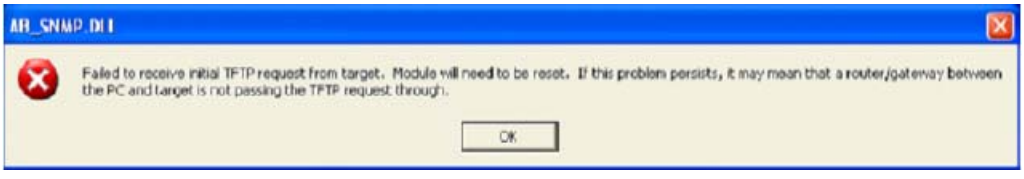


This error message is displayed when the target module is not in a proper state for programming.

To clear this error:

1. Put the controller in the PROGRAM mode.
2. Restart the firmware upgrade procedure as described in the section Using ControlFLASH for Firmware Upgrade on page 169. If the error occurs again, cycle power and restart the firmware upgrade process.

Failed to Receive Initial TFTP Request from Target





This error message is displayed when the initial TFTP request is not received.

To clear this error:

1. Connect the controller's Ethernet port directly to the computer's Ethernet port using a crossover cable, or disable or uninstall any firewall VPN or virus protection software running on the computer.
2. Cycle power to the processor.
3. Restart the firmware upgrade procedure as described in the section Using ControlFLASH for Firmware Upgrade on page 169.

Communication error during TFTP transfer



This error message is displayed when there is a communication error during TFTP transfer.

To clear this error:

1. Check your Ethernet connections are intact.
2. Cycle power to the processor.
3. Restart the firmware upgrade procedure as described in the section Using ControlFLASH for Firmware Upgrade on page 169
4. If the error still persists, connect the controller's Ethernet port directly to the computer's Ethernet port using a crossover cable, and then repeat from step 2.

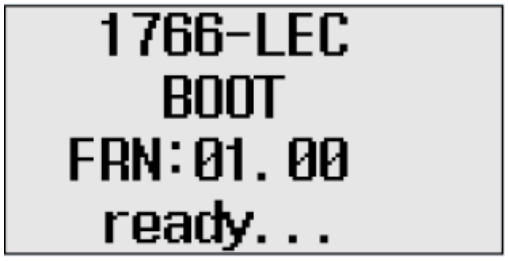
Missing or Corrupt OS state

The Boot Firmware runs the controller in this state.

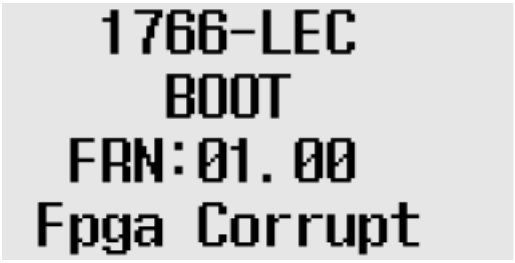
ATTENTION: Do not interrupt the flash procedure, once you have begun to download the firmware. If the flash procedure is interrupted the controller will be in a Missing or Corrupt OS state on the next power up.

When the controller is in this state, the controller shows either one of the following:

- The POWER LED is solid ON and the RUN, FAULT and FORCE LEDs are blinking simultaneously. The LCD shows this information:



- The POWER and FAULT LED are solid ON and the LCD shows this information:



When the LCD displays the Fpga Corrupt information, the LEDs do not show the Walking pattern during the firmware upgrade process.

Recovering from Missing or Corrupt OS State

In order to recover from this controller state, you need to restart the operating system firmware upgrade as described here:

1. Ensure that the Ethernet connections are intact.
   SNMP is enabled by default in the controller.
2. If the IP Address was configured during the Preparing for firmware upgrade stage, the same IP configuration is retained in the controller.
3. Start the Firmware upgrade as explained in Using ControlFLASH for Firmware Upgrade on page 169.

Connecting to Networks via RS-232/RS-485 Interface

The following protocols are supported from the RS-232/485 combo communication channel (Channel 0) and the RS-232 communication channel (Channel 2):

- DF1 Full Duplex
- DF1 Half-Duplex Master/Slave
- DF1 Radio Modem
- DH-485
- Modbus RTU Master/Slave
- ASCII
- DNP3 Slave

RS-232 Communication Interface

The communications port on Channel 0 of the MicroLogix 1400 controller utilizes a combined, isolated RS-232/485 interface. RS-232 and RS-485 are Electronics Industries Association (EIA) standards that specify the electrical and mechanical characteristics for serial binary communication. They provide a variety of system configuration possibilities (RS-232 and RS-485 define electrical connection characteristics, *not* protocols).

The MicroLogix 1400 controller supports an additional, non-isolated RS-232 interface on Channel 2. One of the biggest benefits of an RS-232 interface is that it lets you integrate telephone and radio modems into your control system (using the appropriate DF1 protocol only, not DH-485 protocol), but it is for point-to-point connections only between two devices.

RS-485 Communication Interface

The RS-485 interface supports connection of devices in a multidrop hard-wired configuration using DH-485, DF1-Half Duplex, Modbus, or DNP3 protocols. Also, the RS-485 interface supports connection in a multidrop hard-wired configuration using ASCII protocols.

DF1 Full-Duplex Protocol

DF1 Full-Duplex protocol provides a point-to-point connection between two devices. DF1 Full-Duplex protocol combines data transparency (American National Standards Institute ANSI - X3.28-1976 specification subcategory D1) and 2-way simultaneous transmission with embedded responses (subcategory F1).

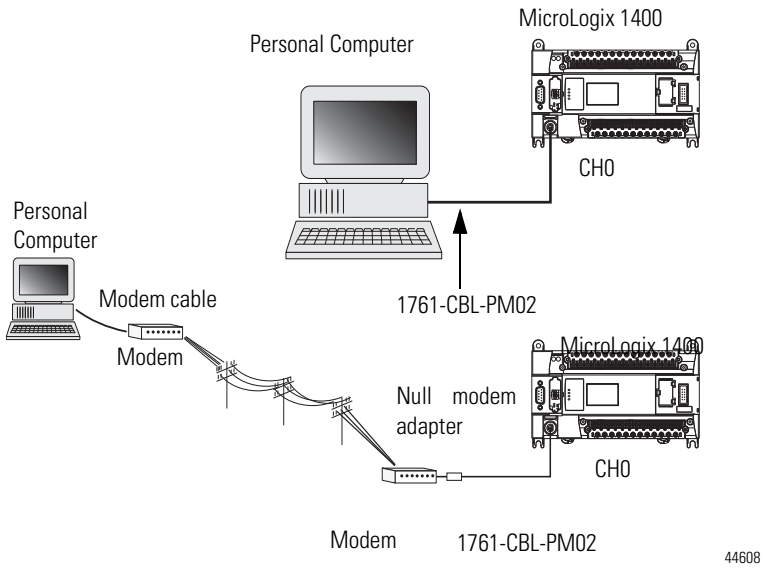
The MicroLogix controller supports the DF1 Full-Duplex protocol via RS-232 connection to external devices, such as computers, or other controllers that support DF1 Full-Duplex.

DF1 is an open protocol. Refer to DF1 Protocol and Command Set Reference Manual, publication 1770-6.5.16, for more information.

DF1 Full-Duplex protocol (also referred to as DF1 point-to-point protocol) is useful where RS-232 point-to-point communication is required. DF1 protocol controls message flow, detects and signals errors, and retries if errors are detected.

Example DF1 Full-Duplex Connections

For information about required network connecting equipment, see Chapter 4, Communication Connections.



DF1 Half-Duplex Protocol

DF1 Half-Duplex protocol is a multi-drop single master/multiple slave network. DF1 Half-Duplex protocol supports data transparency (American National Standards Institute ANSI - X3.28-1976 specification subcategory D1). In contrast to DF1 Full-Duplex, communication takes place in one direction at a time. You can use the RS-232/485 port on the MicroLogix as both a Half-Duplex programming port and a Half-Duplex peer-to-peer messaging port.

DF1 Half-Duplex Operation

A DF1 Half-Duplex master device initiates all communication by “polling” each slave device. The slave device may only transmit when it is polled by the master. It

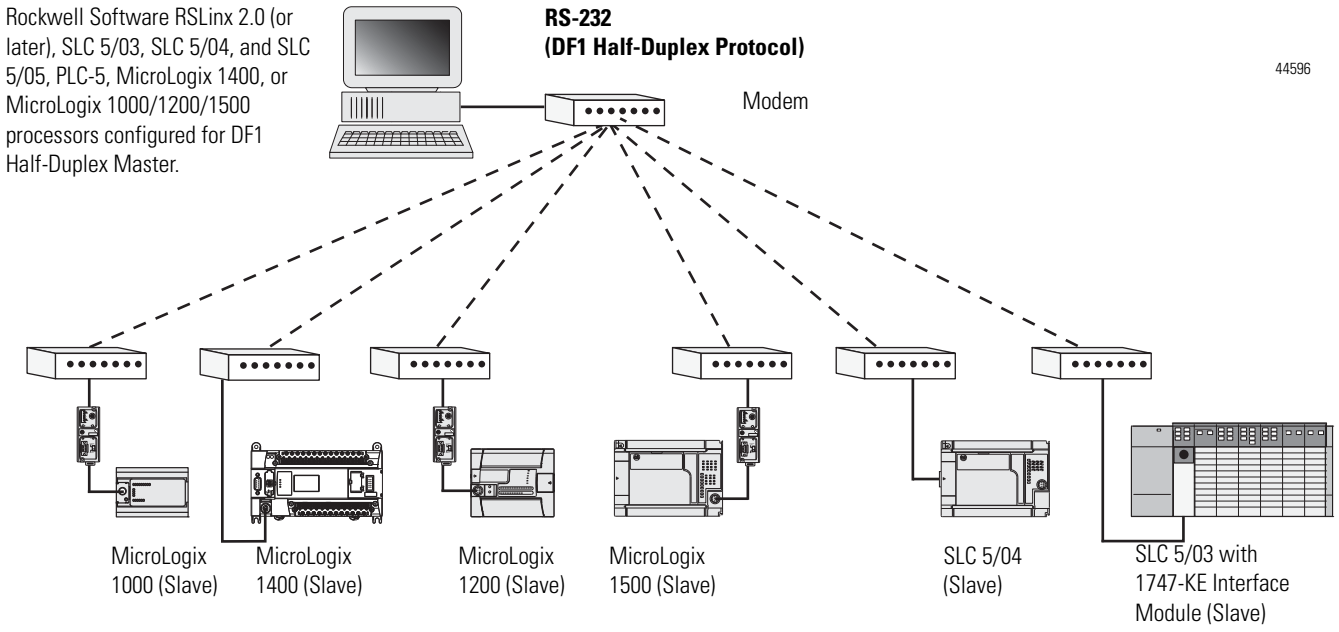
is the master's responsibility to poll each slave on a regular and sequential basis to allow slave devices an opportunity to communicate.

An additional feature of the DF1 Half-Duplex protocol is that it is possible for a slave device to enable a MSG write or read to/from another slave. When the initiating slave is polled, the MSG is sent to the master. The master recognizes that the message is not intended for it, but for another slave, so the master immediately forwards the message to the intended slave. The master does this automatically; you do not need to program the master to move data between slave nodes. This slave-to-slave transfer can also be used by programming software to allow slave-to-slave upload and download of programs to processors (including the master) on the DF1 Half-Duplex link.

MicroLogix 1400 can act as the master or as a slave on a Half-Duplex network. When the MicroLogix 1400 is a slave device, a master device is required to "run" the network. Several other Allen-Bradley products support DF1 Half-Duplex master protocol. They include the SLC 5/03™ and higher processors, enhanced PLC-5 processors, MicroLogix 1200/1500 and Rockwell Software RSLinx (version 2.x and higher).

DF1 Half-Duplex supports up to 255 devices (address 0 to 254) with address 255 reserved for master broadcasts. As a DF1 Half-Duplex slave device, the MicroLogix supports broadcast reception. As a DF1 Half-Duplex master, the MicroLogix 1400 supports both the reception and initiation of broadcast write commands (via the MSG instruction). The MicroLogix also supports Half-Duplex modems using RTS/CTS hardware handshaking.

Example DF1 Half-Duplex Connections



Considerations When Communicating as a DF1 Slave on a Multi-drop Link

When communication is between either your programming software and a MicroLogix Programmable Controller or between two MicroLogix 1400 Programmable Controllers via slave-to-slave communication on a larger multi-drop link, the devices depend on a DF1 Half-Duplex Master to give each of them access in a timely manner. As the number of slave devices increase, the time between when slave devices are polled also increases. This increase in time may also be large if you are using low baud rates. As these time periods grow, you may need to increase the poll timeout and reply timeout values for slave devices.

IMPORTANT	If a program download is started when using DF1 Half-Duplex, but then is interrupted due to electromagnetic interference or other events, discontinue communications to the controller for the *ownership timeout* period and then restart the program download. The *ownership timeout* period is 60 seconds. After the timeout, you can re-establish communications with the processor and try the program download again. The only other way to remove program ownership is to cycle power on the processor.

Using Modems with MicroLogix Programmable Controllers

The types of modems you can use with MicroLogix controllers include the following:

- dial-up phone modems.
  A MicroLogix controller, on the receiving end of the dial-up connection, can be configured for DF1 Full-Duplex protocol with or without handshaking. The modem connected to the MicroLogix controller should support auto-answer. The MicroLogix 1400 supports ASCII out communications. Therefore, it can cause a modem to initiate or disconnect a phone call.

- leased-line modems.
  Leased-line modems are used with dedicated phone lines that are typically leased from the local phone company. The dedicated lines may be in a point-to-point topology supporting Full-Duplex communications between two modems or in a multi-drop topology supporting Half-Duplex communications between three or more modems.

- radio modems.
  Radio modems may be implemented in a point-to-point topology supporting either Half-Duplex or Full-Duplex communications, or in a multi-drop topology supporting Half-Duplex communications between three or more modems. MicroLogix 1400 also supports DF1 Radio Modem protocol.

- line drivers.
  Line drivers, also called short-haul modems, do not actually modulate the serial data, but rather condition the electrical signals to operate reliably over long transmission distances (up to several miles). Line drivers are available in Full-Duplex and Half-Duplex models. Allen-Bradley's AIC+ Advanced Interface Converter is a Half-Duplex line driver that converts an RS-232 electrical signal into an RS-485 electrical signal, increasing the signal transmission distance from 50 to 4000 feet (8000 feet when bridged).

For point-to-point Full-Duplex modem connections that do not require any modem handshaking signals to operate, use DF1 Full-Duplex protocol with no handshaking. For point-to-point Full-Duplex modem connections that require RTS/CTS handshaking, use DF1 Full-Duplex protocol with handshaking.

For radio modem connections, use DF1 Radio Modem protocol, especially if store and forward capability is required.

For general multi-drop modem connections, or for point-to-point modem connections that require RTS/CTS handshaking, use DF1 Half-Duplex slave protocol. In this case, one (and only one) of the other devices must be configured for DF1 Half-Duplex master protocol.

IMPORTANT	Never attempt to use DH-485 protocol through modems under any circumstance.

TIP	All MicroLogix controllers support RTS/CTS modem handshaking when configured for DF1 Full-Duplex protocol with the control line parameter set to Full-Duplex Modem Handshaking or DF1 Half-Duplex slave protocol with the control line parameter set to "Half-Duplex Modem". MicroLogix 1400 controllers also support DCD (Data Carrier Detect) line for DF1 Radio Modem protocol. For other protocols, you can only access the DCD signal from your ladder logic. No other modem handshaking lines (such as Data Set Ready and Data Terminal Ready) are supported by MicroLogix 1400 controller.

DH-485 Communication Protocol

The DH-485 protocol defines the communication between multiple devices that coexist on a single pair of wires. DH-485 protocol uses RS-485 Half-Duplex as its physical interface. (RS-485 is a definition of electrical characteristics; it is *not* a protocol.) RS-485 uses devices that are capable of co-existing on a common data circuit, thus allowing data to be easily shared between devices.

The DH-485 network offers:

- interconnection of 32 devices
- multi-master (peer-to-peer) capability
- token passing access control
- the ability to add or remove nodes without disrupting the network

- maximum network segment of 1,219 m (4,000 ft.)

The DH-485 protocol supports two classes of devices: initiators and responders. All initiators on the network get a chance to initiate message transfers. To determine which initiator has the right to transmit, a token passing algorithm is used.

Control of message transfers on the DH-485 network is performed by rotating the token along the nodes on the network. A node holding the token can send a message onto the network. Each node is allowed a fixed number of transmissions (based on the Token Hold Factor) each time it receives the token. After a node sends a message, it passes the token to the next device.

The allowable range of node addresses is 1...31. There must be at least one initiator on the network (such as a MicroLogix controller, or an SLC 5/02 or later processor).

DH-485 Configuration Parameters

When MicroLogix communications are configured for DH-485, the following parameters can be changed:

DF1 Full-Duplex Configuration Parameters

Parameter	Options
Baud Rate	9600, 19.2K
Node Address	1…31 decimal
Token Hold Factor	1…4

See Software Considerations on page 191 for tips on setting the parameters listed above.

Devices that use the DH-485 Network

In addition to the MicroLogix controllers, the devices shown in the following table also support the DH-485 network .

Devices that Support DH-45 Network

Catalog Number	Description	Installation	Function	Publication
Bulletin 1761 Controllers	MicroLogix 1000	Series C or later	These controllers support DH-485 communications.	1761-6.3
Bulletin 1762	MicroLogix 1200	Series A or later	These controllers support DH-485 communications.	1762-UM001
Bulletin 1763	MicroLogix 1100	Series A or later	These controllers support DH-485 communications.	1763-UM001
Bulletin 1764	MicroLogix 1500	Series A or later	These controllers support DH-485 communications.	1764-UM001
Bulletin 1747 Processors	SLC 500 Processors	SLC Chassis	These processors support a variety of I/O requirements and functionality.	1747-UM011

Devices that Support DH-45 Network

Catalog Number	Description	Installation	Function	Publication
1746-BAS	BASIC Module	SLC Chassis	Provides an interface for SLC 500 devices to foreign devices. Program in BASIC to interface the 3 channels (2 RS232 and 1 DH-485) to printers, modems, or the DH-485 network for data collection.	1746-UM004 1746-PM001 1746-RM001
2760-RB	Flexible Interface Module	(1771) PLC Chassis	Provides an interface for SLC 500 (using protocol cartridge 2760-SFC3) to other A-B PLCs and devices. Three configurable channels are available to interface with Bar Code, Vision, RF, Dataliner™, and PLC systems.	1747-6.12 2760-ND001
1784-PKTX, -PKTXD	PC DH-485 IM	PCI Computer Bus	Provides DH-485 using RSLinx.	1784-6.5.22
1784-PCMK	PCMCIA IM	PCMCIA slot in computer	Provides DH-485 using RSLinx.	1784-UM519
2711-K5A2, -B5A2, -K5A5, -B5A5, -K5A1, -B5A1, -K9A2, -T9A2, -K9A5, -T9A5, -K9A1, and -T9A1	PanelView 550 and PanelView 900 Operator Terminals	Panel Mount	Provides electronic operator interface for SLC 500 processors.	2711-UM014

Important DH-485 Network Planning Considerations

Carefully plan your network configuration before installing any hardware. Some of the factors that can affect system performance are:

- amount of electrical noise, temperature, and humidity in the network environment.
- number of devices on the network.
- connection and grounding quality in installation.
- amount of communication traffic on the network.
- type of process being controlled.
- network configuration.

The major hardware and software issues you need to resolve before installing a network are discussed in the following sections.

Hardware Considerations

You need to decide the length of the communication cable, where you route it, and how to protect it from the environment where it will be installed.

When the communication cable is installed, you need to know how many devices are to be connected during installation and how many devices will be added in the future. The following sections help you understand and plan the network.

Number of Devices and Length of Communication Cable

The maximum length of the communication cable is 1219 m (4000 ft). This is the total cable distance from the first node to the last node in a segment. However, two segments can be used to extend the DH-485 network to 2438 m

(8000 ft.). For additional information on connections using the AIC+, refer to the Advanced Interface Converter (AIC+) User Manual, publication 1761-6.4.

Planning Cable Routes

Follow these guidelines to help protect the communication cable from electrical interference:

- Keep the communication cable at least 1.52 m (5 ft.) from any electric motors, transformers, rectifiers, generators, arc welders, induction furnaces, or sources of microwave radiation.
- If you must run the cable across power feed lines, run the cable at right angles to the lines.
- If you do not run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.15 m (6 in.) from AC power lines of less than 20 A, 0.30 m (1 ft.) from lines greater than 20 A, but only up to 100K VA, and 0.60 m (2 ft.) from lines of 100 K VA or more.
- If you run the cable through a contiguous metallic wireway or conduit, keep the communication cable at least 0.08 m (3 in.) from AC power lines of less than 20 A, 0.15 m (6 in.) from lines greater than 20 A, but only up to 100 K VA, and 0.30 m (1 ft.) from lines of 100 K VA or more.

  Running the communication cable through conduit provides extra protection from physical damage and electrical interference. If you route the cable through conduit, follow these additional recommendations:
  - Use ferromagnetic conduit near critical sources of electrical interference. You can use aluminum conduit in non-critical areas.
  - Use plastic connectors to couple between aluminum and ferromagnetic conduit. Make an electrical connection around the plastic connector (use pipe clamps and the heavy gauge wire or wire braid) to hold both sections at the same potential.
  - Ground the entire length of conduit by attaching it to the building earth ground.
  - Do not let the conduit touch the plug on the cable.
  - Arrange the cables loosely within the conduit. The conduit should contain only serial communication cables.
  - Install the conduit so that it meets all applicable codes and environmental specifications.

For more information on planning cable routes, see *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1.

Software Considerations

Software considerations include the configuration of the network and the parameters that can be set to the specific requirements of the network. The following are major configuration factors that have a significant effect on network performance:

- number of nodes on the network
- addresses of those nodes
- baud rate

The following sections explain network considerations and describe ways to select parameters for optimum network performance (speed). See your programming software's user manual for more information.

Number of Nodes

The number of nodes on the network directly affects the data transfer time between nodes. Unnecessary nodes (such as a second programming terminal that is not being used) slow the data transfer rate. The maximum number of nodes on the network is 32.

Setting Node Addresses

The best network performance occurs when node addresses are assigned in sequential order. Initiators, such as personal computers, should be assigned the lowest numbered addresses to minimize the time required to initialize the network. The valid range for the MicroLogix controllers is 1...31 (controllers cannot be node 0). The default setting is 1. The node address is stored in the controller Communications Status file (CS0:5/0 to CS0:5/7).

Setting Controller Baud Rate

The best network performance occurs at the highest baud rate, which is 19,200. This is the default baud rate for a MicroLogix device on the DH-485 network. All devices must be at the same baud rate. This rate is stored in the controller Communications Status file (CS0:5/8 to CS0:5/15).

Setting Maximum Node Address

Once you have an established network set up and are confident that you will not be adding more devices, you may enhance performance by adjusting the maximum node address of your controllers. It should be set to the highest node address being used.

IMPORTANT All devices should be set to the same maximum node address.

MicroLogix Remote Packet Support

MicroLogix controllers can respond and initiate with communications (or commands) that do not originate on the local DH-485 network. This is useful in installations where communication is needed between DH-485 and DH+ networks.

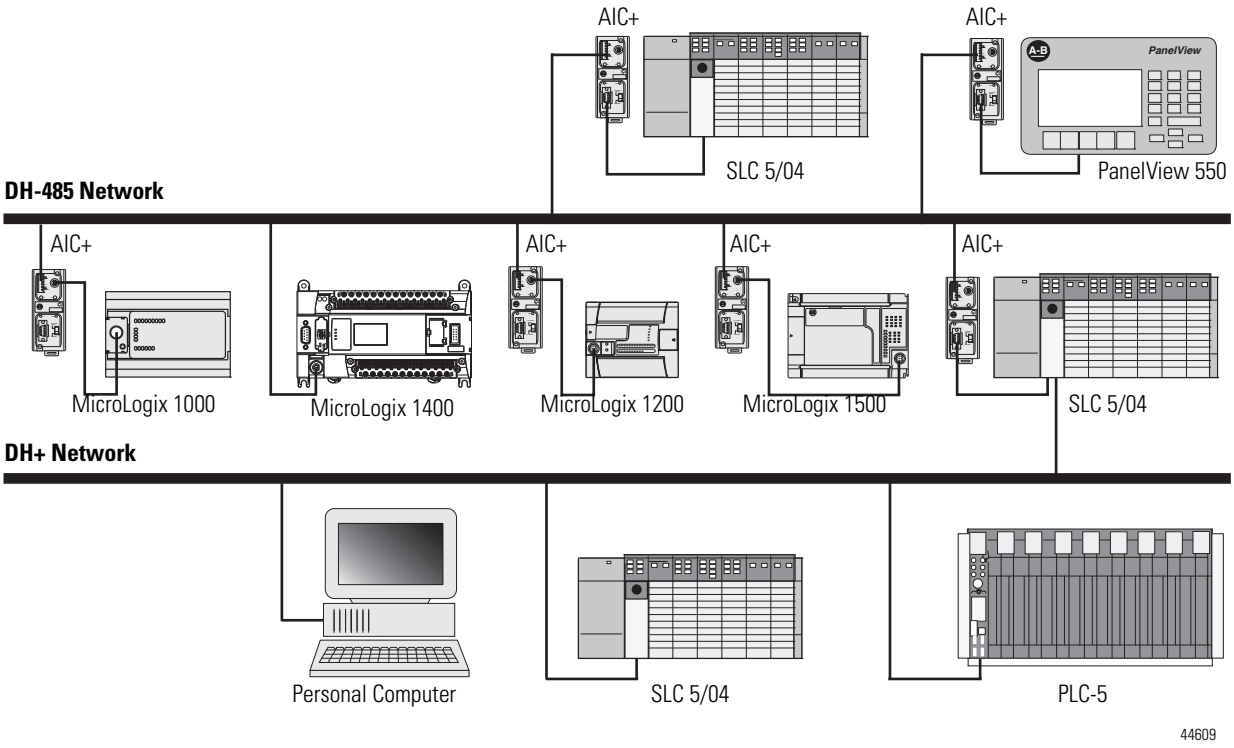
The example below shows how to send messages from a device on the DH+ network to a MicroLogix controller on the DH-485 network. This method uses an SLC 5/04 processor as the bridge connection.

When using this method (as shown in the illustration below):

- PLC-5 devices can send read and write commands to MicroLogix controllers.
- MicroLogix controllers can respond to MSG instructions received.
- The MicroLogix controllers can initiate MSG instructions to devices on the DH+ network.
- PC can send read and write commands to MicroLogix controllers.
- PC can do remote programming of MicroLogix controllers.

TIP Use a 1763-NC01 Series A or later cable to connect a MicroLogix 1400 controller to a DH-485 network.

You can connect a MicroLogix 1400 controller to your DH-485 network directly without using a RS-232 to RS-485 converter and optical isolator, such as the AIC+, catalog number 1761-NET-AIC, as shown in the illustration below, because Channel 0 has isolation and RS-485 built-in.

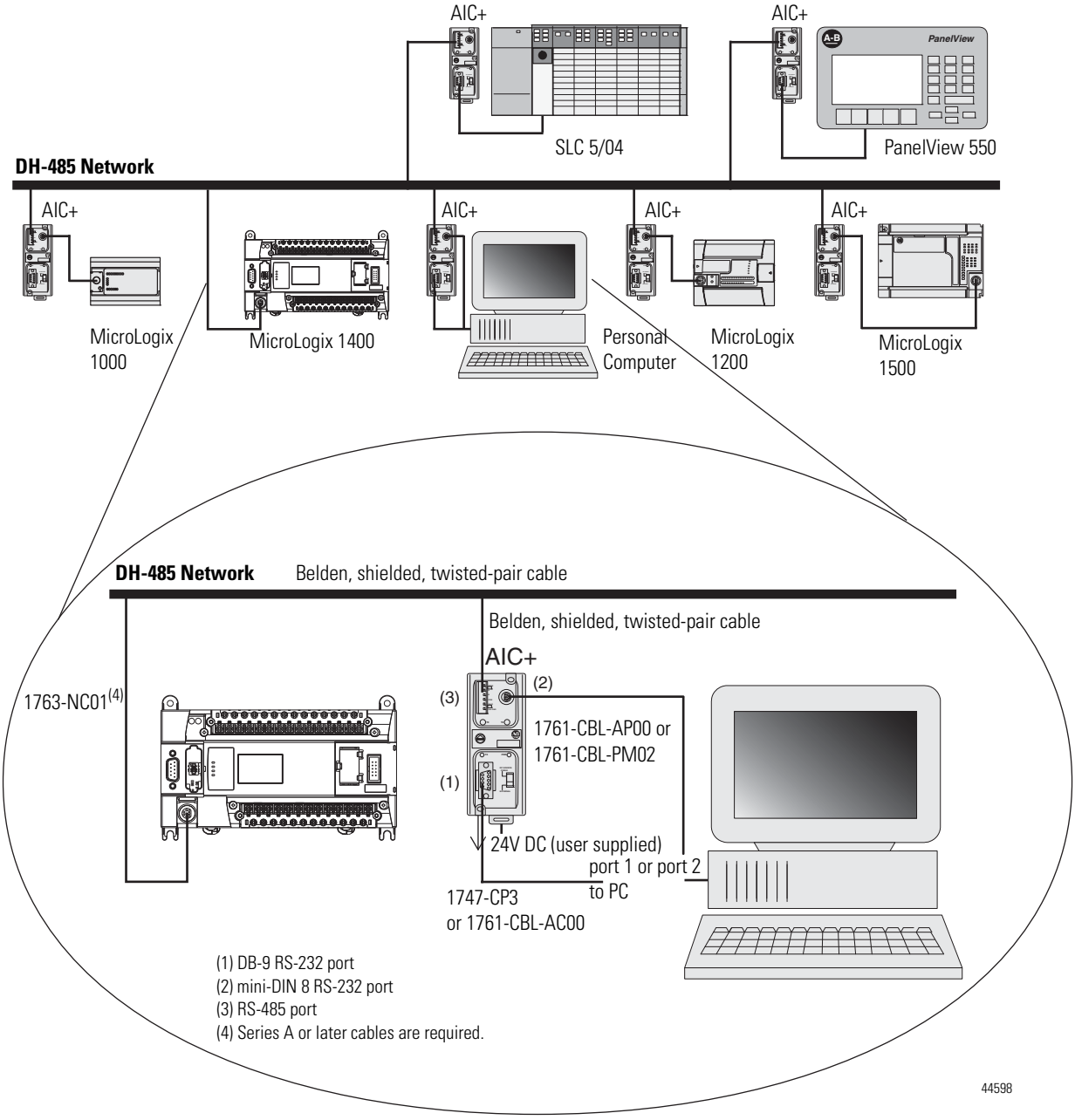


Example DH-485 Connections

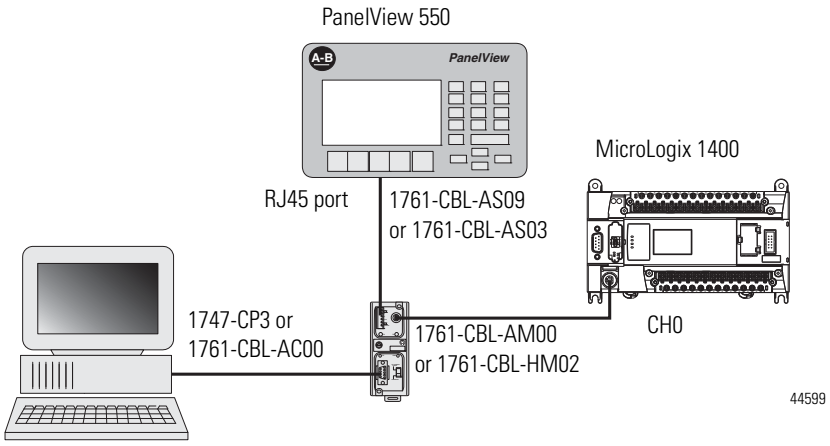
The following network diagrams provide examples of how to connect MicroLogix controllers to the DH-485 network. You can connect a MicroLogix 1400 controller to your DH-485 network directly without using a RS-232 to RS-485 converter and optical isolator, such as the Advanced Interface Converter (AIC+), catalog number 1761-NET-AIC, as shown in the illustrations below, because Channel 0 has isolation and RS-485 built-in.

However, you may need to use an AIC+ to connect Channel 2 of the MicroLogix 1400 controller to a DH-485 network. For more information on the AIC+, see the Advanced Interface Converter and DeviceNet Interface Installation Instructions, Publication 1761-5.11.

DH-485 Network with a MicroLogix *Controller*



Typical 3-Node Network



TIP This 3-node network is not expandable.

Modbus Communication Protocol

Modbus is a Half-Duplex, master-slave communications protocol. The Modbus network master reads and writes coils and registers. Modbus protocol allows a single master to communicate with a maximum of 247 slave devices. MicroLogix 1400 controllers support Modbus RTU Master and Modbus RTU Slave protocol.

For more information on configuring your MicroLogix 1400 controller for Modbus protocol, refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001. For more information about the Modbus protocol, see the Modbus Protocol Specifications (available from http://www.modbus.org).

ASCII

ASCII provides connection to other ASCII devices, such as bar code readers, weigh scales, serial printers, and other intelligent devices.

You can use ASCII by configuring the RS-232/485 port, channel 0 and the RS-232 port, Channel 2 for the ASCII driver. Refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001 for detailed configuration information.

Distributed Network Protocol (DNP3)

For more information on configuring your MicroLogix 1400 controller for Distributed Network Protocol, see Channel Configuration for DNP3 Slave on page 197. For more information about Distributed Network Protocol, see the Distributed Network Protocol Specifications, available from http://www.dnp.org.

Notes:

MicroLogix 1400 Distributed Network Protocol (DNP3)

This appendix:

- describes the MicroLogix 1400 Distributed Network Protocol (DNP3).
- describes the procedures used to program and troubleshoot DNP3 protocol in the controller.
- gives an overview of the DNP3 implementation in the controller
- shows application examples of DNP3 applications.

Channel Configuration for DNP3 Slave

The default communication protocol for the serial ports Channel 0 and Channel 2 in the MicroLogix 1400 is DF1 Full-Duplex. To communicate with DNP3 protocol, the channel must be configured to DNP3 protocol.

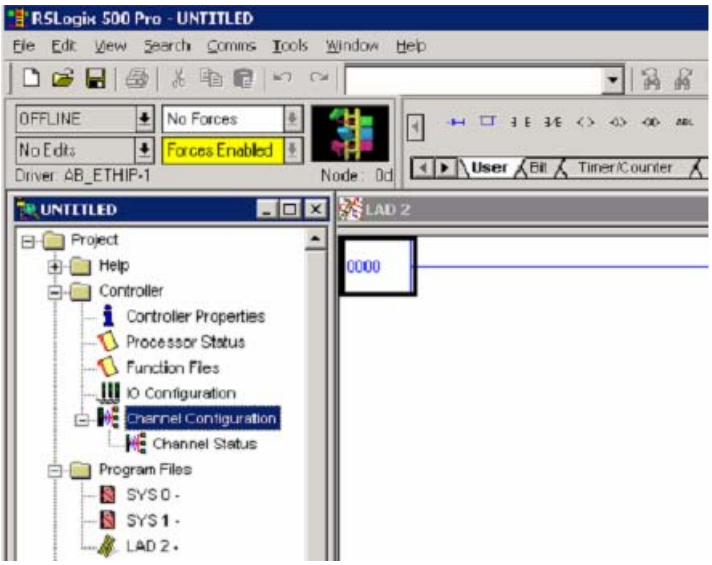
The default communication protocol for the Ethernet Channel 1 in the MicroLogix 1400 is Ethernet/IP. To communicate with DNP3 over IP protocol in the MicroLogix 1400 Series B controller, the channel must be configured to use the DNP3 protocol.

The MicroLogix 1400 Series A controller supports DNP3 protocol via Channel 0 and/or Channel 2 Serial ports.

The MicroLogix 1400 Series B controller also supports DNP3 over IP protocol via Channel 1 Ethernet port.

To program the MicroLogix 1400 controller, use RSLogix 500/RSLogix Micro software, version 8.10.00 or later for Series A controller and version 8.30.00 or later for Series B controller.

In RSLogix 500/RSLogix Micro, open Channel Configuration in the MicroLogix 1400 project tree.

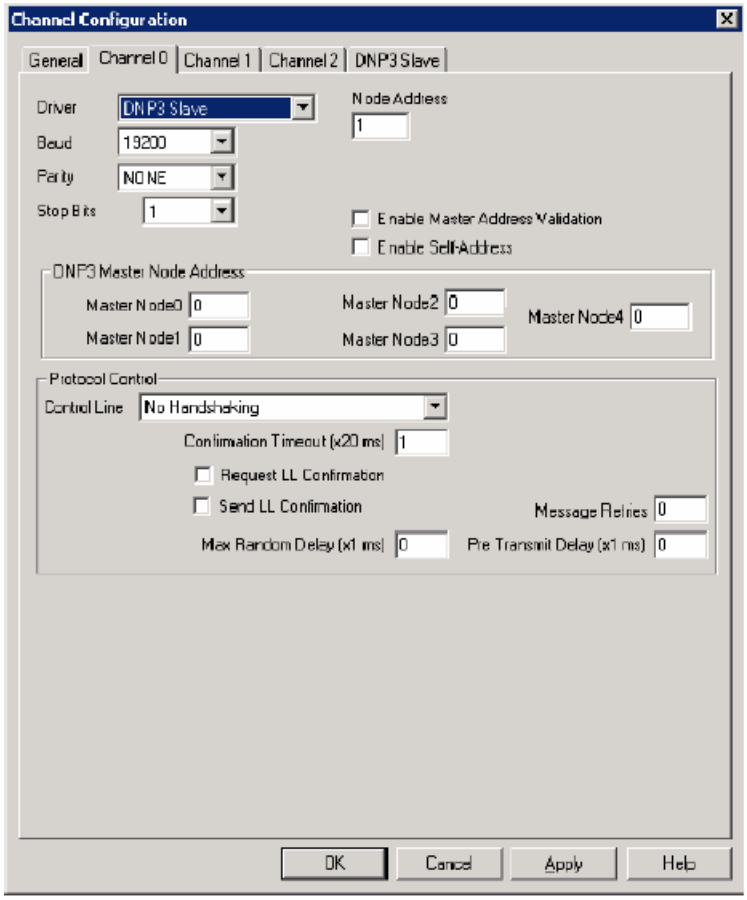


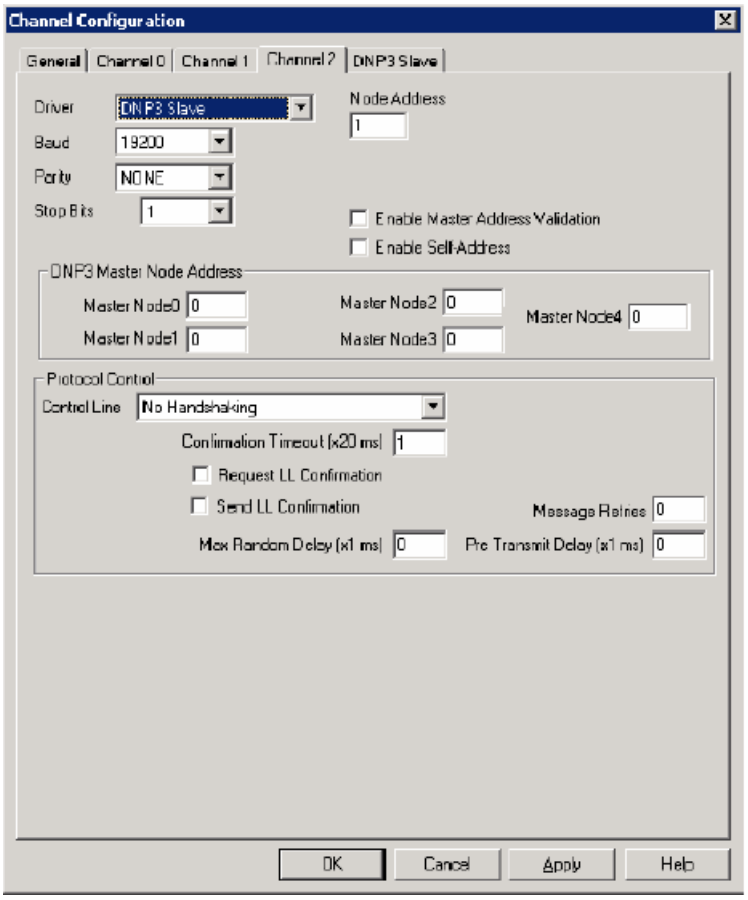
There are 4 configurations related to DNP3 protocol in RSLogix 500/RSLogix Micro software:

- Channel 0 configuration
- Channel 2 configuration
- Channel 1 configuration
- DNP3 Slave Application Layer configuration.

Channel 0 and Channel 2 Link Layer Configuration

Link Layer related configuration can be done in the Channel 0 and/or Channel 2 tab.



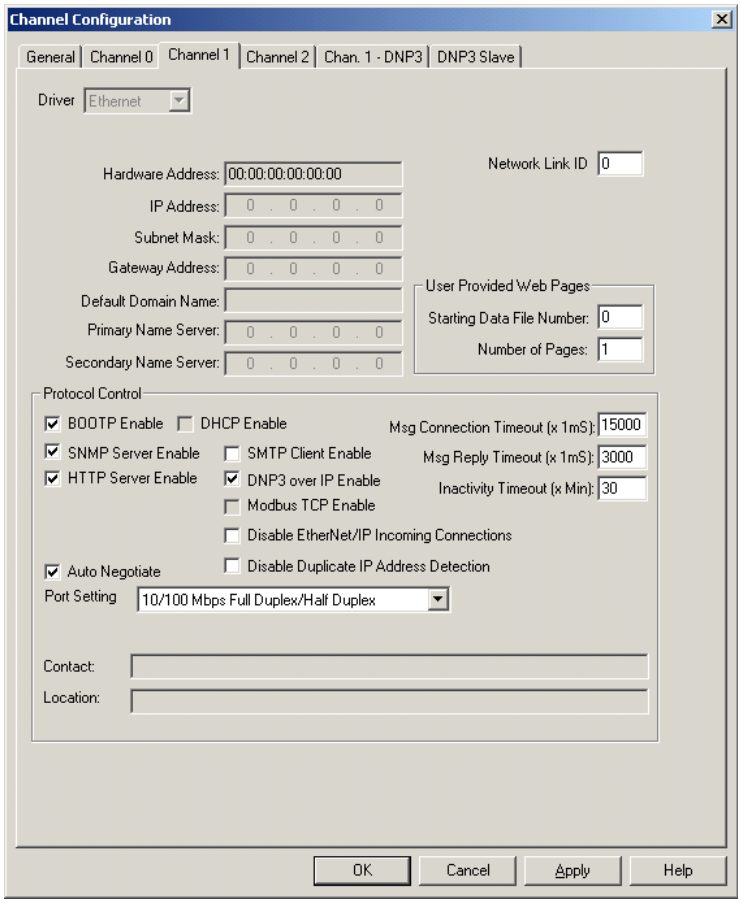


Channel 1 Link Layer Configuration

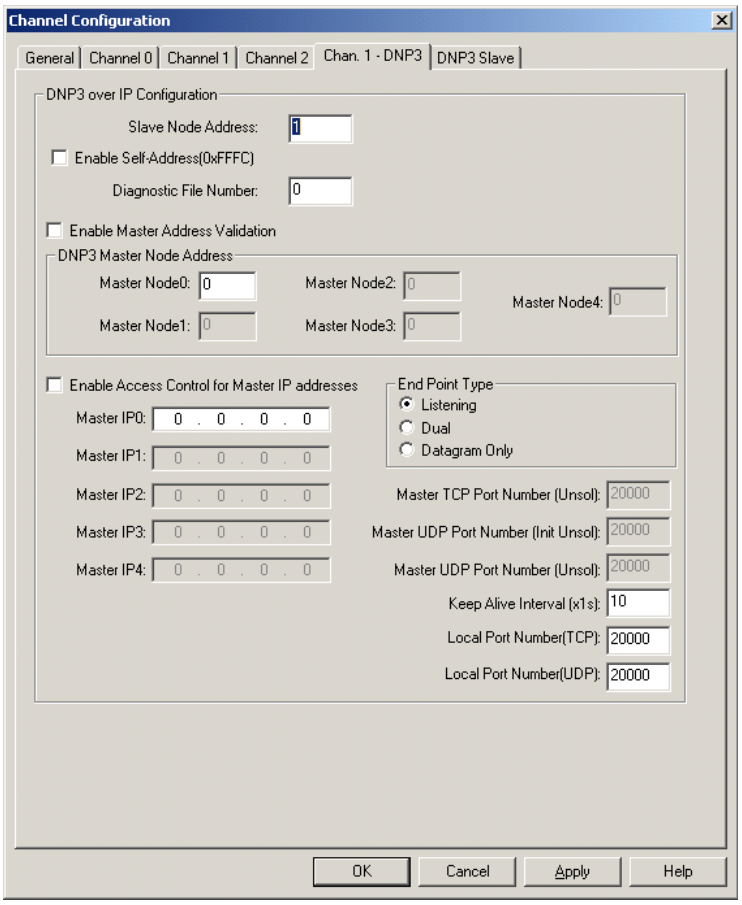
In RSLogix 500/RSLogix Micro, open Channel Configuration in the MicroLogix 1400 Series B project tree.

To enable DNP3 over IP protocol, check DNP3 over IP Enable in the Channel 1 configuration.

Unlike serial port configuration, cycle power to the controller after downloading the Ethernet port configuration to enable the DNP3 over IP feature.



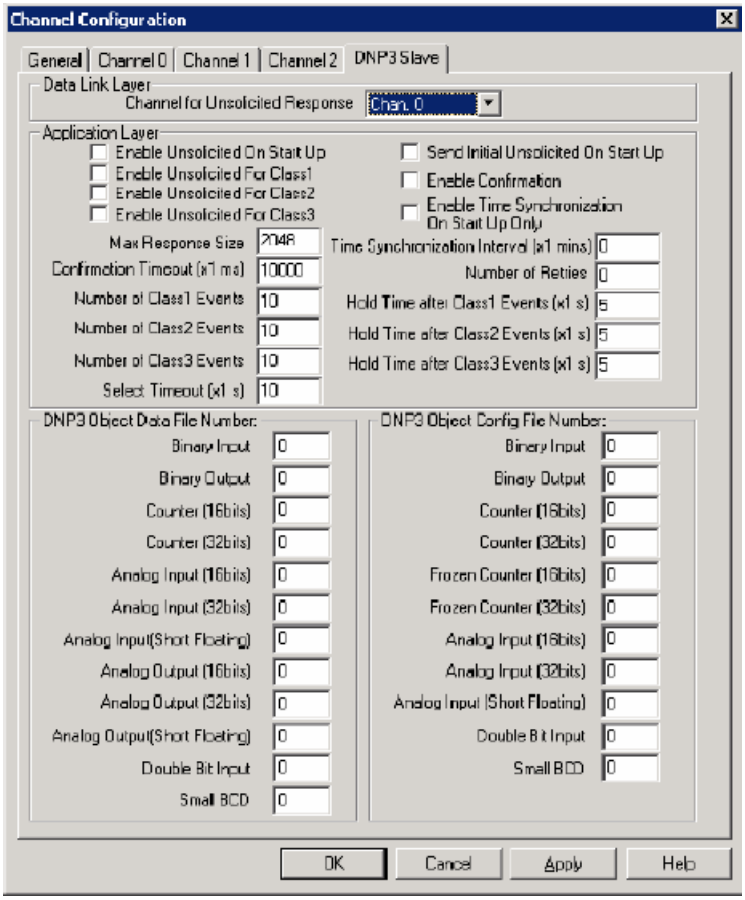
Link Layer related configuration can also be done in the Chan. 1 - DNP3 tab.



DNP3 Slave Application Layer Configuration

Application Layer related configuration can be done in the DNP3 Slave tab.

For the MicroLogix 1400 Series A controllers, you can see the following tabs.



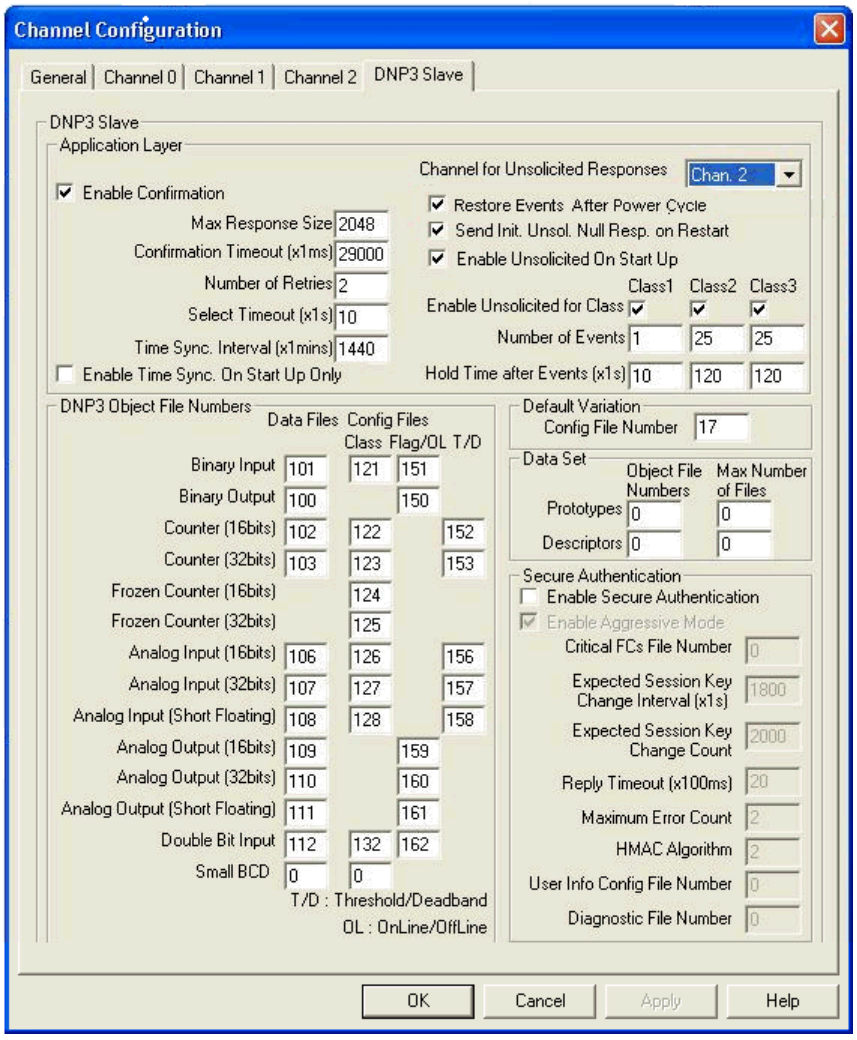
If you want to communicate with DNP3 protocol using Channel 0 port, both Channel 0 and DNP3 Slave configurations should be set. If you want to communicate with DNP3 protocol using Channel 2 port, Channel 2 and DNP3 Slave configurations should be set.

If you want to communicate with DNP3 protocol using both Channel 0 port and Channel 2 port, Channel 0, Channel 2 and DNP3 Slave configurations should be set.

In this case, the channel which is directed in DNP3 Slave configuration supports full functionality. But, the other port supports limited functionality and it does not support some features like Unsolicited Response.

DNP3 Slave configuration is shared by both Channel 0 and Channel 2 ports if the Channel 0 and Channel 2 are configured to DNP3 protocol. Any changes in DNP3 Slave configuration tab will affect both channels.

For the MicroLogix 1400 Series B controllers, you can see the following tabs.



DNP3 Slave configuration is shared by Channel 0, Channel 1 and Channel 2 ports if Channels 0, 1 and 2 are configured for DNP3 protocol. Any changes in the DNP3 Slave configuration tab will affect all channels.

Channel 0 and Channel 2 Link Layer Configuration Parameters

Driver

This selection should be set to DNP3 Slave to communicate with DNP3 protocol.

Node Address

This value is a node address of this DNP3 Slave.
The valid range is 0 to 65519.
Default value is 1.

Baud

The selections can be "38.4 K", "19200", "9600", "4800", "2400", "1200", "600", and "300".
Default selection is "19200".

Parity

The selections can be "NONE", "EVEN", and "ODD". Default selection is "NONE".

Stop Bits

The selections can be "1", "1.5", and "2".
Default selection is "1".

Enable Master Address Validation

Valid selections are Enabled(Checked) and Disabled(Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled(Unchecked), the MicroLogix 1400 accepts the requests from any DNP3 Master.

When the selection is Enabled(Checked), the MicroLogix 1400 accepts the requests only from the DNP3 Master which is configured in the Master Node0 to Master Node4. The maximum number of Master Node Addresses for the Master Address Validation is 5.

Enable Self-Address

Valid selections are Enabled(Checked) and Disabled(Unchecked). Default value is Disabled (Unchecked).

When this bit is Disabled(Unchecked), any packets which contain the destination address 65532(FFFCh) are ignored.

When this bit is Enabled(Checked), any packets which contain the destination address 65532(FFFCh) are accepted and processed.

Master Node0

This value is used to:

- validate the Master node address when the Enable Master Address Validation is Enabled (Checked)
- send Unsolicited Response when Unsolicited Response functionality is enabled. An Unsolicited Response is sent out to the DNP3 Master having this address.

The valid range is 0 to 65519. Default value is 0.

Master Node1, Master Node2, Master Node3, Master Node4

The valid range is 0 to 65519. Default value is 0.

This value is used to check validation for Master node address when Enable Master Address Validation is Enabled (Checked).

Control

For Channel 0, the selections can be No Handshaking, Half Duplex Modem(CTS/RTS handshaking) and No Handshaking (485 Network). Default selection is No Handshaking.

For Channel 2, the selections can be No Handshaking, and Half Duplex Modem(CTS/RTS handshaking).
Default selection is No Handshaking.

When the MicroLogix 1400 is connected to DNP3 Master using RS-232 line directly, you must select No Handshaking. If you want to use the Modem line in a half duplex network, you must select Half Duplex Modem(CTS/RTS handshaking). If the MicroLogix 1400 is connected to an RS-485 network and a 1763-NC01 cable is used, you must select No Handshaking (485 Network).

If you want to send an ASCII string via a serial channel which is configured to DNP3 Slave protocol, use AWA and AWT instructions to control the Modem.

For Cabling and Connections, see Communication Connections on page 59.

For AWA and AWT instructions, refer to the MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, 1766-RM001.

Request LL Confirmation

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), Primary Frames from the MicroLogix 1400 are sent out with the function code FC_UNCONFIRMED_USER_DATA (4).

When the selection is Enabled (Checked), Primary Frames from the MicroLogix 1400 are sent out with the function code FC_CONFIRMED_USER_DATA (3). In this case, the MicroLogix 1400 waits for the confirmation and may retry the Frame if it did not receive the confirmation from DNP3 Master within the time Confirmation Timeout (x1 ms).

Send LL Confirmation

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), the optional Secondary Frame is not sent out with the function code FC_NACK (1) or FC_NOT_SUPPORTED (15).

When the selection is Enabled (Checked), the optional Secondary Frame is sent out with the function code FC_NACK (1) or FC_NOT_SUPPORTED (15).

Confirmation Timeout (x20 ms)

When Request LL Confirmation is enabled, the MicroLogix 1400 waits to receive a confirmation frame until this timeout has expired.

The valid range is 1...65535. Default value is 1.

Message Retries

When Confirmation Timeout (x1 ms) has expired and this parameter was non-zero value, the MicroLogix 1400 tries to send retry packets.

The valid range is 0...255. Default value is 0.

Pre Transmit Delay (x1 ms)

The MicroLogix 1400 waits for the specified time before sending the packet.

The valid range is 0...65535. Default value is 0.

RTS Off Delay (x20 ms)

When the Control is set at Half Duplex Modem(CTS/RTS handshaking), this feature is enabled. This specifies a time delay between the end of a transmission and dropping of the RTS signal.

The valid range is 0...65535. Default value is 0.

RTS Send Delay (x20 ms)

When the Control is set at Half Duplex Modem(CTS/RTS handshaking), this entry is enabled. This specifies a time delay between the raising of the RTS and the initiation of a transmission.

The valid range is 0...65535. Default value is 0.

Max Random Delay (x1 ms)

This parameter is used with Pre Transmit Delay (x1 ms) for Collision Avoidance on RS-485 network. For more details, see Collision Avoidance on page 286.

The valid range is 0...65535. Default value is 0.

Channel 1(Ethernet) Link Layer Configuration Parameters

This section is only applicable to MicroLogix 1400 Series B controllers.

The DNP3 over IP subsystem in the MicroLogix 1400 supports Listening End Point, TCP Dual End Point and Datagram End Point type.

Listening End Point type supports a single TCP connection as a Server and UDP datagram.

TCP Dual End Point type supports a single TCP connection as a Server, a single TCP connection as a Client and UDP datagram.

Datagram End Point type supports UDP datagram from DNP3 Masters. The default TCP and UDP port numbers are 20000 and the port numbers are configurable.

The End Point type can be determined by the parameter End Point Type. According to the parameter, the MicroLogix 1400 works as different End Point types. See the following table for each configuration.

End Point Types

End Point Type	Connection	Description
Listening End Point	A single TCP Server connection	Any of the requests are accepted and the responses are transmitted via this connection. The unsolicited responses are transmitted via this connection when this connection is available.
	UDP datagram	Accepts only broadcast packets when DNP3 destination node is one of 0xFFFD, 0xFFFE and 0xFFFF in the request.
Dual End Point	A single TCP Server connection	Any of the requests are accepted and the responses are transmitted via this connection. The unsolicited responses are transmitted via this connection when this connection is available. This connection has higher priority than the Client connection.
	A single TCP Client connection	Any of the requests are accepted and the responses are transmitted via this connection. The unsolicited responses are transmitted via this connection when this connection is available. The MicroLogix 1400 does not request TCP client connection to DNP3 Master until an unsolicited response is generated.
	UDP Datagram	Accepts only broadcast packets when DNP3 destination node is one of 0xFFFD, 0xFFFE and 0xFFFF in the request.
Datagram End Point	UDP Datagram only	Any of the requests are accepted and the responses are transmitted via this connection. All responses can be transmitted to the different DNP3 Master port according to the configuration of the parameters Remote UDP Port Number and Master IP Address0. If this parameter is not set to 0, the solicited responses are sent to the DNP3 Master port that is configured. If this parameter is set to 0, the solicited responses are sent to the DNP3 Master port that sent the request. TCP connection is not available in this configuration.

The parameter DNP3 over IP Enable is configured in the Channel 1 tab and other parameters are configured in the Chan. 1 - DNP3 tab.

DNP3 over IP Enable

The valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked). Power cycle is required for changes to take effect.

When the selection is Disabled (Unchecked), DNP3 service over Ethernet is disabled after power-cycle.

When the selection is Enabled (Checked), DNP3 service over Ethernet is enabled after power-cycle.

Enable Master Address Validation

The valid selections are Enabled(Checked) and Disabled(Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled(Unchecked), the MicroLogix 1400 accepts the requests from any DNP3 Master.

When the selection is Enabled(Checked), the MicroLogix 1400 accepts the requests only from the DNP3 Master Node Address which is configured in the parameters Master Node0 on page 210, and Master Node1, Master Node2, Master Node3, Master Node4 on page 211. The maximum number of Master Node Address for the Master Address Validation is 5.

Enable Self-Address

The valid selections are Enabled(Checked) and Disabled(Unchecked). Default value is Disabled (Unchecked).

When this bit is Disabled(Unchecked), any packets which contain the destination address 65532(FFFCh) are ignored.

When this bit is Enabled(Checked), any packets which contain the destination address 65532(FFFCh) are accepted and processed.

Enable Access Control

The valid selections are Enabled(Checked) and Disabled(Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled(Unchecked), the MicroLogix 1400 accepts the requests from any DNP3 Master.

When the selection is Enabled(Checked), the MicroLogix 1400 accepts the requests only from the DNP3 Master IP Address which is configured in the parameters Master IP Address0 to Master IP Address4. The maximum number of Master IP Address for the Access Control is 5.

End Point Type

The valid selections are Listening, Dual and Datagram Only.

Default is Listening End Point Type.

Master Node0

This value is used to:

- validate Master node address when the Enable Master Address Validation is Enabled (Checked)
- send Unsolicited Response when Unsolicited Response functionality is enabled. An Unsolicited Response is sent out to the DNP3 Master having this address.

The valid range is 0 to 65519. Default value is 0.

Master Node1, Master Node2, Master Node3, Master Node4

This value is used for validation of the Master node address when the Enable Master Address Validation is Enabled (Checked). This value is only valid when the Enable Master Address Validation is Enabled (Checked).

The valid range is 0 to 65519. Default value is 0.

Master IP Address0

This value is used to:

- validate Master IP address when the Enable Access Control is Enabled (Checked)
- send Unsolicited Response when Unsolicited Response functionality is enabled. An Unsolicited Response is sent out to the DNP3 Master having this address.

The valid value is an IP address. Default value is 0.0.0.0.

Master IP Address1, Master IP Address2, Master IP Address3, Master IP Address4

This value is used for validation of the Master IP address when the Enable Access Control is Enabled (Checked). This value is only valid when the Enable Access Control is Enabled (Checked).

The valid value is an IP address. Default value is 0.0.0.0.

Remote TCP Port Number

This value is used to configure Master TCP Port Number for Unsolicited Response.

The valid range is 0 to 65535. Default value is 20000.

Remote UDP Port Number for Initial Unsolicited

This value is used to configure Master UDP Port Number for Initial Unsolicited Response if the parameter End Point Type is selected as Datagram Only.

The valid range is 0 to 65535. Default value is 20000.

Remote UDP Port Number

This value is used to configure Master UDP Port Number if the parameter End Point Type is selected as Datagram Only.

The valid range is 0 to 65535. Default value is 20000.

Keep Alive Interval (x1 s)

This parameter specifies a time interval for TCP Keep Alive mechanism.

If the timer times out, the MicroLogix 1400 transmits a keep-alive message. The keep-alive message is a DNP Data Link Layer status request (FC_REQUEST_LINK_STATUS). If a response is not received to the keep-alive message, the MicroLogix 1400 deems the TCP connection broken and closes the TCP connection.

The valid range is 1 to 65535. Default value is 10.

Slave Node Address

This value is a node address of this DNP3 Slave.

The valid range is 0 to 65519. Default value is 1.

Local TCP Port Number

This value is used to configure Local TCP Port Number which is used for TCP socket listening.

The valid range is 0 to 65535. Default value is 20000.

Local UDP Port Number

This value is used to configure Local UDP Port Number which is used for UDP socket listening.

The valid range is 0 to 65535. Default value is 20000.

Diagnostic File Number

The diagnostic file number is used to store the diagnostics for the troubleshooting of DNP3 Ethernet subsystem. The status of DNP3 TCP and UDP subsystem is stores to this data file.

The value of this parameter is N file only. Valid range is 0, 7, 9 to 255. Default value is 0.

See Diagnostics on page 296.

DNP3 Slave Application Layer Configuration Parameters

Channel for Unsolicited Response

Only channels already configured for DNP3 protocol appear in the Channel for Unsolicited Response dropdown menu. Any and all Unsolicited Responses are transmitted via this selected channel.

Channel 1 is only supported in MicroLogix 1400 Series B controllers.

Valid selections are enabled (checked) and disabled (unchecked), with disabled as default value.

Restore Events After Power Cycle

When the selection is disabled (unchecked), DNP3 events which are generated before a power cycle are flushed after a power cycle. When the option is enabled (checked), all DNP3 events are restored after a power cycle.

Enable Unsolicited On Start Up

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), the MicroLogix 1400 will not send any enabled Unsolicited Responses after a restart until it has received a FC_ENABLE_UNSOLICITED (20) command from the DNP3 Master..

When the selection is Enabled (Checked), the MicroLogix 1400 will send any enabled Unsolicited Responses after a restart to the DNP3 Master unconditionally

Enable Unsolicited For Class1

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), Unsolicited Response is disabled for Class 1 events. To prevent overflowing of the event buffer, DNP3 Master should poll for Class 1 events.

When the selection is Enabled (Checked), Unsolicited Response is enabled for Class 1 events.

Enable Unsolicited For Class2

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), Unsolicited Response is disabled for Class 2 events. To prevent overflowing of the event buffer, DNP3 Master should poll for Class 2 events.

When the selection is Enabled (Checked), Unsolicited Response is enabled for Class 2 events.

Enable Unsolicited For Class3

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), Unsolicited Response is disabled for Class 3 events. To prevent overflowing of the event buffer, DNP3 Master should poll for Class 3 events.

When the selection is Enabled (Checked), Unsolicited Response is enabled for Class 3 events.

Send Initial Unsolicited Null Response On Start Up

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), the MicroLogix 1400 does not send Unsolicited NULL Response with RESTART IIN bit on startup.

When the selection is Enabled (Checked), the MicroLogix 1400 sends Unsolicited NULL Response with RESTART IIN bit on startup.

Enable Confirmation

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), the MicroLogix 1400 sends Response packets with CON bit set in its header under the following conditions only:

- When the response has Event data.
- When the response is multi-fragment response.
- When the Unsolicited Response is sent.

When the selection is Enabled (Checked), the MicroLogix 1400 always sends Response packets with the CON bit set in its header, which causes the DNP3 Master to send replies confirming that it received each Response packet without error.

Enable Time Synchronization On Start Up Only

Valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

This parameter used with Time Synchronization Interval (x1 mins).

When the selection is Disabled (Unchecked), the MicroLogix 1400 sets IIN1.4 bit on power up and every interval configured in Time Synchronization Interval (x1 mins).

When the selection is Enabled (Checked), the MicroLogix 1400 only sets the NEED_TIME Internal Indication bit (IIN1.4) upon startup.

Time Synchronization Interval (x1 mins)

This parameter used with Enable Time Synchronization On Start Up Only. Only valid when Enable Time Synchronization On Start Up Only is Disabled (Unchecked).

The valid range is 0...32767. Default value is 0. As long as it is set for greater than 0, the NEED_TIME Internal Indication (IIN1.4) bit will be set at startup and then after every Time Synchronization Interval minutes.

When the parameter Enable Time Synchronization On Start Up Only is Disabled (Unchecked) and the parameter Time Synchronization Interval (x1 mins) is configured to 0, IIN1.4 bit is never turned on.

Max Response Size

The MicroLogix 1400 sends Application Layer frame to fit in Max Response Size. If the Response packet size is larger than this value, the MicroLogix 1400 fragments the Response packet.

The valid range is 27...2048 in bytes. Default value is 2048.

Confirmation Timeout (x1 ms)

When Enable Confirmation is enabled, the MicroLogix 1400 waits for Application Layer Confirmation until the Confirmation Timeout (x1 ms) has expired.

The valid range is 100...65535 in 1ms increments. Default value is 10000.

Number of Retries

This parameter is only for Unsolicited Response. If this value has the maximum which is 65535, it means infinite retries of the Unsolicited Response.

The valid range is 0...65535. Default value is 0.

Number of Class1 Events

If the MicroLogix 1400 is configured not to initiate Unsolicited Response, this parameter used to limit the maximum number of events which is generated and logged into the event buffer for Class 1 events. In this case, value 0 will disable to generate the event.

If the MicroLogix 1400 is configured to generate Unsolicited Response, and the number of queued Class 1 events is reached to this value, Unsolicited Response is initiated.

The valid range is 0 to 6013. Default value is 10.

Hold Time after Class1 Events (x1 s)

This parameter is only for Unsolicited Response. The MicroLogix 1400 holds the events during Hold Time after Class1 Events (x1 s) before initiating an Unsolicited Response.

The valid range is 0...65535. Default value is 5.

The value of 0 indicates that responses are not delayed due to this parameter.

Note that parameters Number of Class1 Events and Hold Time after Class1 Events (x1 s) are used together so that if either one of the criteria are met, an Unsolicited Response is transmitted.

Number of Class2 Events

If the MicroLogix 1400 is configured not to initiate Unsolicited Response, this parameter used to limit the maximum number of events which is generated and logged into the event buffer for Class 2 events. In this case, value 0 will disable to generate the event.

If the MicroLogix 1400 is configured to generate Unsolicited Response, and the number of queued Class 2 events is reached to this value, Unsolicited Response is initiated.

The valid range is 0 to 6013. Default value is 10.

Hold Time after Class2 Events (x1 s)

This parameter is only for Unsolicited Response. The MicroLogix 1400 holds the events during Hold Time after Class2 Events (x1 s) before initiating an Unsolicited Response.

The valid range is 0 to 65535. Default value is 5.

The value of 0 indicates that responses are not delayed due to this parameter.

Note that parameters Number of Class2 Events and Hold Time after Class2 Events (x1 s) are used together so that if either one of the criteria are met, an Unsolicited Response is transmitted.

Number of Class3 Events

If the MicroLogix 1400 is configured not to initiate Unsolicited Response, this parameter used to limit the maximum number of events which is generated and logged into the event buffer for Class 3 events. In this case, value 0 will disable to generate the event.

If the MicroLogix 1400 is configured to generate Unsolicited Response, and the number of queued Class 3 events is reached to this value, Unsolicited Response is initiated.

The valid range is 0 to 6013. Default value is 10.

Hold Time after Class3 Events (x1 s)

This parameter is only for Unsolicited Response. The MicroLogix 1400 holds the events during Hold Time after Class3 Events (x1 s) before initiating an Unsolicited Response.

The valid range is 0 to 65535. Default value is 5.

The value of 0 indicates that responses are not delayed due to this parameter.

Note that parameters Number of Class3 Events and Hold Time after Class3 Events (x1 s) are used together so that if either one of the criteria are met, an Unsolicited Response is transmitted.

Select Timeout (x1 s)

The valid range is 1...65535. Default value is 10.

This parameter is used for controlling CROB(Control Relay Output Block) and AOB(Analog Output Block). After receiving the request with the function code FC_SELECT(3), DNP3 Master should send the request with the function code FC_OPERATE(4) within this configured time.

DNP3 Object Data File Number

The DNP3 Object Data File Numbers define the mapping of the listed DNP3 objects to MicroLogix 1400 data table files. The number of elements defined for each of those data table files also defines the number of corresponding DNP3 objects.

See DNP3 Objects and MicroLogix 1400 Data Files on page 232 for more details.

DNP3 Object Config File Number

The DNP3 Object Config File Numbers define the mapping of the listed DNP3 object properties (class number, online/offline status, object quality flags, deadbands and/or thresholds) to MicroLogix 1400 data table files.

See DNP3 Objects and MicroLogix 1400 Data Files on page 232 for more details.

DNP3 Secure Authentication

This section is applicable only to MicroLogix 1400 Series B controllers.

The MicroLogix 1400 implements the DNP3 Secure Authentication based on the DNP3 Specification, Supplement to Volume 2, Secure Authentication, Version 2.00.

DNP3 Secure Authentication has been implemented in the DNP3 Application Layer of the MicroLogix 1400 system. If you configure any parameters regarding DNP3 Secure Authentication in the DNP3 Slave Application Layer configuration, it affects all ports which are configured for DNP3 protocol in the MicroLogix 1400 controller.

Enable Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

The valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Disabled (Unchecked).

When the selection is Disabled (Unchecked), the MicroLogix 1400 disables DNP3 Secure Authentication subsystem.

When the selection is Enabled (Checked), the MicroLogix 1400 enables DNP3 Secure Authentication subsystem.

Enable Aggressive Mode in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

The valid selections are Enabled (Checked) and Disabled (Unchecked). Default value is Enabled (Checked).

When the selection is Disabled (Unchecked), the MicroLogix 1400 disables DNP3 Aggressive Mode in Secure Authentication subsystem.

When the selection is Enabled (Checked), the MicroLogix 1400 enables DNP3 Aggressive Mode in Secure Authentication subsystem.

Critical FCs File Number in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This file number is used to define the list of the critical function codes in Secure Authentication. A critical function code should be defined in a word element in this file. The maximum number of element in this file should not exceed 32(the maximum number of the function codes that can be defined).

The value of this parameter is N file only. Valid range is 0, 7, 9 to 255. Default value is 0.

When this file number is configured to 0 and there is no configuration file assigned, some function codes are considered as critical by default. See the table below for the critical function codes. When this file number of this parameter is not 0 and it is a valid N data file, all function codes are considered as non-critical. In this case, you must define all critical function codes in this file.

Note that the function code 0(FC_CONFIRM) is considered as critical once the file number is configured newly. If you don't want the function code 0 to be considered as critical, the number of elements in the file should be adjusted and the element value 0 should not be in any elements.

Function Code	Critical FCs File Number = 0	Critical FCs File Number = 0
0 (0x00)	-	optional
1 (0x01)	-	optional
2 (0x02)	critical	optional
3 (0x04)	critical	optional
4 (0x04)	critical	optional
5 (0x05)	critical	optional
6 (0x06)	critical	optional
7 (0x07)	-	optional
8 (0x08)	-	optional
9 (0x09)	-	optional
10 (0x0A)	-	optional
11 (0x0B)	-	-
12 (0x0C)	-	-
13 (0x0D)	critical	optional
14 (0x0E)	critical	optional

Function Code	Critical FCs File Number = 0	Critical FCs File Number = 0
15 (0x0F)	N.A.	N.A.
16 (0x10)	critical	optional
17 (0x11)	critical	optional
18 (0x12)	critical	optional
19 (0x13)	N.A.	N.A.
20 (0x14)	critical	optional
21 (0x15)	critical	optional
22 (0x16)	-	-
23 (0x17)	-	optional
24 (0x18)	critical	optional
25 (0x19)	-	optional
26 (0x1A)	-	optional
27 (0x1B)	-	optional
28 (0x1C)	-	optional
29 (0x1D)	critical	optional
30 (0x1E)	-	optional
31 (0x1F)	critical	optional
32 (0x20)	N.A.	N.A.
33 (0x21)	N.A.	N.A.
129 (0x81)	-	optional
130 (0x82)	-	optional
131 (0x83)	N.A.	N.A.

Expected Session Key Change Interval (x1 s) in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This parameter is used for configuring the expected session key change interval in seconds.

The valid range is 0...7200 (2 hrs). Default value is 1800 (30 mins).

When DNP3 Master does not change the Session Key within this time configured, the MicroLogix 1400 invalidate the Session Key and its state for each user.

Expected Session Key Change Count in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This parameter is used for configuring the expected session key change count.

The valid range is 1 to 10000. Default value is 2000.

Reply Timeout (x100 ms) in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This parameter is used for configuring the reply timeout in 100 msec.

The valid range is 0...1200 (120 s). Default value is 20 (2 s).

Maximum Error Count in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This parameter is used for configuring the maximum error count.

The valid range is 0...10. Default value is 2.

HMAC Algorithm in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

This parameter is used for configuring the HMAC Algorithm.

- 1 = HMAC SHA-1 truncated to 4 octets (serial)
- 2 = HMAC SHA-1 truncated to 10 octets (networked)
- 3 = HMAC SHA-256 truncated to 8 octets (serial)
- 4 = HMAC SHA-256 truncated to 16 octets (networked)

The valid range is 1...4. Default value is 2.

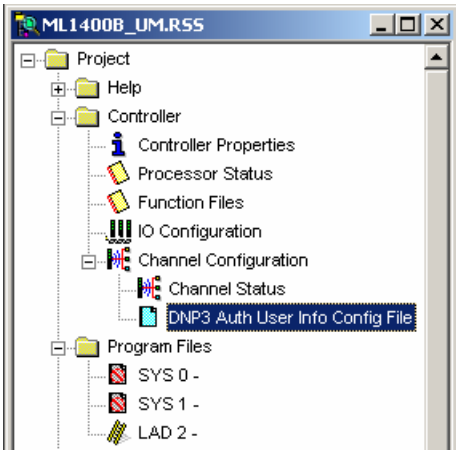
User Info Config File Number in Secure Authentication

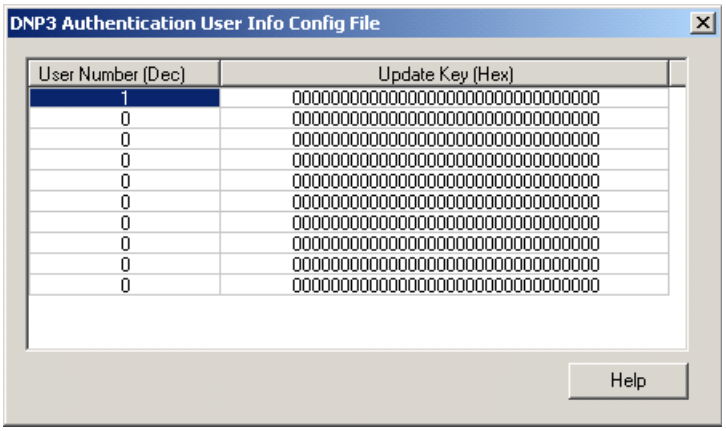
This parameter is supported only in MicroLogix 1400 Series B controllers.

This file number is used to define user information Secure Authentication.

The value of this parameter is N file only. Valid range is 0, 7, 9...255. Default value is 0.

In RSLogix 500/RSLogix Micro software, when this parameter is configured properly, you can see a DNP3 Auth User Info Config File tree in Channel Configuration.





The following table shows the structure of the DNP3 Secure Authentication User Info Configuration File. An Update Key is made up of 16 bytes and must be entered in as 32 hexadecimal digits.

DNP3 Secure Authentication User Info Configuration File Structure

Word Offset	Name	Default Value By Controller (DEC)	Default Value By RSLogix500 (DEC)	Valid Range (DEC)	Description
0	User Number	0	1	0 to 65535	For User 1
1	Reserved	0	0	0	For User 1
2	Update Key (0)	0	0	0 to 65535	
3	Update Key (1)	0	0	0 to 65535	
4	Update Key (2)	0	0	0 to 65535	
5	Update Key (3)	0	0	0 to 65535	
6	Update Key (4)	0	0	0 to 65535	
7	Update Key (5)	0	0	0 to 65535	

DNP3 Secure Authentication User Info Configuration File Structure

Word Offset	Name	Default Value By Controller (DEC)	Default Value By RSLogix500 (DEC)	Valid Range (DEC)	Description
8	Update Key (6)	0	0	0 to 65535	
9	Update Key (7)	0	0	0 to 65535	
10	User Number	0	0	0 to 65535	For User 2
11	Reserved	0	0	0	For User 1
12	Update Key (0)	0	0	0 to 65535	
13	Update Key (1)	0	0	0 to 65535	
14	Update Key (2)	0	0	0 to 65535	
15	Update Key (3)	0	0	0 to 65535	
16	Update Key (4)	0	0	0 to 65535	
17	Update Key (5)	0	0	0 to 65535	
18	Update Key (6)	0	0	0 to 65535	
19	Update Key (7)	0	0	0 to 65535	
…					
90	User Number	0	0	0 to 65535	For User 10
91	Reserved	0	0	0	For User 10
92	Update Key (0)	0	0	0 to 65535	
93	Update Key (1)	0	0	0 to 65535	
94	Update Key (2)	0	0	0 to 65535	
95	Update Key (3)	0	0	0 to 65535	
96	Update Key (4)	0	0	0 to 65535	
97	Update Key (5)	0	0	0 to 65535	
98	Update Key (6)	0	0	0 to 65535	
99	Update Key (7)	0	0	0 to 65535	

Diagnostic File Number in Secure Authentication

This parameter is supported only in MicroLogix 1400 Series B controllers.

The diagnostic file number is used to store the diagnostics for the troubleshooting of DNP3 Secure Authentication subsystem.

The value of this parameter is N file only. Valid range is 0, 7, 9 to 255. Default value is 0.

See the table for the contents of the data file in the section Diagnostics.

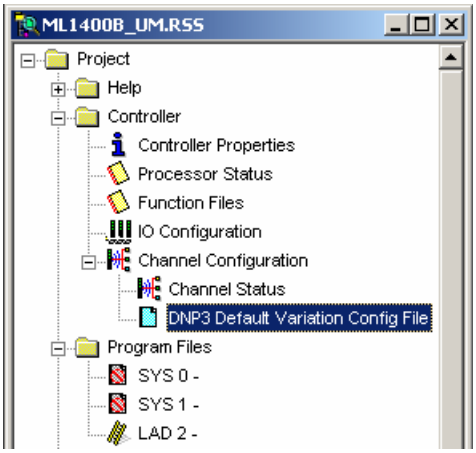
Default Variation Config File Number

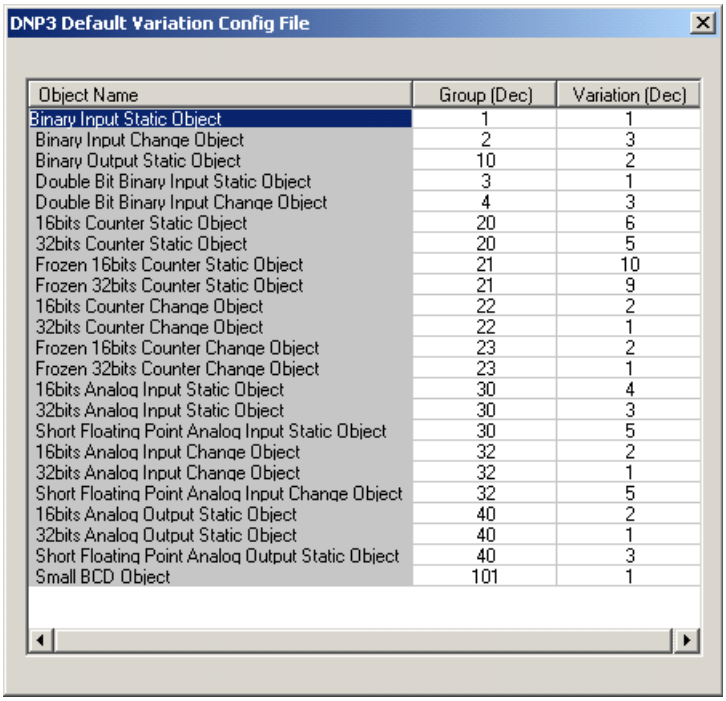
This parameter is supported only in MicroLogix 1400 Series B controllers.

This file number is used to define default variations in a response to a Class 0 poll request.

The value of this parameter is N file only. Valid range is 0, 7, 9 to 255. Default value is 0.

In RSLogix 500/RSLogix Micro software, when this parameter is configured properly, you can see a DNP3 Default Variation Config File tree in Channel Configuration.





Object Name	Group (Dec)	Variation (Dec)
Binary Input Static Object	1	1
Binary Input Change Object	2	3
Binary Output Static Object	10	2
Double Bit Binary Input Static Object	3	1
Double Bit Binary Input Change Object	4	3
16bits Counter Static Object	20	6
32bits Counter Static Object	20	5
Frozen 16bits Counter Static Object	21	10
Frozen 32bits Counter Static Object	21	9
16bits Counter Change Object	22	2
32bits Counter Change Object	22	1
Frozen 16bits Counter Change Object	23	2
Frozen 32bits Counter Change Object	23	1
16bits Analog Input Static Object	30	4
32bits Analog Input Static Object	30	3
Short Floating Point Analog Input Static Object	30	5
16bits Analog Input Change Object	32	2
32bits Analog Input Change Object	32	1
Short Floating Point Analog Input Change Object	32	5
16bits Analog Output Static Object	40	2
32bits Analog Output Static Object	40	1
Short Floating Point Analog Output Static Object	40	3
Small BCD Object	101	1

The following table shows the structure of the DNP3 Default Variation Configuration File.

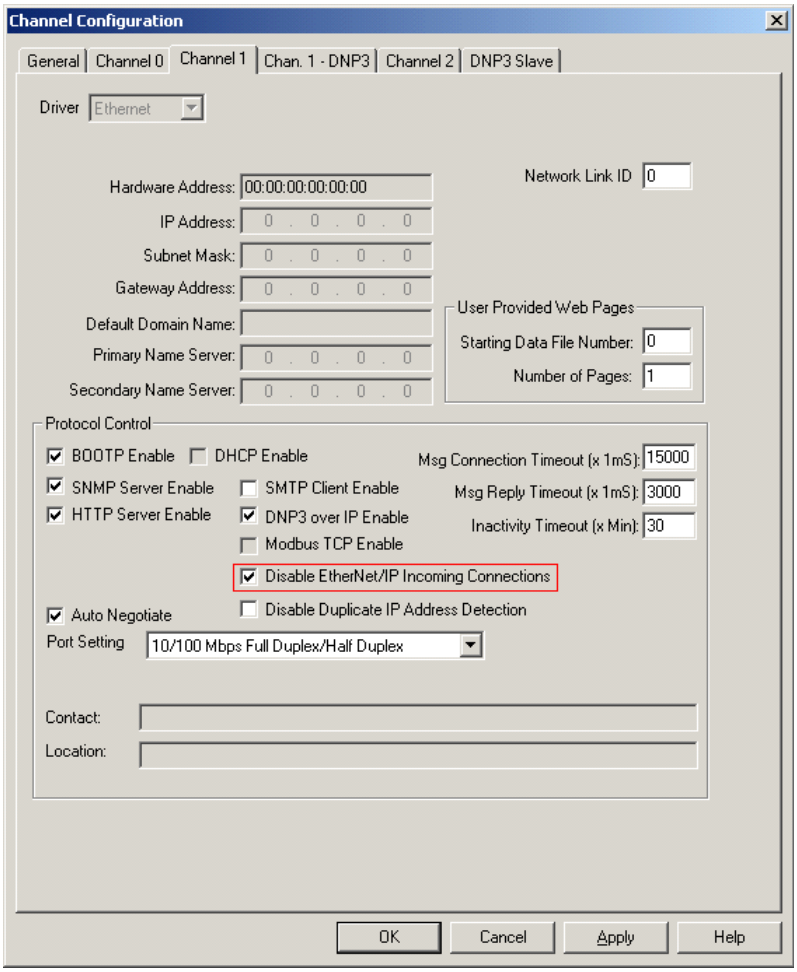
Table 2.1

Word Offset	Default Variation for the following Objects	Group and Standard Default Variation	Alternate Default Variations
0	Binary Input Static Object	g1v1	v2
1	Binary Input Change Object	g2v3	v1, v2
2	Binary Output Static Object	g10v2	none
3	Reserved	-	
4	Double Bit Binary Input Static Object	g3v1	v2
5	Double Bit Binary Input Change Object	g4v3	v1, v2
6	16-bit Counter Static Object	g20v6	v2
7	32-bit Counter Static Object	g20v5	v1
8	Frozen 16-bit Counter Static Object	g21v10	v2, v6
9	Frozen 32-bit Counter Static Object	g21v9	v1, v5
10	16-bit Counter Change Object	g22v2	none
11	32-bit Counter Change Object	g22v1	none
12	Frozen 16-bit Counter Change Object	g23v2	v6
13	Frozen 32-bit Counter Change Object	g23v1	v5
14	16-bit Analog Input Static Object	g30v4	v2
15	32-bit Analog Input Static Object	g30v3	v1
16	Short Floating Point Analog Input Static Object	g30v5	none
17	16-bit Analog Input Change Object	g32v2	v4
18	32-bit Analog Input Change Object	g32v1	v3
19	Short Floating Point Analog Input Change Object	g32v5	v7
20	16-bit Analog Output Static Object	g40v2	none
21	32-bit Analog Output Static Object	g40v1	none
22	Short Floating Point Analog Output Static Object	g40v3	none
23	Reserved	-	
24	Reserved	-	
25	Reserved	-	
26	Small BCD Object	g101v1	none
27	Reserved	-	
28	Reserved	-	
29	Reserved	-	
30	Reserved	-	
31	Reserved	-	

Disable EtherNet/IP Incoming Connections

If you have a critical application and do not want to allow any Ethernet/IP Incoming Connections, use the parameter Disable Ethernet/IP Incoming Connections.

When this parameter is checked (disabled) in the Channel 1 Ethernet configuration, the MicroLogix 1400 does not allow any incoming Ethernet/IP connections. In doing so, you cannot use RSLogix 500/RSLogix Micro over Ethernet port to monitor or change the configuration/user program.



DNP3 Slave Application Layer

This section covers DNP3 Slave Application Layer Function Codes and Internal Indications.

For details of Packet Formats for the request and response, refer to the DNP3 Protocol specifications.

Function Codes

FC_CONFIRM (FC Byte = 0x00)

00 - Confirm

A DNP3 master sends a message with this function code to confirm receipt of a response fragment. In a general environment, the MicroLogix 1400 receives a response with this function code. But the MicroLogix 1400 may generate a response with this function code when a DNP3 Master sends a request with the CON bit set in the application control header.

FC_READ (FC Byte = 0x01)

01 - Read

The READ function code is used by a DNP3 master to request data from the MicroLogix 1400.

FC_WRITE (FC Byte = 0x02)

02 - Write

The WRITE function code is used to write the contents of DNP3 objects from the DNP3 master to the MicroLogix 1400. This function code is used for clearing bit IIN1.7 [DEVICE_RESTART], setting time in the MicroLogix 1400 and downloading user programs to the MicroLogix 1400 controller.

FC_SELECT (FC Byte = 0x03)

03 - Select

The SELECT function code is used in conjunction with the OPERATE function code as part of select-before-operate method for issuing control requests. This procedure is used for controlling binary output (CROB) or analog output (AOB) objects.

FC_OPERATE (FC Byte = 0x04)

04 - Operate

See the comment for FC_SELECT (FC Byte = 0x03) on page 227.

FC_DIRECT_OPERATE (FC Byte = 0x05)

05 - Direct Operate

This direct operate function is similar to the FC_OPERATE function code except that no preceding select command is required.

FC_DIRECT_OPERATE_NR (FC Byte = 0x06)

06 - Direct Operate No Resp

See the comment for FC_DIRECT_OPERATE. No response message is returned when this request is issued from a DNP3 master.

FC_IMMED_FREEZE (FC Byte = 0x07)

07 - Immediate Freeze

Upon receiving a request with this function, the MicroLogix 1400 copies the current value of a counter point to a separate memory location associated with the same point. The copied value remains constant until the next freeze operation to the same point.

FC_IMMED_FREEZE_NR (FC Byte = 0x08)

08 - Immediate Freeze No Resp

See the comment for FC_IMMED_FREEZE. No response message is returned when this request is issued from a DNP3 master..

FC_FREEZE_CLEAR (FC Byte = 0x09)

09 - Freeze and Clear

Upon receiving a request with this function, the MicroLogix 1400 copies the current value to the frozen value, then clears the current value to 0 immediately.

FC_FREEZE_CLEAR_NR (FC Byte = 0x0A)

10 - Freeze and Clear No Resp

See the comment for FC_FREEZE_CLEAR. No response message is returned when this request is issued from a DNP3 master.

FC_COLD_RESTART (FC Byte = 0x0D)

13 - Cold Restart

This function code forces the MicroLogix 1400 to perform a complete restart upon powering up.

FC_WARM_RESTART (FC Byte = 0x0E)

14 - Warm Restart

This function code forces the MicroLogix 1400 to perform a partial reset. This applies only to the MicroLogix 1400 Series B controller.

FC_INITIALIZE_APPL (FC Byte = 0x10)

16 - Initialize Application

This function code is used to initialize the user program which was downloaded by RSLogix 500/RSLogix Micro software.

FC_START_APPL (FC Byte = 0x11)

17 - Start Application

This function code is used to start the user program which was downloaded by RSLogix 500/RSLogix Micro software.

FC_STOP_APPL (FC Byte = 0x12)

18 - Stop Application

This function code is used to stop the user program which was downloaded by RSLogix 500/RSLogix Micro.

FC_ENABLE_UNSOLICITED (FC Byte = 0x14)

20 - Enable Unsolicited Message

This function is used to dynamically enable unsolicited messages generated in the MicroLogix 1400.

FC_DISABLE_UNSOLICITED (FC Byte = 0x15)

21 - Disable Unsolicited Message

This function is used to dynamically disable unsolicited messages generated in the MicroLogix 1400.

FC_DELAY_MEASURE (FC Byte = 0x17)

23 - Delay Measurement, used for Non-LAN Procedure

This function code is used to measure the communication channel delay time.

FC_RECORD_CURRENT_TIME (FC Byte = 0x18)

24 - Record Current Time, used for LAN Procedure

This function code is used in the procedure for time synchronizing MicroLogix 1400 controllers that communicate over a LAN.
This applies only to MicroLogix 1400 Series B controllers.

FC_OPEN_FILE (FC Byte = 0x19)

25 - Open File

This function code is used to make a file available for reading or writing.

FC_CLOSE_FILE (FC Byte = 0x1A)

26 - Close File

After the file reading or writing operation, this function code used to unlock the file.

FC_DELETE_FILE (FC Byte = 0x1B)

27 - Delete File

A DNP3 master uses this function code to delete a file.

FC_GET_FILE_INFO (FC Byte = 0x1C)

28 - Get File Information

This function code is for the master to retrieve information about a file in the MicroLogix 1400.
This applies only to MicroLogix 1400 Series B controllers.

FC_AUTHENTICATE_FILE (FC Byte = 0x1D)

29 - Authenticate File

This function code is used to obtain an authentication key that is needed to open or delete a file.

FC_ABORT_FILE (FC Byte = 0x1E)

30 - Abort File

This function code is used to immediately request termination of the current read/write operation and close the file, without saving.

This applies only to MicroLogix 1400 Series B controllers.

FC_ACTIVATE_CONFIG (FC Byte = 0x1F)

31 - Activate Config

This function code is used to begin using the configuration or executable code specified by the objects included in the request.

This applies only to MicroLogix 1400 Series B controllers.

FC_AUTHENTICATION_REQUEST (FC Byte = 0x20)

32 - Authentication Request

The master uses this function code when sending authentication messages to the MicroLogix 1400 that require a response

This applies only to MicroLogix 1400 Series B controllers.

FC_AUTHENTICATION_REQUEST_NR (FC Byte = 0x21)

33 - Authentication Request No Resp

This function code is used by the master to send authentication messages when no return response is required.

This applies only to MicroLogix 1400 Series B controllers.

FC_RESPONSE (FC Byte = 0x81)

129 - Response

All responses except for Unsolicited Response messages use this function code.

FC_UNSOLICITED_RESPONSE (FC Byte = 0x82)

130 - Unsolicited Response

Unsolicited Responses always use this function code regardless of which DNP3 objects are included.

FC_AUTHENTICATION_RESPONSE (FC Byte = 0x83)

131 - Authentication Response

This function code is used to issue authentication messages to the master. This applies only to MicroLogix 1400 Series B controllers.

Internal Indications

Internal Indication bits are set under the following conditions of the MicroLogix 1400 controllers:

- IIN1.0: ALL_STATIONS. This bit is set when an all-stations message is received.
- IIN1.1: CLASS_1_EVENTS. This bit is set when Class 1 event data is available.
- IIN1.2: CLASS_2_EVENTS. This bit is set when Class 2 event data is available.
- IIN1.3: CLASS_3_EVENTS. This bit is set when Class 3 event data is available.
- IIN1.4: NEED_TIME. This bit is set when Time synchronization is required.
- IIN1.5: LOCAL_CONTROL. This bit is set when the controller is in Non-Executing mode.
- IIN1.6: DEVICE_TROUBLE. This bit is set when the controller is in Fault mode.
- IIN1.7: DEVICE_RESTART. This bit is set when the DNP3 driver is just configured, in channel configuration .
- IIN2.0: NO_FUNC_CODE_SUPPORT. This bit is set when a request which has an unknown function code is received.
- IIN2.1: OBJECT_UNKNOWN. This bit is set when a request which has an unknown object is received.
- IIN2.2: PARAMETER_ERROR. This bit is set when a request with a qualifier/range field that cannot be processed is received.
- IIN2.3: EVENT_BUFFER_OVERFLOW. This bit is set when an event buffer overflow condition exists in the controller and at least one unconfirmed event is lost.
- IIN2.4: ALREADY_EXECUTING. Not supported.
- IIN2.5: CONFIG_CORRUPT. This bit is set when a bad file type and bad file number are detected.
- IIN2.6: Reserved.
- IIN2.7: Reserved.

You can access the last transmitted IIN bits in the response through accessing the element of Communication Status file, CS0:58 or CS2:58. For more details, see Diagnostics.

DNP3 Objects and MicroLogix 1400 Data Files

All of the DNP3 Objects which are supported in the MicroLogix 1400 are summarized in Implementation Table on page 314.

Data file types used in DNP3 Objects are not the same as that used in the MicroLogix controller, but are similar. Mapping is required between DNP3 data files and MicroLogix 1400 data files.

Overview

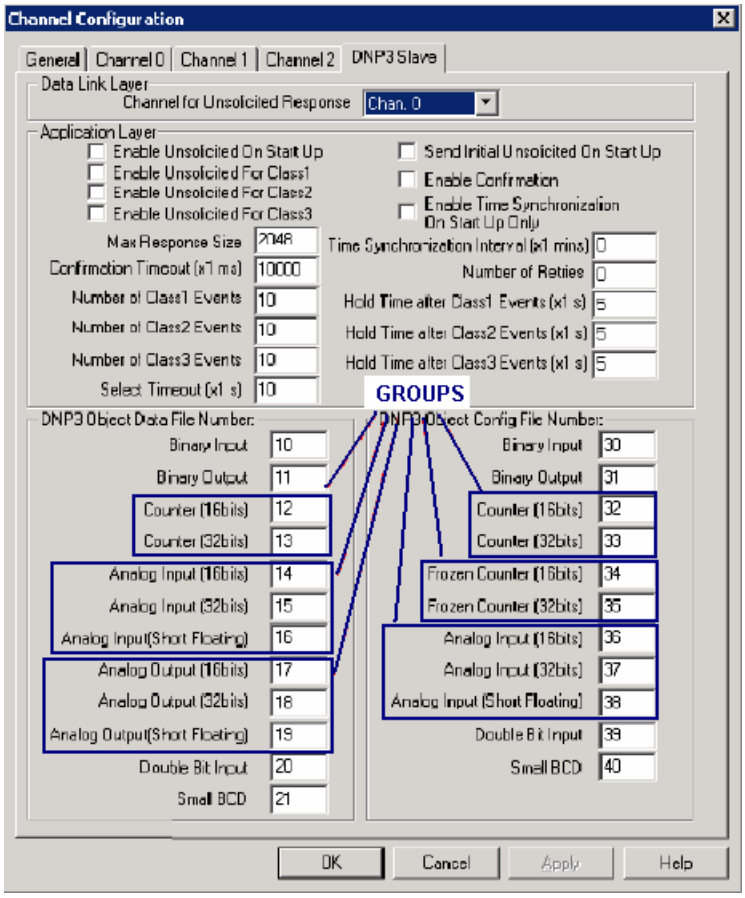
DNP3 Data objects that are implemented in the MicroLogix 1400 controller are listed below:

- DNP3 Binary Input Object
- DNP3 Double Bit Binary Input Object
- DNP3 Binary Output Object
- DNP3 Counter Object
- DNP3 Frozen Counter Object
- DNP3 Analog Input Object
- DNP3 Analog Output Object
- DNP3 BCD Object
- DNP3 Data Set Object (Series B controllers only)

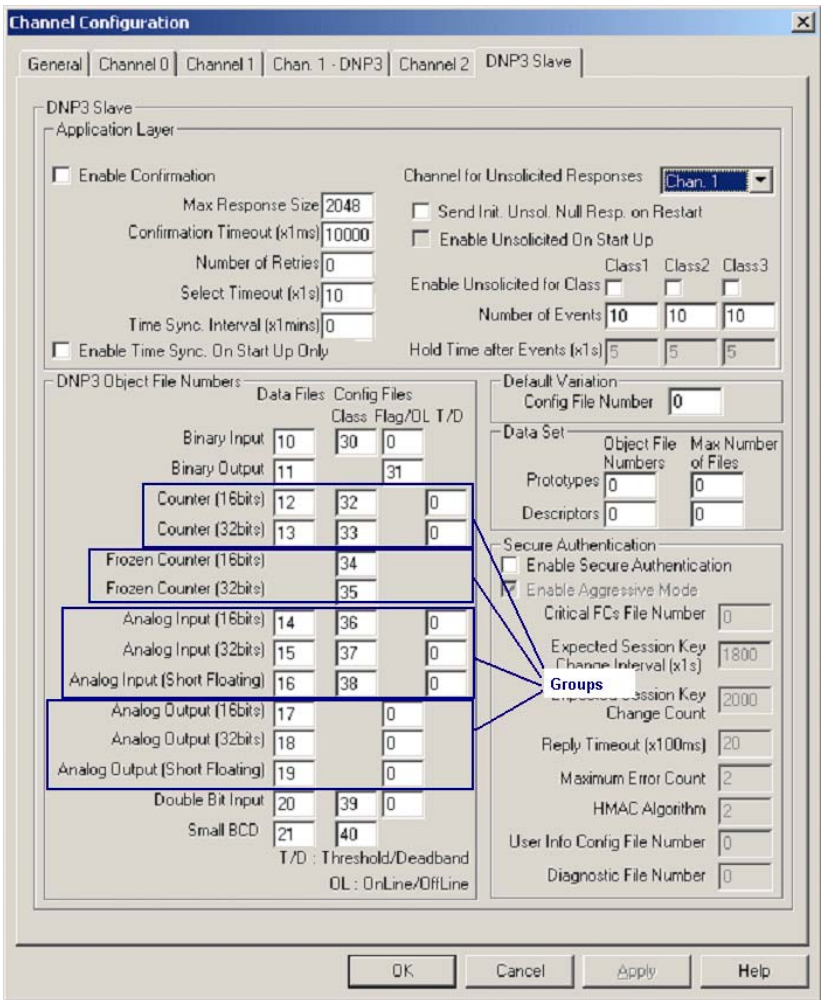
Some of objects are divided into several Object files to map data files in the MicroLogix 1400 controller.

- Counter Object — 16bit and 32bit Counter Object File
- Analog Input Object — 16bit and 32bit Analog Input Object File, and Short Floating Point Analog Input Object File.
- Analog Output Object — 16bit and 32bit Analog Output Object File, and Short Floating Point Analog Output Object File.

For the MicroLogix 1400 Series A controllers:



For the MicroLogix 1400 Series B controllers:



Each of the data files for a DNP3 Object will have a file number in the user memory as shown below. You can configure the Data file number for each DNP3 Object in the DNP3 Slave tab of the DNP3 Slave Application Layer Configuration. File types for this object file can be Binary, Integer, Long, or Float data files.

The file numbers for each DNP3 Object cannot be in conflict with each other.

DNP3 Data Files

Relationship between DNP3 object database and MicroLogix data files

DNP Objects			Micrologix Data Files			
Object Name	**Related Groups**	**Maximum Configurable Index**	**File name for Data**	**File Type**	**File Number**	**Maximum Configurable Elements**
Binary Input Object	1, 2	4096	Binary Input Object File	Only B file	3, 9 to 255	256
Double Bit Binary Input Object	3, 4	2048	Double Bit Binary Input Object File	Only B file	3, 9 to 255	256
Binary Output Object	10, 12	4096	Binary Input Object File	Only B file	3, 9 to 255	256
Counter Object	20, 22	256	16-bit Counter Object File	Only N file	7, 9 to 255	256
			32 bit Counter Object File	Only L file	9 to 255	
Frozen Counter Object	21, 23	reflection of Counter Object which was configured	reflection of 16-bit Counter Object File	-	-	-
			reflection of 32-bit Counter Object File			
Analog Input Object	30, 32	256	16-bit Analog Input Object File	Only N file	7, 9 to 255	256
			32-bit Analog Input Object File	Only L file	9 to 255	
			Short Floating Point Analog Input Object File	Only F file	8, 9 to 255	
Analog Output Object	40, 41	256	16-bit Analog Output Object File	Only N file		256
			32-bit Analog Output Object File	Only L file	9 to 255	
			Short Floating Point Analog Output Object File	Only F file	8, 9 to 255	
BCD Object	101	256	Small BCD Object File	Only N file	7, 9 to 255	256
Data Set Object(In Series B)	85, 87, 88	10	Data Set Prototypes Object File	Only N file	7, 9 to 255	10
	86, 87, 88		Data Set Descriptors Object File			

Basically, the index number of DNP objects of each type is evaluated by the firmware automatically per the number of elements. For example, if a Binary Input object file was configured as an element, the highest index number of the Binary Input object is 15. The index number can only be increased by 16. If a Double-Bit Binary Input object file was configured as an element, the highest index number of the Double-Bit Binary Input object is 7. The index number can only be increased by 8.

As another example, if a 16-bit Analog Input object file was configured as an element, the highest index number is 1. Except for Binary and Double-Bit Binary type objects, the index number can be increased by 1.

DNP3 Configuration Files

You can set configuration files for each object. These configuration files allow you to configure parameters such as Class level and Object Flag bit information for each element. Only a Binary Data file type can be used for configuration file.

Relationship between MicroLogix Data Files and Configuration Files

MicroLogix Data Files	Configuration Files	File Type	File Number	Maximum Configurable Elements
Binary Input File	Binary Input Config File	Only B file	3, 9 to 255	256
	Binary Input Online Config File (In Series B)			
Double Bit Binary Input File	Double Bit Binary Input Config File	Only B file	3, 9 to 255	256
	Double-Bit Binary Input Online Config File (In Series B)			
Binary Output File	Binary Output Config File	Only B file	3, 9 to 255	256
16-bit Counter File	16-bit Counter Config File	Only B file	3, 9 to 255	256
	16-bit Counter Threshold Config File (In Series B)	Only N file	7, 9 to 255	
32-bit Counter File	32-bit Counter Config File	Only B file	3, 9 to 255	256
	32-bit Counter Threshold Config File (In Series B)	Only L file	9 to 255	
Frozen 16-bit Counter File	Frozen 16-bit Counter Config File	Only B file	3, 9 to 255	256
Frozen 32-bit Counter File	Frozen 32-bit Counter Config File	Only B file	3, 9 to 255	256
16-bit Analog Input File	16-bit Analog Input Config File	Only B file	3, 9 to 255	256
	16-bit Analog Input Deadband Config File (In Series B)	Only N file	7, 9 to 255	
32-bit Analog Input File	32-bit Analog Input Config File	Only B file	3, 9 to 255	256
	32-bit Analog Input Deadband Config File (In Series B)	Only L file	9 to 255	
Short Floating Point Analog Input File	Short Floating Point Analog Input Config File	Only B file	3, 9 to 255	256
	Short Floating Point Analog Input Deadband Config File (In Series B)	Only F file	8, 9 to 255	
16-bit Analog Output File	16-bit Analog Output Config File (In Series B)	Only B file	3, 9 to 255	256
32-bit Analog Output File	32-bit Analog Output Config File (In Series B)	Only B file	3, 9 to 255	256
Short Floating Point Analog Output File	Short Floating Point Analog Output Config File (In Series B)	Only B file	3, 9 to 255	256
Small BCD File	Small BCD Class Config File	Only B file	3, 9 to 255	256

For Binary Input, Double Bit Binary Input and Small BCD type data, you can configure Class information in the Configuration file. The lower 2 bits in the elements of the Configuration files are the configuration of Class information to the relative objects. Other bits are reserved.

Related Configuration Files:

- Binary Input Config File Number

- Double Bit Binary Input Config File Number

Class Information Configuration for Binary Input, Double Bit Binary Input, and Small BCD

Bit Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Element 0	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 1	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 2	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 3	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 4	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 5	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
…																

r: reserved
C1/C0: Class level, 0 to 3
For Binary Input, Element_0 for data index 0 to 15
For Double-Bit Binary Input, Element _0 for data index 0 to 7

For Binary Input and Binary Output type data, you can configure Online information of the object flag in the Configuration file. If this bit is set, the Online bit(bit 0) in the object flag for each point is set when you read Status type objects. You can set this information using ladder logic.

Related Configuration File:

- Binary Input Online Config File Number (In Series B)
- Binary Output Online Config File Number

Binary Input and Binary Output Type Configuration Data File

Bit Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Element 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Element 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Element 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Element 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Element 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Element 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
…																

0: offline
1: online
For Binary Output, Element_0 for data index 0 to 15

For other Input type data, you can configure Class information and the object flag information in the Configuration file. The lower 2 bits in the elements of the Configuration files are the configuration of Class information to the relevant objects. The upper byte of the configuration file of these objects is used to configure the object flag. Other bits are reserved.

Two new bits are defined in MicroLogix 1400 Series B controllers.
The bit TE is used to generate an event by setting it regardless of the change of state. This bit can be used to generate the timed events. Once this bit is set by the

ladder logic or communications, the MicroLogix 1400 clears it automatically after generating an event at the end of scan. The bit DCE is used to suppress the events by the change of state.

For example, if you want to trigger an event for an analog point every 15 minutes, you should set the TE bit every 15 minutes by the ladder logic. But, in this case, you may not want the state change events to be generated. Then, set the bit DCE. You can get the timed events every 15 minutes.

Related Configuration File Number:

- 16-bit Counter Config File Number
- 32-bit Counter Config File Number
- 16-bit Frozen Counter Config File Number
- 32-bit Frozen Counter Config File Number
- 16-bit Analog Input Config File Number
- 32-bit Analog Input Config File Number
- Short Floating Point Analog Input Config File Number

Class and Object Configuration for Other Input Data Type

Bit Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Element 0	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
Element 1	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
Element 2	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
Element 3	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
Element 4	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
Element 5	F7	F6	F5	F4	F3	F2	F1	F0	r	r	DCE	TE	r	r	C1	C0
…																

r: reserved
C1/C0: Class level, 0 to 3
TE: Trigger Event for the point (In Series B)
DCE: Disable Change of state Event for the point (In Series B)
For other Inputs, Element _0 for data index 0
F7-F0: Object Flags, FLAG7/FLAG6/FLAG5/LOCAL_FORCED/REMOTE_FORCED/COMM_LOST/RESTART/ONLINE

For Counter type data, you can configure Threshold information in the Configuration file. Each element can be configured to the threshold value for each point. A counter event is generated if the absolute value of the difference between the present value of a counter point and the value that was most recently queued as an event for that point exceeds the threshold value that was configured in this file.

Related Configuration File Numbers:

- 16-bit Counter Threshold Config File Number (In Series B)

- 32-bit Counter Threshold Config File Number (In Series B)

Word Offet	Description
Element 0	Threshold for point 0
Element 1	Threshold for point 1
Element 2	Threshold for point 2
Element 3	Threshold for point 3
Element 4	Threshold for point 4
Element 5	Threshold for point 5
…	

For Analog Input type data, you can configure Deadband information in the Configuration file. Each element can be configured to the deadband value for each point. An analog input event is generated if the absolute value of the difference between the present value of an analog input point and the value that was most recently queued as an event for that point exceeds the deadband value that was configured in this file.

Related Configuration File Numbers:

- 16-bit Analog Input Deadband Config File Number (In Series B)
- 32-bit Analog Input Deadband Config File Number (In Series B)
- Short Floating Point Analog Input Deadband Config File Number (In Series B)

Word Offet	Description
Element 0	Deadband for point 0
Element 1	Deadband for point 1
Element 2	Deadband for point 2
Element 3	Deadband for point 3
Element 4	Deadband for point 4
Element 5	Deadband for point 5
…	

For Analog Output type data, you can configure the object flag information in the Configuration file. The upper byte of the configuration file of these objects is used to configure the object flag. Other bits are reserved.

Related Configuration File Numbers:

- 16-bit Analog Input Deadband Config File Number (In Series B)
- 32-bit Analog Input Deadband Config File Number (In Series B)
- Short Floating Point Analog Input Deadband Config File Number (In Series B)

Analog Output Configuration Data File

Bit Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Element 0	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
Element 1	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
Element 2	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
Element 3	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
Element 4	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
Element 5	F7	F6	F5	F4	F3	F2	F1	F0	r	r	r	r	r	r	r	r
…																

r: reserved
F7-F0: Object Flags, FLAG7/FLAG6/FLAG5/LOCAL_FORCED/REMOTE_FORCED/COMM_LOST/RESTART/ONLINE

For Small BCD type data, you can configure Class information in the Configuration file. The lower 2 bits in each element of the Configuration files are the configuration of Class information to the relevant objects. P0 bit in the first element is for excluding Small BCD Data from Class 0 poll responses. Other bits are reserved.

Related Configuration File Numbers:

- Small BCD Config File Number

Small BCD Configuration File Data

Bit Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Element 0	r	r	r	r	r	r	r	r	P0	r	r	r	r	r	C1	C0
Element 1	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 2	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 3	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 4	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
Element 5	r	r	r	r	r	r	r	r	r	r	r	r	r	r	C1	C0
…															C1	C0

r: reserved
C1/C0 : Class level, 0 to 3
For Small BCD, Element_0 for data index 0
P0: 0 for including Small BCD Data to Class 0 poll response

DNP3 Binary Input Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read the object with all variations.

Binary Input Static Objects:

- g1v0 - Binary Input - All Variations

- g1v1 - Binary Input - Packed format (default)
- g1v2 - Binary Input - With flags

Binary Input Event Objects:

- g2v0 - Binary Input Event - All Variations
- g2v1 - Binary Input Event - Without time
- g2v2 - Binary Input Event - With absolute time
- g2v3 - Binary Input Event - With relative time (default)

Related Object File Number:

- Binary Input Object File Number

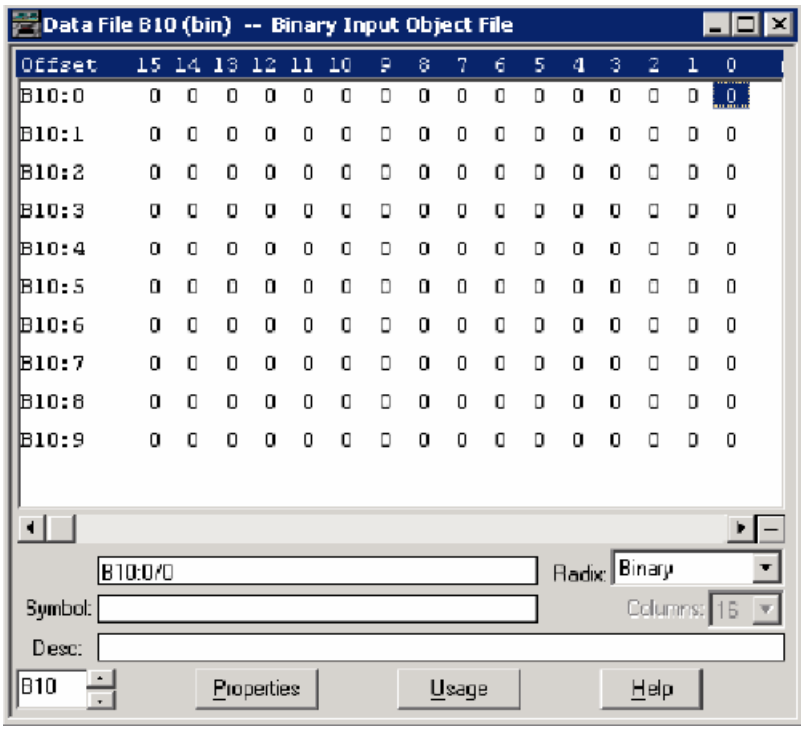
Related Configuration File Number:

- Binary Input Config File Number

To generate a Binary Input Object from the DNP3 Subsystem in the controller, you should configure Binary Input Object File Number in the DNP3 Slave Application Layer Configuration file.

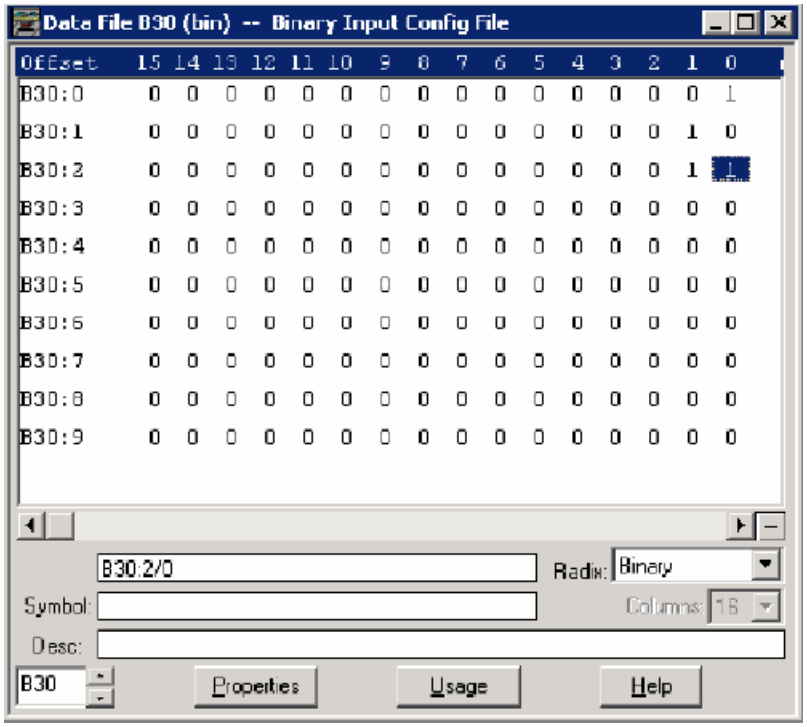
When the Binary Input Object File is configured, Index number starts from 0. 1 bit is used for 1 Index.

As an example, a Binary Input Object File is configured as shown below. This file has 10 elements and 160 Binary Input points. Index 0 of the Binary Input Object is B10:0/0, Index 1 is B10:0/1 and Index 159 is B10:9/15.



As an example, a Binary Input Config File shown below has 10 elements. B30:0/0 and B30:0/1 can be configured for Class Level 0, 1, 2 or 3 for DNP3 Index 0 to 15 of the Binary Input Object File. B30:1/0 and B30:1/1 can be configured for Class Level for DNP3 Index 16 to 31 of the Binary Input Object File. Default Class Level is 0. Any other bits are reserved.

Class Level of Index 0 to 15 is 1(B30:0/0 and B30:0/1), Class Level of Index 16 to 31 is 2(B30:1/0 and B30:1/1), Class Level of Index 32 to 47 is 3(B30:2/0 and B30:2/1), and Class Level of other Indexes are 0.



DNP3 Binary Output Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read the object with Any Variation.

Binary Output Static Objects:

- g10v0 - Binary Output - All Variations
- g10v2 - Binary Output - Output status with flags (default)

Binary Output Command Objects:

- g12v1 - Binary Command - Control relay output block (CROB)

Related Object File Number:

- Binary Output Object File Number

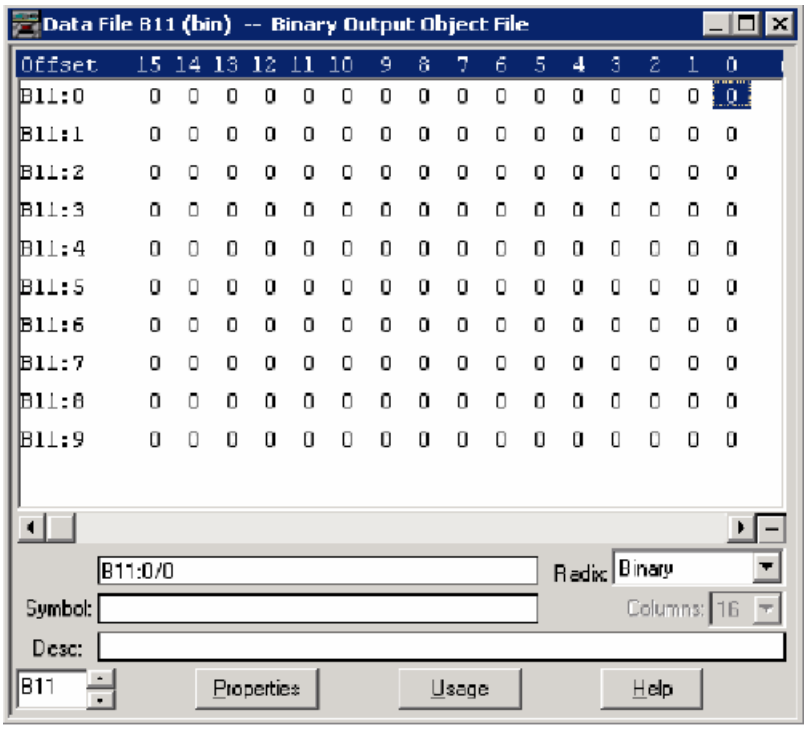
Related Configuration File Number:

- Binary Output Config File Number

To generate a Binary Output Object from the DNP3 Subsystem in the controller, you should configure Binary Output Object File Number in the DNP3 Slave Application Layer Configuration file.

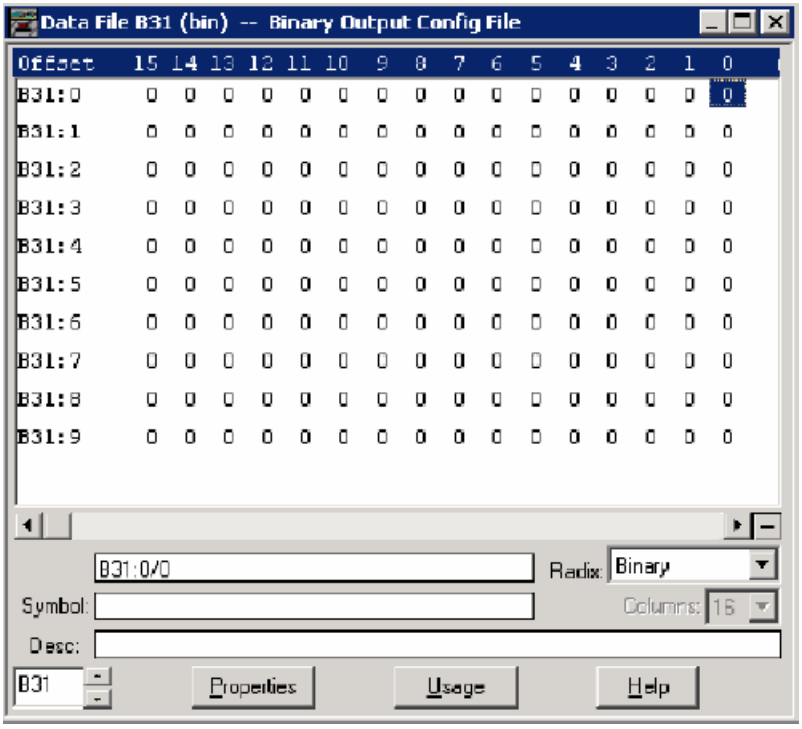
When the Binary Output Object File is configured, Index number starts from 0. 1 bit is used for 1 Index.

As an example, a Binary Output Object File is configured as shown below. This file has 10 elements and 160 Binary Output points. Index 0 of the Binary Output Object is B11:0/0, Index 1 is B11:0/1 and Index 159 is B11:9/15.



As an example, a Binary Output Config File shown below has 10 elements. Each bit can be configured for Online information (if the corresponding point is active or not, 0=offline, 1=online) of the Binary Output points. B31:0/0 is for Index 0, B31:0/1 is for Index 1 and B31:9/15 is for Index 159. In the example below, all bits are cleared and all of the points are in offline state.

If this bit is set, the Online bit in the status flag of each Binary Output points is set when you read Binary Output Status objects.



Binary Command - Control relay output block (CROB)

The MicroLogix 1400 has three control models for Binary Output Control. They are Activation model, Complementary latch model and Complementary two-output model.

For the Complementary two-output model, two bits are required to control this model in the Binary output object. The point index is different than in the Activation or Complementary latch model. The point index varies as shown in the table below. The maximum number of Binary Output index for Complementary two-output model is 2048.

Binary Output Database Index	Activation model or Complementary latch model	Complementary two-output model
0	BO Index 0	BO Close Index 0
1	BO Index 1	BO Trip Index 0
2	BO Index 2	BO Close Index 1
3	BO Index 3	BO Trip Index 1
4	BO Index 4	BO Close Index 2
5	BO Index 5	BO Trip Index 2
…	…	…
4094	BO Index 4094	BO Close Index 2047
4095	BO Index 4095	BO Trip Index 2047

These control codes and point models are implemented in the MicroLogix 1400 controller:

- 0x00 (NUL/NUL): Clear field Off
- 0x20 (NUL/NUL): Clear field On
- 0x01 (Pulse On/NUL): Clear field Off, Activation Model
- 0x21 (Pulse On/NUL): Clear field On, Activation Model
- 0x03 (Latch On/NUL): Clear field Off, Complementary latch model
- 0x23 (Latch On/NUL): Clear field On, Complementary latch model
- 0x04 (Latch Off/NUL): Clear field Off, Complementary latch model
- 0x24 (Latch Off/NUL): Clear field On, Complementary latch model
- 0x41 (Pulse On/Close): Clear field Off, Complementary two-output model
- 0x61 (Pulse On/Close): Clear field On, Complementary two-output model
- 0x81 (Pulse On/Trip): Clear field Off, Complementary two-output model
- 0xA1 (Pulse On/Trip): Clear field On, Complementary two-output model

When the MicroLogix 1400 is in Non-Executing mode, the controller will not accept a Binary Command. The MicroLogix 1400 returns a Control Status Code 7 in response. To access objects 12(CROB), the controller should be in Executing mode.

Note that Executing mode includes Run, Remote Run, Test Continuous Scan, and Test Single Scan modes. Any others are Non-Executing modes.

DNP3 Double Bit Binary Input Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read an object with Any variation.

Double-bit Binary Input Static Objects:

- g3v0 - Double-bit Binary Input - All Variations
- g3v1 - Double-bit Binary Input - Packed format (default)
- g3v2 - Double-bit Binary Input - With flags

Double-bit Binary Input Event Objects:

- g4v0 - Double-bit Binary Input Event - All Variations
- g4v1 - Double-bit Binary Input Event - Without time
- g4v2 - Double-bit Binary Input Event - With absolute time
- g4v3 - Double-bit Binary Input Event - With relative time (default)

Related Object File Number:

- Double Bit Binary Input Object File Number

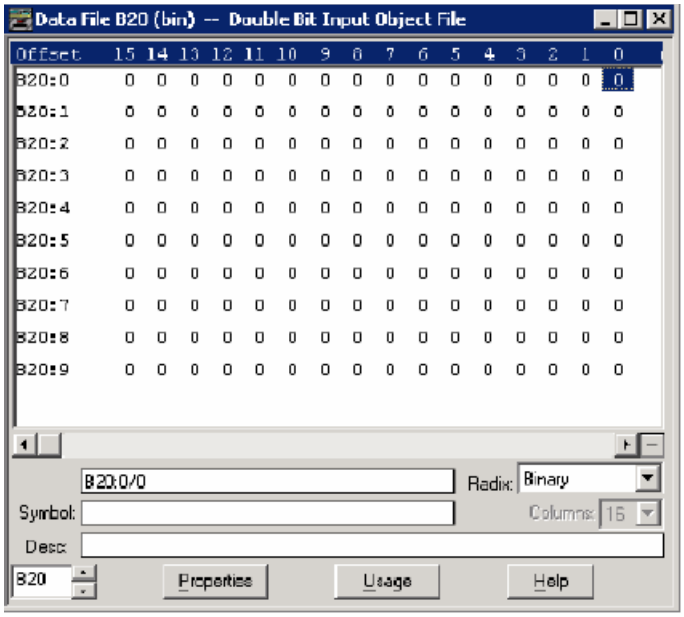
Related Configuration File Number:

- Double Bit Binary Input Config File Number

To generate a Double Bit Binary Input Object from the DNP3 Subsystem in the controller, you should configure Double Bit Binary Input Object File Number in the DNP3 Slave Application Layer Configuration file.

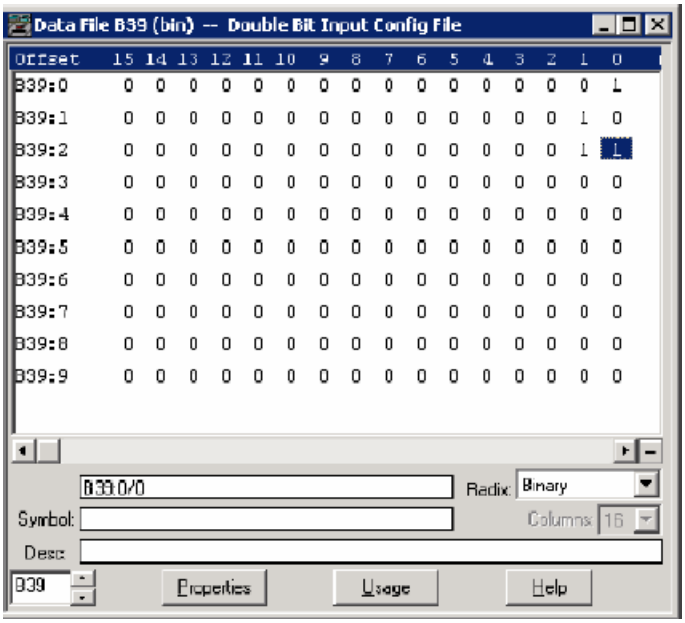
When the Double Bit Binary Input Object File is configured, the Index number starts from 0.
2 bits are used for one Index.

As an example, a Double Bit Binary Input Object File is shown below. This file has 10 elements and 80 Double Bit Binary Input points. Index 0 of the Double Bit Binary Input Object is B20:0/0 and B20:0/1, Index 1 is B20:0/2 and B20:0/3, and Index 79 is B20:9/14 and B20:9/15.



As an example, a Double Bit Binary Input Config File is shown below. This file has 10 elements. B39:0/0 and B39:0/1 can be configured for Class Level 0, 1, 2 or 3 for DNP3 Index 0 to 7 of the Double Bit Binary Input Object File. B39:1/0 and B39:1/1 can be configured for Class Level for DNP3 Index 8 to 15 of the Double Bit Binary Input Object File. Default Class Level is 0. Any other bits are reserved. So, in the example below, Class Level of Index 0 to 7 is 1(B39:0/0 and

B39:0/1), Class Level of Index 8 to 15 is 2(B39:1/0 and B39:1/1), Class Level of Index 16 to 23 is 3(B39:2/0 and B39:2/1), and Class Level of other Indexes are 0.



DNP3 Counter Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read an object with Any variation.

Counter Static Objects:

- g20v0 - Counter - Any Variation
- g20v1 - Counter - 32-bit with flag
- g20v2 - Counter - 16-bit with flag
- g20v5 - Counter - 32-bit without flag (default)
- g20v6 - Counter - 16-bit without flag (default)

Counter Event Objects:

- g22v0 - Counter Event - Any Variation
- g22v1 - Counter Event - 32-bit with flag (default)
- g22v2 - Counter Event - 16-bit with flag (default)

Related Object File Number:

- 16-bit Counter Object File Number
- 32-bit Counter Object File Number

Related Configuration File Number:

- 16-bit Counter Config File Number

- 32-bit Counter Config File Number

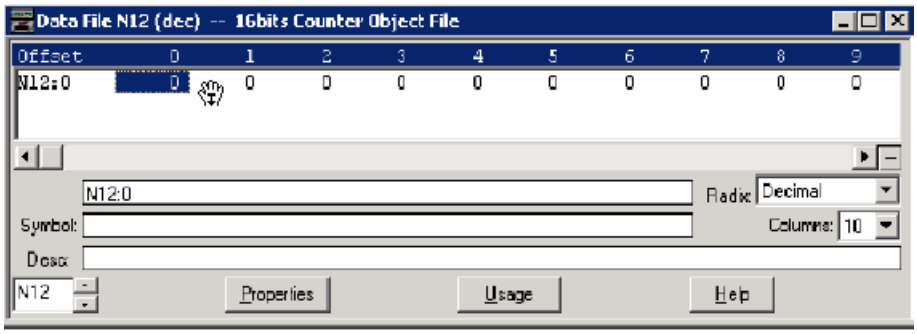
To generate a Counter Object from the DNP3 Subsystem in the controller, you should configure Counter Object File Numbers in the DNP3 Slave Application Layer Configuration file.

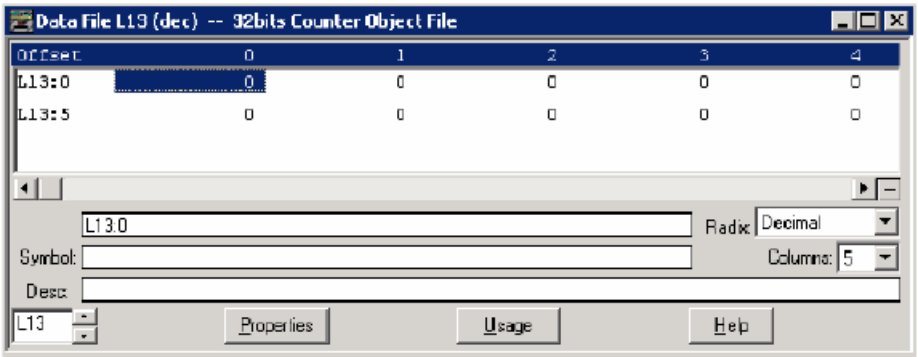
When only one Counter Object File is configured, the Index number starts from 0 for the configured object. One word is used for one Index of a 16-bit Counter Object and one double word is used for one Index of a 32-bit Counter Object.

If both the 16-bit Counter Object File Number and 32-bit Counter Object File Number were configured in the DNP3 Slave Application Layer Configuration file, the starting index number of 16-bit Counter Object is 0 and the starting index number of 32-bit Counter Object starts from the ending index number of the 16-bit Counter Object. For example, if 10 elements of a 16-bit Counter Object were configured and 10 elements of a 32-bit Counter Object were configured, the index number will be as below:

- 16-bit Counter Object: From 0 to 9
- 32-bit Counter Object: From 10 to 19

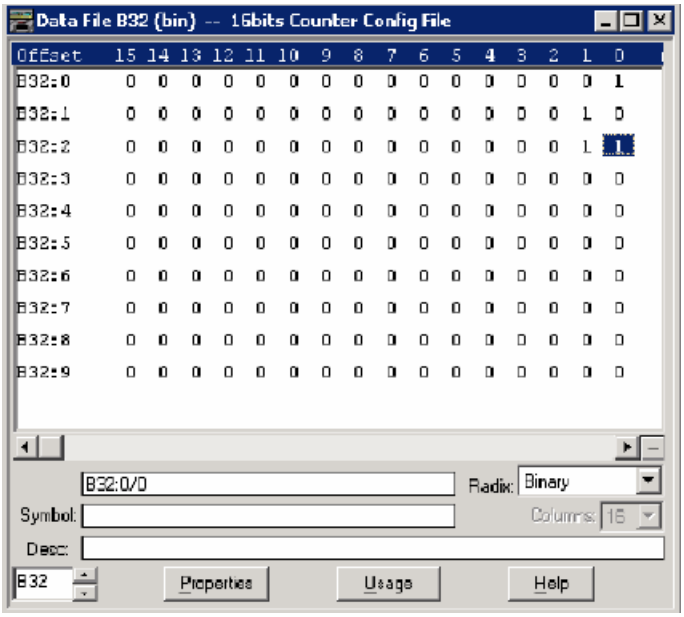
Let's suppose you configured both 16-bit and 32-bit Counter Object Files as below. Data File N12 has 10 elements and L13 has 10 elements accordingly. In total, 20 Counter Object indexes are configured. Index 0 of the Counter Object is N12:0, Index 1 is N12:1, Index 10 is L13:0 and Index 19 is L13:9.



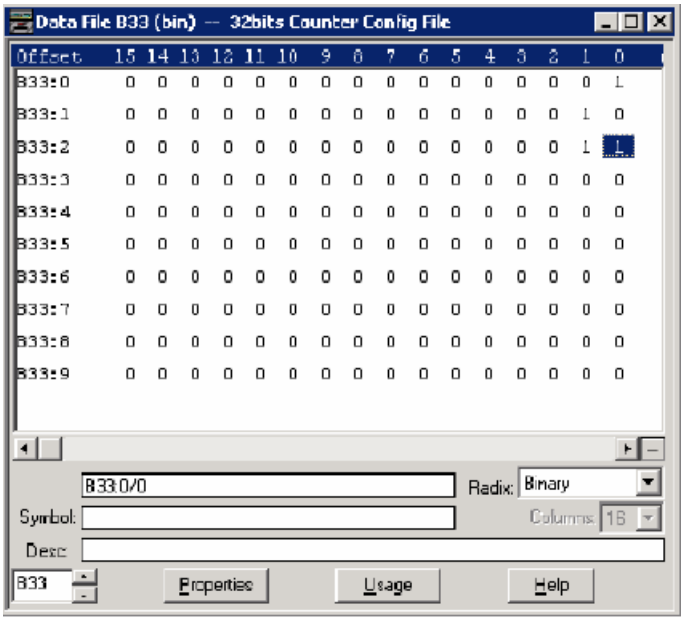


As an example, a Counter Config File is shown below. These files have 10 elements for each. B32:0/0 and B32:0/1 can be configured for Class Level 0, 1, 2

or 3 for DNP3 Index 0 of the 16 bits Counter Object File. B32:1/0 and B32:1/1 can be configured for Class Level for DNP3 Index 1 of the Counter Object File. Default Class Level is 0. Any other bits are reserved. So, in the example below, for 16-bit Counter Config File, Class Level of Index 0 is 1(B32:0/0 and B32:0/1), Class Level of Index 1 is 2(B32:1/0 and B32:1/1), Class Level of Index 2 is 3(B32:2/0 and B32:2/1), and Class Level of other Indexes are 0.



For a 32-bit Counter Config File, Class Level of Index 10 is 1(B33:0/0 and B33:0/1), Class Level of Index 11 is 2(B33:1/0 and B33:1/1), Class Level of Index 12 is 3(B33:2/0 and B33:2/1), and Class Level of other Indexes are 0.



DNP3 Frozen Counter Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read the object with all variations.

Frozen Counter Static Objects:

- g21v0 - Frozen Counter - All Variations
- g21v1 - Frozen Counter - 32-bit with flag
- g21v2 - Frozen Counter - 16 bit with flag
- g21v5 - Frozen Counter - 32-bit with flag and time
- g21v6 - Frozen Counter - 16-bit with flag and time
- g21v9 - Frozen Counter - 32-bit without flag (default)
- g21v10 - Frozen Counter - 16-bit without flag (default)

Frozen Change Event Objects:

- g23v0 - Frozen Counter Event - All Variations
- g23v1 - Frozen Counter Event - 32-bit with flag (default)
- g23v2 - Frozen Counter Event - 16-bit with flag (default)
- g23v5 - Frozen Counter Event - 32-bit with flag and time
- g23v6 - Frozen Counter Event - 16-bit with flag and time

Related Object File Number:

- 16-bit Counter Object File Number
- 32-bit Counter Object File Number

Related Configuration File Number:

- 16-bit Frozen Counter Config File Number
- 32-bit Frozen Counter Config File Number

To generate a Frozen Counter Object from the DNP3 Subsystem in the controller, you should configure Counter Object File Number in the DNP3 Slave Application Layer Configuration file.

The number of elements for Frozen Counter Object is the same as the number of Counter Objects. For example, if 10 Counter elements were configured, 10 Frozen Counter elements will be generated in the MicroLogix 1400 controllers internally. You cannot access the Frozen Counter database directly.

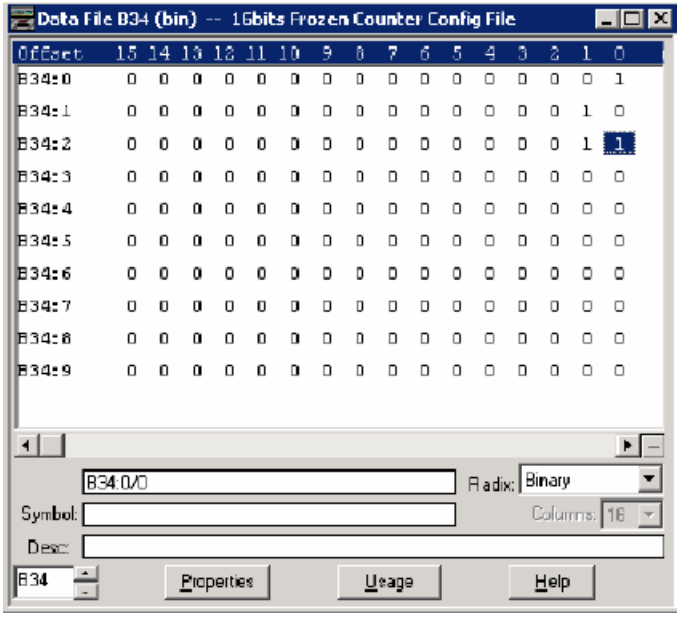
There is one buffer for Frozen Counter Object. Read the Frozen Counter Object before you send another request with Freeze function codes. If two consecutive Freeze function codes are received without Read operation into them for Frozen Counter Object, the values of Frozen Counter Objects are overwritten by the second Freeze operation.

If both 16-bit Counter Object File Number and 32-bit Counter Object File Number were configured in the DNP3 Slave Application Layer Configuration file, the 16-bit Frozen Counter Object starting index number is 0 and the 32-bit Frozen Counter Object starting index number of starts after the last index number for 16-bit Frozen Counter Object. For example, if 10 elements of 16-bit Counter Object were configured and 10 elements of 32-bit Counter Object were configured, the index numbers will be:

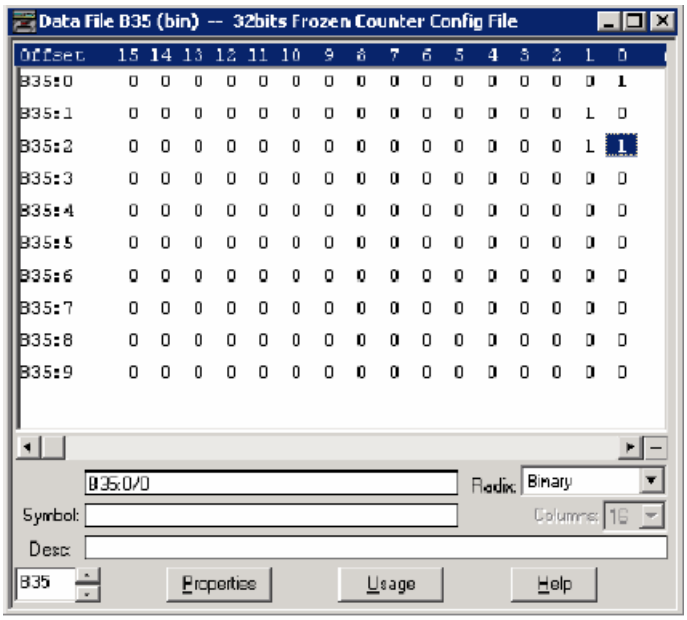
- 16-bit Frozen Counter Object: From 0 to 9
- 32-bit Frozen Counter Object: From 10 to 19

When only one of the Counter Object File was configured, Index number starts from 0 for the configured object.

As an example, a Frozen Counter Config File is shown below. These files have 10 elements for each. B34:0/0 and B34:0/1 can be configured for Class Level 0, 1, 2 or 3 for DNP3 Index 0 of the 16 bits Frozen Counter Object File. B34:1/0 and B34:1/1 can be configured for Class Level for DNP3 Index 1 of the Counter Object File. Default Class Level is 0. Any other bits are reserved. So, in the example below, for 16-bit Frozen Counter Config File, Class Level of Index 0 is 1(B34:0/0 and B34:0/1), Class Level of Index 1 is 2(B34:1/0 and B34:1/1), Class Level of Index 2 is 3(B34:2/0 and B34:2/1), and Class Level of other Indexes are 0.



For 32-bit Frozen Counter Config File, Class Level of Index 10 is 1(B35:0/0 and B35:0/1), Class Level of Index 11 is 2(B35:1/0 and B35:1/1), Class Level of Index 12 is 3(B35:2/0 and B35:2/1), and Class Level of other Indexes are 0.



DNP3 Analog Input Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read the object with Any variation.

Analog Input Static Objects:

- g30v0 - Analog Input - Any Variations
- g30v1 - Analog Input - 32-bit with flag
- g30v2 - Analog Input - 16-bit with flag
- g30v3 - Analog Input - 32-bit without flag (default)
- g30v4 - Analog Input - 16-bit without flag (default)
- g30v5 - Analog Input - Single-prec flt-pt with flag (default)

Analog Input Event Objects:

- g32v0 - Analog Input Event - Any Variation
- g32v1 - Analog Input Event - 32-bit without time (default)
- g32v2 - Analog Input Event - 16-bit without time (default)
- g32v3 - Analog Input Event - 32-bit with time
- g32v4 - Analog Input Event - 16-bit with time
- g32v5 - Analog Input Event - Single-prec flt-pt without time (default)
- g32v7 - Analog Input Event - Single-prec flt-pt with time

Related Object File Number:

- 16-bit Analog Input Object File Number
- 32-bit Analog Input Object File Number
- Short Floating Point Analog Input Object File Number

Related Configuration File Number:

- 16-bit Analog Input Config File Number
- 32-bit Analog Input Config File Number
- Short Floating Point Analog Input Config File Number

To generate an Analog Input Object from the DNP3 Subsystem in the controller, you should configure Analog Input Object File Number in the DNP3 Slave Application Layer Configuration file.

When only one Analog Input Object File is configured, the Index number starts from 0 for the configured object. 1 word is used for 1 Index of 16-bit Analog Input Object, 1 double word is used for 1 Index of 32-bit Analog Input Object, and 1 short float is used for 1 Index of Short Floating Point Analog Input Object.

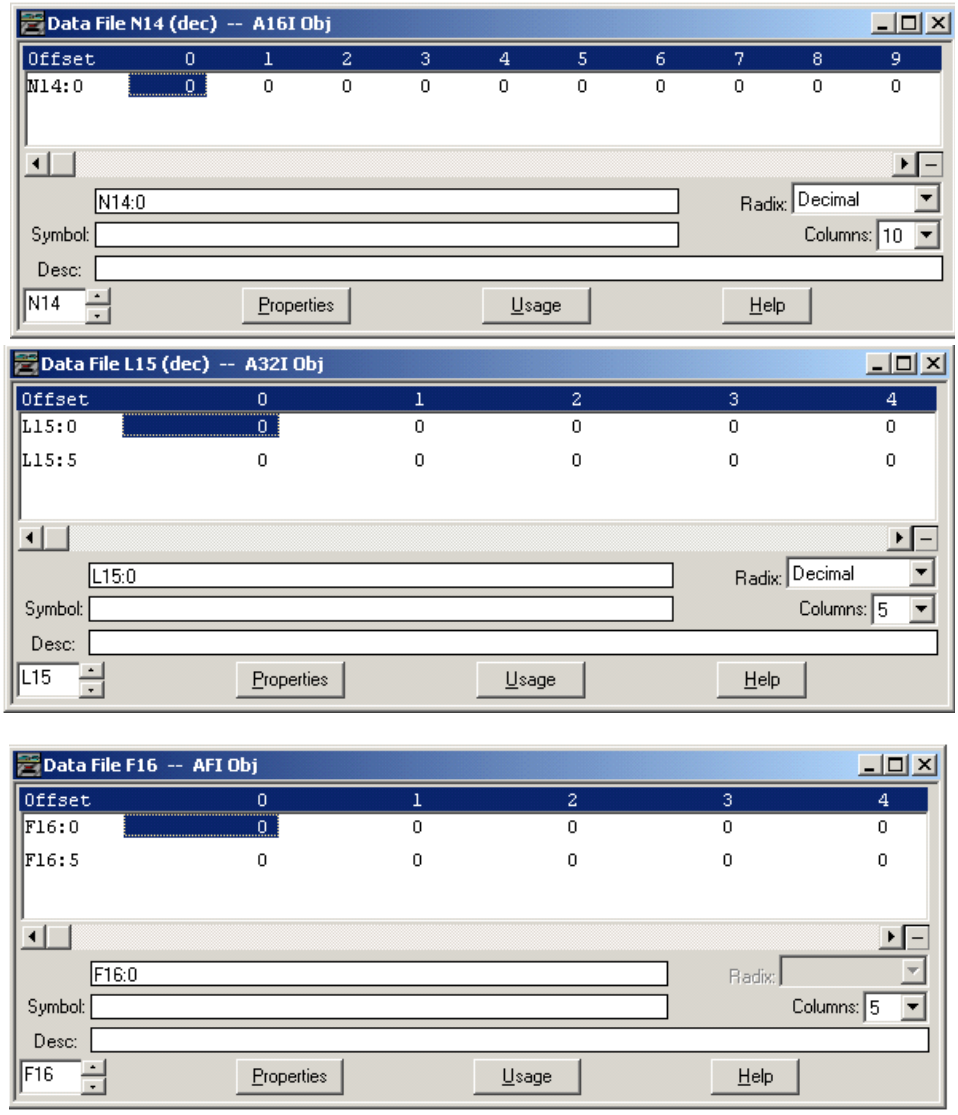
If 16-bit Analog Input Object File Number, 32-bit Analog Input Object File Number, and Short Floating Point Analog Input Object File Number were configured in the DNP3 Slave Application Layer Configuration file, the starting index number of 16-bit Analog Input Object is 0 and the starting index number of 32-bit Analog Input Object starts from the ending index number of 16-bit Analog Input Object.

For example, if 10 elements of 16-bit Analog Input Object were configured, 10 elements of 32-bit Analog Input Object, and 10 elements of Short Floating Point Analog Input Object were configured, the index numbers will be:

- 16-bit Analog Input Object: From 0 to 9
- 32-bit Analog Input Object: From 10 to 19
- Short Floating Point Analog Input Object: From 20 to 29

As an example, a configuration of 16-bit, 32-bit and Short Floating Point Analog Input Object Files is shown below. Data File N14 has 10 elements, L15 has 10 elements and F16 has 10 elements accordingly. A total of 30 Analog Input Object

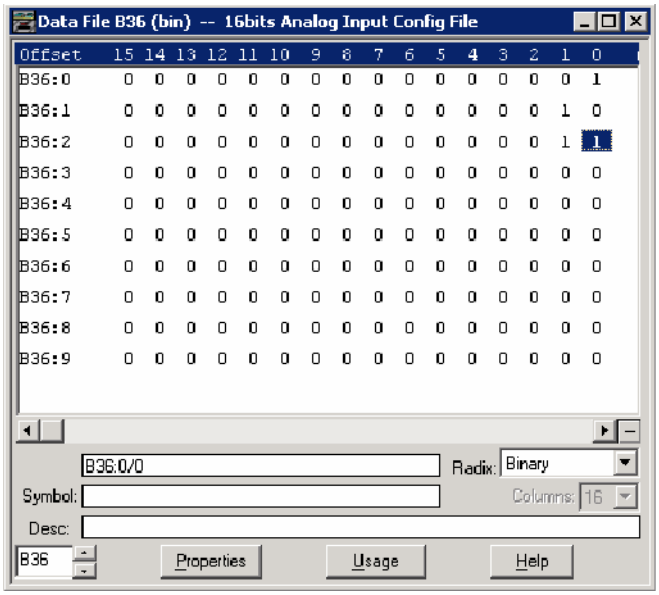
indexes are configured. Index 0 of the Analog Input Object is N14:0, Index 10 is L15:0, Index 20 is F16:0 and Index 29 is F16:9.



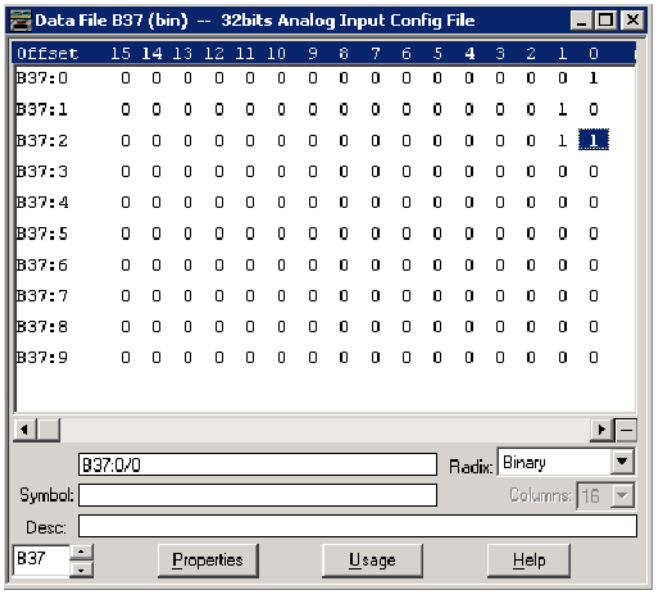
As an example, an Analog Input Config File is shown below. These files have 10 elements each.

B36:0/0 and B36:0/1 can be configured for Class Level 0, 1, 2 or 3 for DNP3 Index 0 of the 16 bits Analog Input Object File.
B36:1/0 and B36:1/1 can be configured for Class Level for DNP3 Index 1 of the Analog Input Object File. Default Class Level is 0. Any other bits are reserved.
In the example below, for 16-bit Analog Input Config File, Class Level of Index 0 is 1(B36:0/0 and B36:0/1), Class Level of Index 1 is 2(B36:1/0 and B36:1/1),

Class Level of Index 2 is 3(B36:2/0 and B36:2/1), and Class Level of other Indexes are 0.

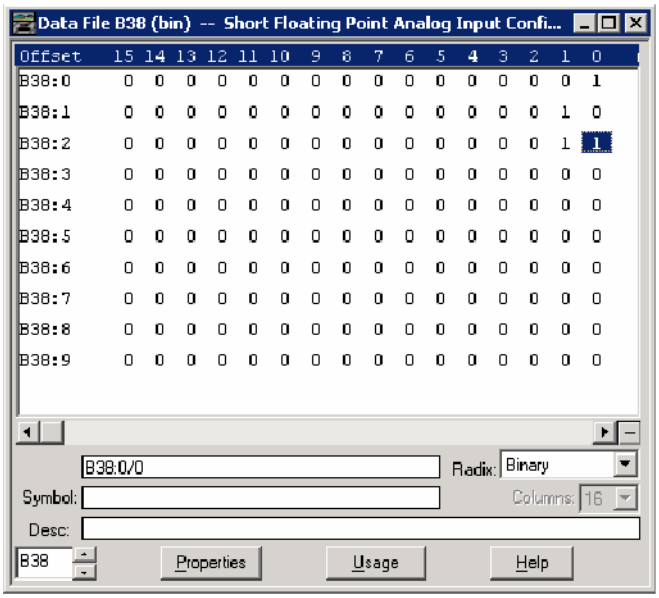


For a 32-bit Analog Input Config File, Class Level of Index 10 is 1(B37:0/0 and B37:0/1), Class Level of Index 11 is 2(B37:1/0 and B37:1/1), Class Level of Index 12 is 3(B37:2/0 and B37:2/1), and Class Level of other Indexes are 0.



For Short Floating Point Analog Input Config File, Class Level of Index 20 is 1(B38:0/0 and B38:0/1), Class Level of Index 21 is 2(B38:1/0 and B38:1/1),

Class Level of Index 22 is 3(B38:2/0 and B38:2/1), and Class Level of other Indexes are 0.



DNP3 Analog Output Object

The supported object group and variations are listed in this section. The MicroLogix 1400 responds with the default group and variation when the DNP3 Master requests to read an object with Any variation.

Analog Output Status Objects:

- g40v0 - Analog Output Status - Any Variations
- g40v1 - Analog Output Status - 32-bit with flag (default)
- g40v2 - Analog Output Status - 16-bit with flag (default)
- g40v3 - Analog Output Status - Single-prec flt-pt with flag (default)

Analog Output Command Objects:

- g41v1 - Analog Output - 32-bit
- g41v2 - Analog Output - 16-bit
- g41v3 - Analog Output - Single-prec flt-pt

Related Object File Number:

- 16-bit Analog Output Object File Number
- 32-bit Analog Output Object File Number
- Short Floating Point Analog Output Object File Number

Related Configuration File Number:
- None

To generate Analog Output Object from the DNP3 Subsystem in the controller, you should configure the Analog Output Object File Number in the DNP3 Slave Application Layer Configuration file.

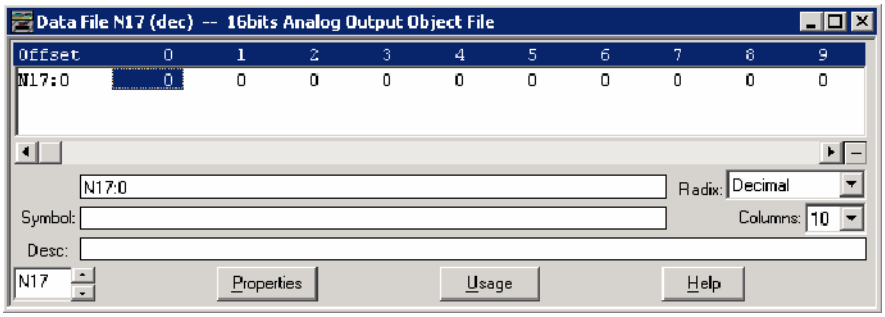
When only one of the Analog Output Object File is configured, Index number starts from 0 for the configured object. 1 word is used for 1 Index of 16-bit Analog Output Object, 1 double word is used for 1 Index of 32-bit Analog Output Object, and 1 short float is used for 1 Index of Short Floating Point Analog Output Object.

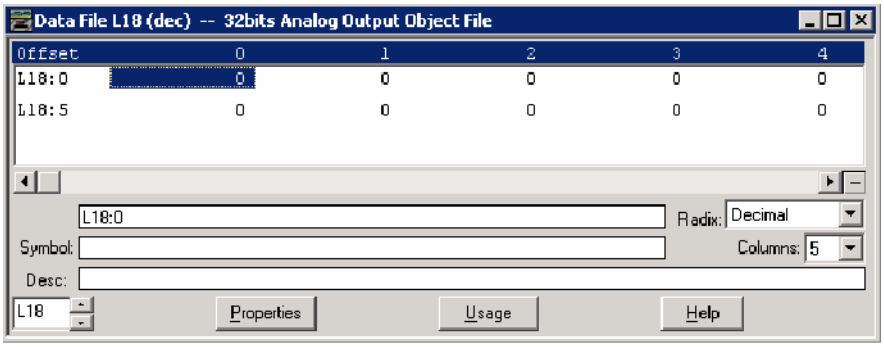
If the 16-bit Analog Output Object File Number, 32-bit Analog Output Object File Number, and Short Floating Point Analog Output Object File Number are configured in the DNP3 Slave Application Layer Configuration file, the starting index number of 16-bit Analog Output Object is 0 and the starting index number of 32-bit Analog Output Object starts from the last index number of 16-bit Analog Output Object.

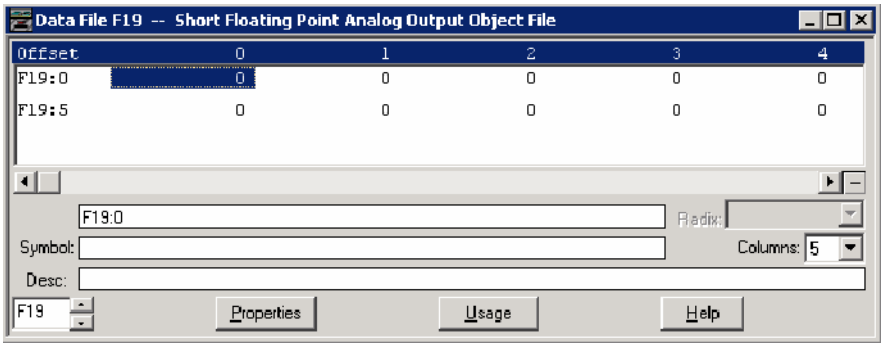
For example, if 10 elements of 16-bit Analog Output Object are configured, 10 elements of 32-bit Analog Output Object, and 10 elements of Short Floating Point Analog Output Object are configured, the index numbers will be:

- 16-bit Analog Output Object: From 0 to 9
- 32-bit Analog Output Object: From 10 to 19
- Short Floating Point Analog Output Object: From 20 to 29

As an example, 16-bit, 32-bit and Short Floating Point Analog Output Object Files are configured as below. Data File N17 has 10 elements, L18 has 10 elements and F19 has 10 elements accordingly. A total of 30 Analog Output Object index are configured. Index 0 of the Analog Output Object is N17:0, Index 10 is L18:0, Index 20 is F19:0 and Index 29 is F19:9.







Analog Output Command - Control analog output block (AOB)

When the controller is in Non-Executing mode, the MicroLogix 1400 will not accept an Analog Output Command. The MicroLogix 1400 returns a Control Status Code 7 in the response. To access the objects 41(AOB), the controller mode should be in Executing mode.

Note that Executing mode includes Run, Remote Run, Test Continuous Scan, and Test Single Scan modes. Any other modes are Non-Executing modes.

DNP3 BCD Object

The supported object group and variations are as below.

Numeric Static Objects:

- g101v1 - Binary-Coded Decimal Integer - Small

Related Object File Number:

- Small BCD Object File Number

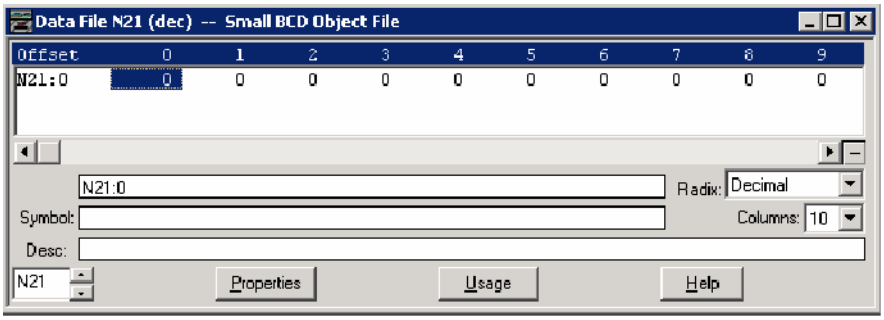
Related Configuration File Number:

- Small BCD Config File Number

To generate a Small BCD Object from the DNP3 Subsystem in the controller, you should configure the Small BCD Object File Number in the DNP3 Slave Application Layer Configuration file.

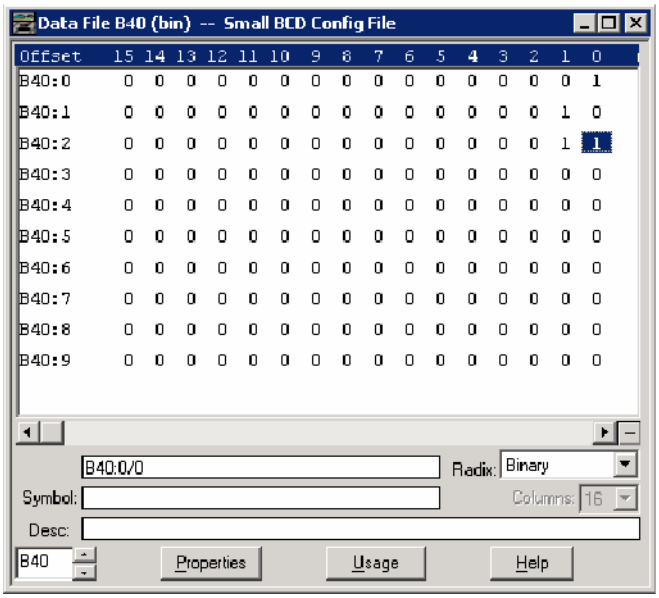
When a Small BCD Object File is configured, the Index number starts from 0. 1 word is used for 1 Index of Small BCD Object.

As an example, a Small BCD Object File is configured as shown below. Data File N21 has 10 elements. Index 0 of the Small BCD Object is N21:0, Index 1 is N21:1 and Index 9 is N21:9.



As an example, a Small BCD Config File is configured as shown below. The file has 10 elements. B40:0/0 and B40:0/1 can be configured for Class Level 0, 1, 2 or 3 for DNP3 Index 0 of the Small BCD Object File. B40:1/0 and B40:1/1 can be configured for Class Level for DNP3 Index 1 of the Small BCD Object File. Default Class Level is 0. Any other bits are reserved.

In the example below, for Small BCD Config File, Class Level of Index 0 is 1(B40:0/0 and B40:0/1), Class Level of Index 1 is 2(B40:1/0 and B40:1/1), Class Level of Index 2 is 3(B40:2/0 and B40:2/1), and Class Level of other Indexes are 0.



DNP3 Data Set Object

This feature is supported only in MicroLogix 1400 Series B controllers.

These object groups and variations are supported.

Data Set Objects:

- g85v0 - Data Set Prototype - Any Variation
- g85v1 - Data Set Prototype - With UUID
- g86v1 - Data Set Descriptor - Data set contents
- g86v2 - Data Set Descriptor - Characteristics
- g87v0 - Static Data Set - Any Variation
- g87v1 - Static Data Set - Present value
- g88v0 - Event Data Set - Any Variation
- g88v1 - Event Data Set - Snapshot

Related Object/Configuration File Number:

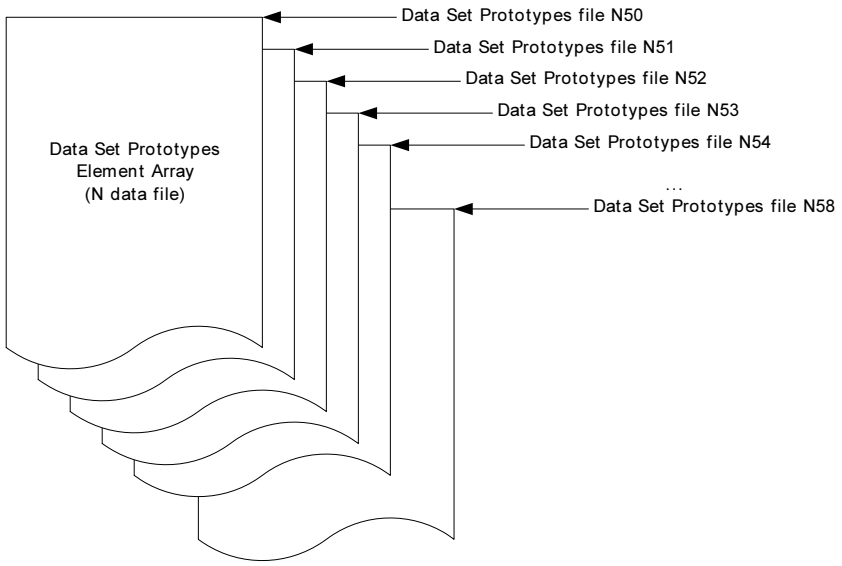
- Data Set Prototypes Object File Number
- Data Set Descriptors Object File Number

To generate a Data Set Object from the DNP3 Subsystem in the controller, configure Data Set Prototypes/Descriptors Object File Number in the DNP3 Slave Application Layer Configuration file and also the Maximum Number of Data Set Prototypes/Descriptors Files.

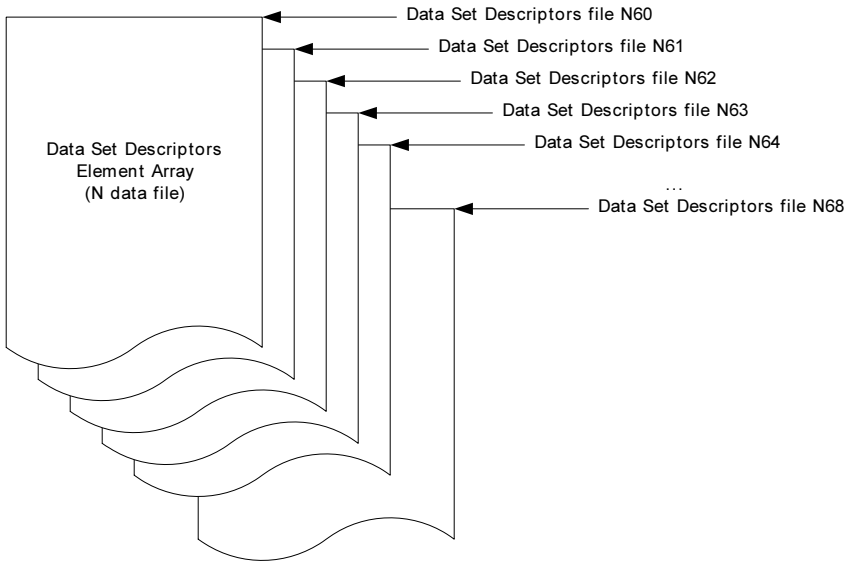
Each Data Set Prototypes Object file (N data file) can have up to 10 elements of Data Set Prototypes, and each Data Set Descriptors Object file (N data file) can have up to 10 elements of Data Set Descriptors.

As an example, with Data Set Prototypes files, if you configure "Data Set Prototypes Object File Numbers" to 50 and "Maximum Number of Data Set

Prototypes Files" to 9, N Data files 50 to 58 are reserved to store the structure of the Data Set Prototypes configuration.

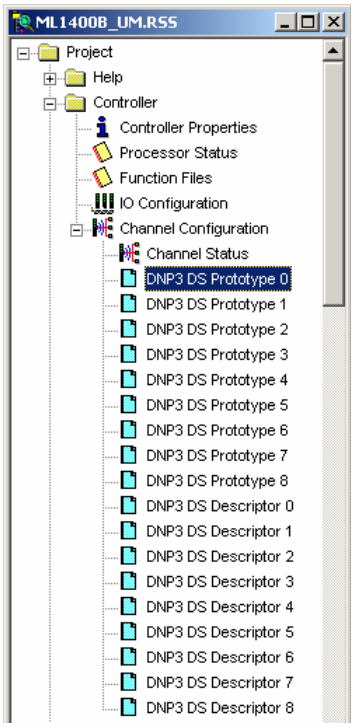


As an example, with Data Set Descriptors files, if you configure "Data Set Descriptors Object File Number" to 60 and "Maximum Number of Data Set Descriptors File" to 9, N Data files 60 to 68 are reserved to store the structure of the Data Set Descriptors configuration.

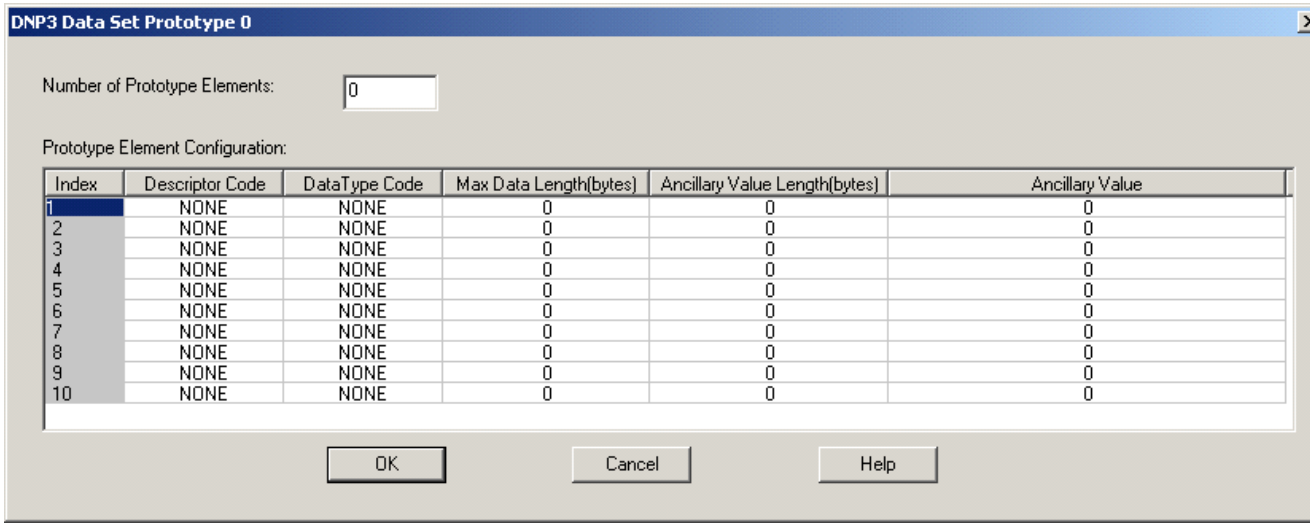


Once the Data Set Prototypes and Descriptors are configured in the DNP3 Slave Application Layer Configuration of RSLogix500/RSLogix Micro software, you can see the DNP3 DS Prototype X and DNP3 DS Descriptor X trees under the

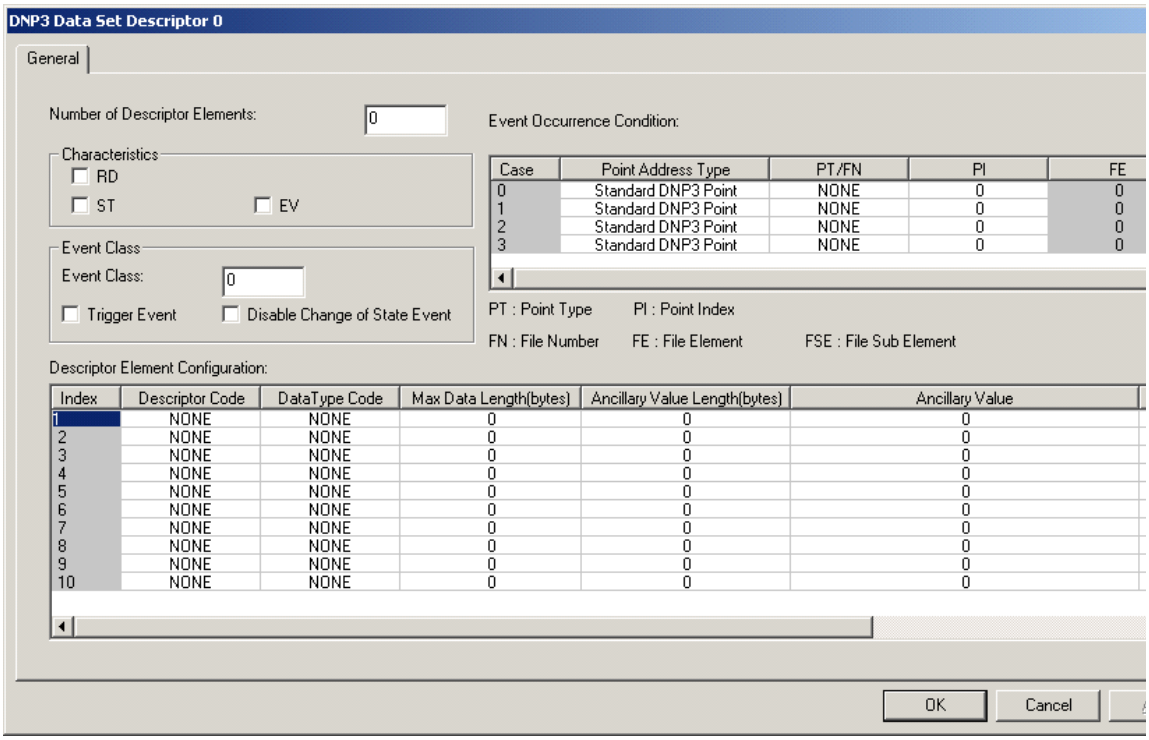
Channel Configuration of RSLogix 500/RSLogix Micro software, where "X" is the element numbers of each Prototype or Descriptor.



For DNP3 DS Prototype X, you can configure the MicroLogix 1400 to construct the Data Set Prototype objects.

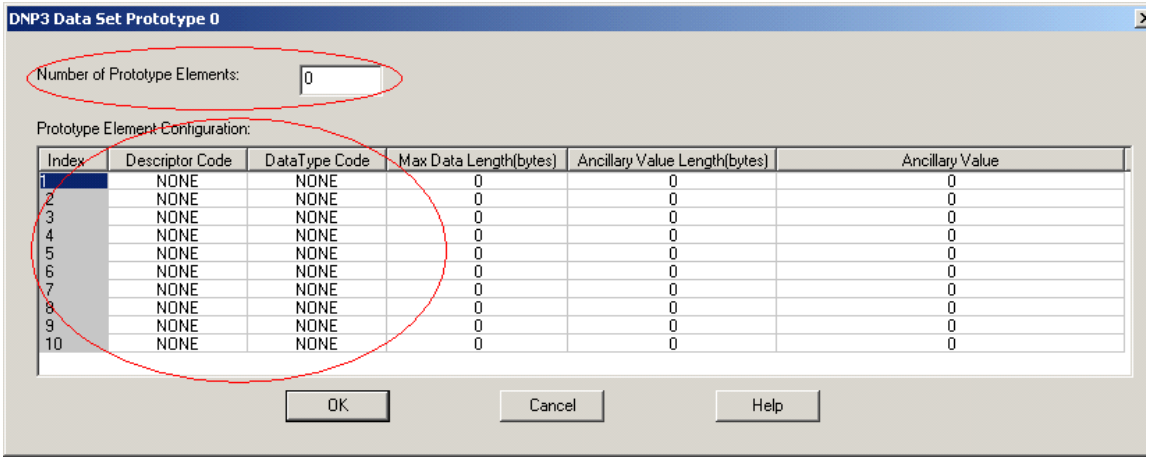


For DNP3 DS Descriptor X, you can configure the MicroLogix 1400 to construct the Data Set Descriptor objects.



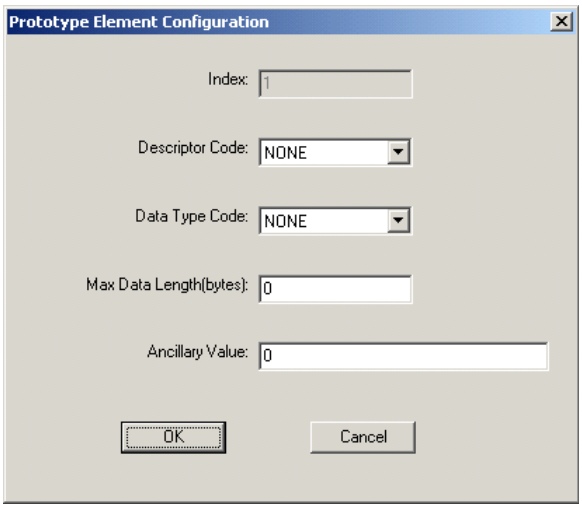
Data Set Prototypes Configuration Parameters

These parameters are used to construct Data Set Prototypes object.



Number of Prototypes Elements: 0...10. This must be the same as the number of the Prototype elements that are configured.

Prototype Element Configuration: Each Prototypes element is configured in this configuration. Double-click an element to edit it.



Descriptor Code: UUID for element 1. NSPC/NAME/DAEL for element 2 or higher.

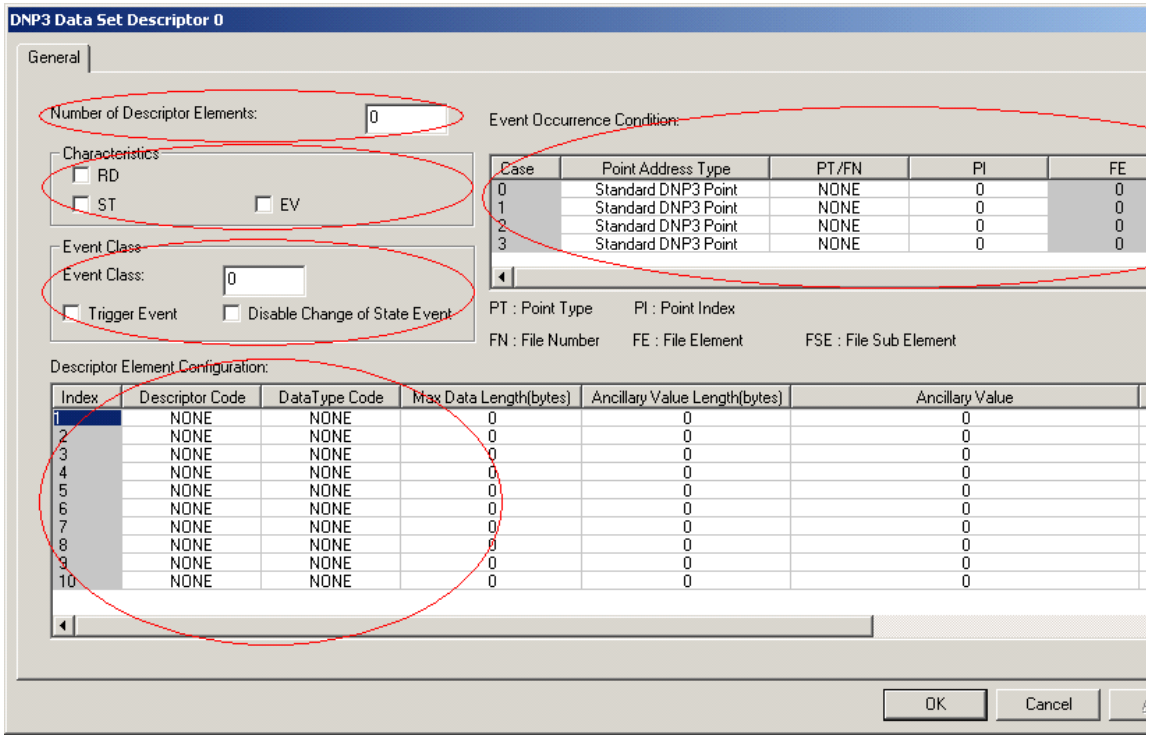
Data Type Code: NONE for element 1. NONE/VSTR/UINT/INT/FLT/OSTR/BSTR/TIME for element 2 or higher.

Max Data Length (bytes): 0 for element 1. 0...255 for element 2 or higher.

Ancillary Value: Binary Array in hexadecimal for element 1. ASCII strings for element 2 or higher. Maximum 32 bytes.

Data Set Descriptors Configuration Parameters

These parameters are used to construct Data Set Descriptors objects.



Number of Descriptor Elements: 0...10. This must be the same as the number of the Descriptor elements that are configured.

Characteristics: Used to assign characteristics to this Descriptor.

- RD - set if data set is readable.
- ST - set if outstation maintains a static data set.
- EV - set if outstation generates a data set event.

Event Class - Used to assign Event Class to this Descriptor.

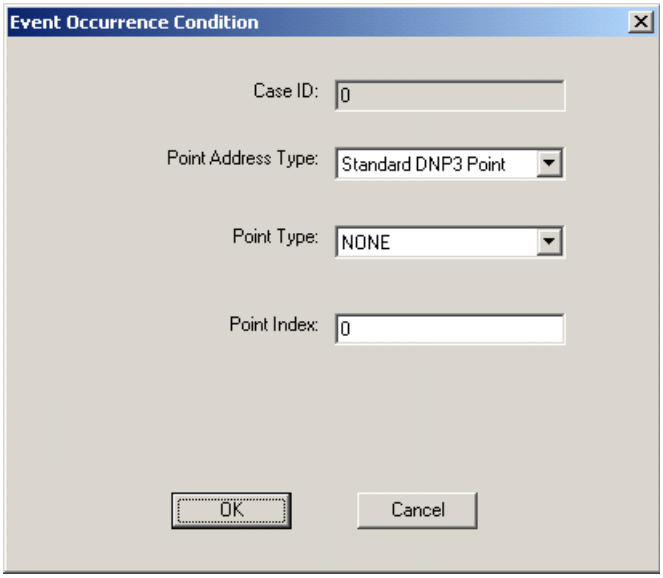
- 0 - None
- 1 - Class 1
- 2 - Class 2
- 3 - Class 3

Trigger Event: Set this parameter to generate an event unconditionally. This bit can also be set by the ladder logic to generate timed events. Once this parameter is set by the ladder logic or communications, the MicroLogix 1400 clears it automatically after generating an event at the end of scan. This parameter is stored as a bit in the relevant Data Set Descriptor Config file and the bit can be accessed by Nx:2/4 where x is the relevant Data Set Descriptor Config file number.

Disable Change of State Event: Setting this parameter suppresses the events generated by any Event Occurrence Condition.

Event Occurrence Condition: The conditions of Data Set Event for each Data Set Descriptor can be configured by Data Set Event Occurrence Condition 0/1/2/3 in the DNP3 Data Set Descriptors Object File. When one of the values that are pointing to the Event Occurrence Condition 0/1/2/3 are changed or the criteria are met, the MicroLogix 1400 generates a Data Set Event, retrievable using the object g88v1.

This table shows the supported conditions for Point Addressing. Double-click each case element to edit it.

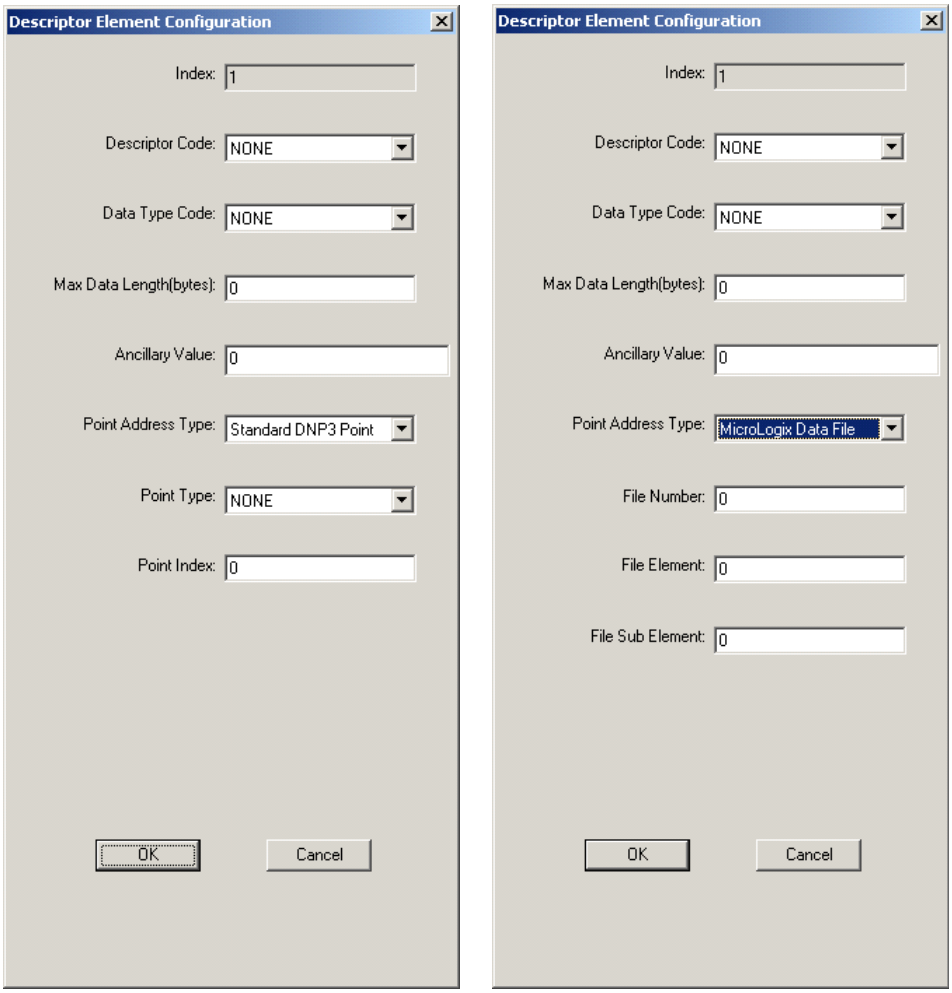


Point Addressing under Event Occurrence Conditions: Valid selections are shown below.

Point Address Type	Point Type	Point Index	Event Occurence Condition
Standard DNP3 Point	NONE : No point type is associated.	0	No Event is generated.
	BI : Binary input	0 to 4095	When the Point Type and Point Index are pointing a specific point, if the value of the point is changed, an event is generated.
	B2I : Double-bit input	0 to 2047	
	CI : Counter	0 to 511	
	AI : Analog input	0 to 767	
	BCD : BCD point	0 to 255	
	Reserved for others.	Reserved for others.	No Event is generated.

Note that a Data Set event can consume any number of event buffers, depending on the Data Set configuration. This is only applicable to Data Set events. The event for other objects consumes a single event buffer. When using Data Set events, increase the number of events in the DNP3 Slave configuration.

Descriptor Element Configuration: Each Descriptors element is configured in this here. Double-click each element to edit it.



Descriptor Code: NONE, NAME, DAEL, PTYP

Data Type Code: NONE, VSTR, UINT, INT, FLT, OSTR, BSTR, TIME

Max Data Length (bytes): 0...255

Ancillary Value: Any string. This can be a binary array or ASCII string, up to 16 words.

Point Addressing under Descriptor Element Configuration: Data Set value for each Data Set element is configured by:

- Point Address Type
- Point Type
- Point Index

- File Number
- File Element
- File Sub Element.

When these values are configured properly according to the supported data files, the MicroLogix 1400 responds with a g87v1 object filled with the value in the data file. The following table shows the supported data files for the Point Addressing.

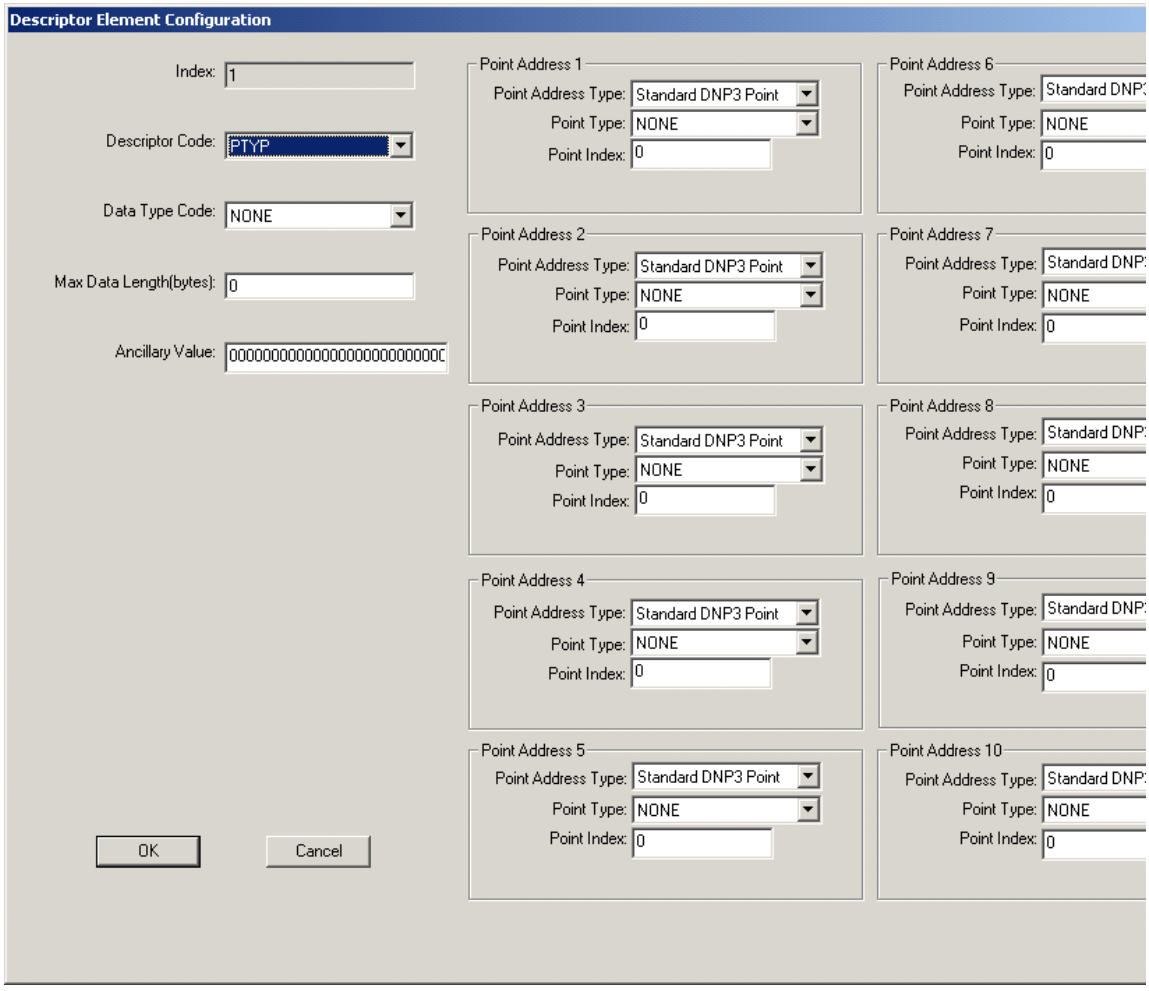
Point Address Type — Standard DNP3 Point

Point Address Type	Data Type Code	Maximum Data Length (bytes)	Point Type	Point Index Low Byte	Point Index High Byte
Standard DNP3 Point	NONE = 0	0	NONE = 0: No point type is associated.	0	
	NONE = 0 UINT = 2 INT = 3 OSTR = 5 BSTR = 6 TIME = 7	0 0, 1, 2 or 4 0, 1, 2 or 4 0 to 255 0 to 255 0 or 6	BI = 1: Binary input	0 to Maximum 4095 When the Data Types other than OSTR and BSTR are used, the Point Index must be set to a point offset that is divisible by 16.	
			B2I = 3: Double-bit input	0 to Maximum 2047 When the Data Types other than OSTR and BSTR are used, the Point Index must be set to a point offset that is divisible by 8.	
			CI = 20: Counter	0 to Maximum 511	
			AI = 30: Analog input	0 to Maximum 767	
			BCD = 101: BCD point	0 to Maximum 255	

Point Address Type — MicroLogix Data File

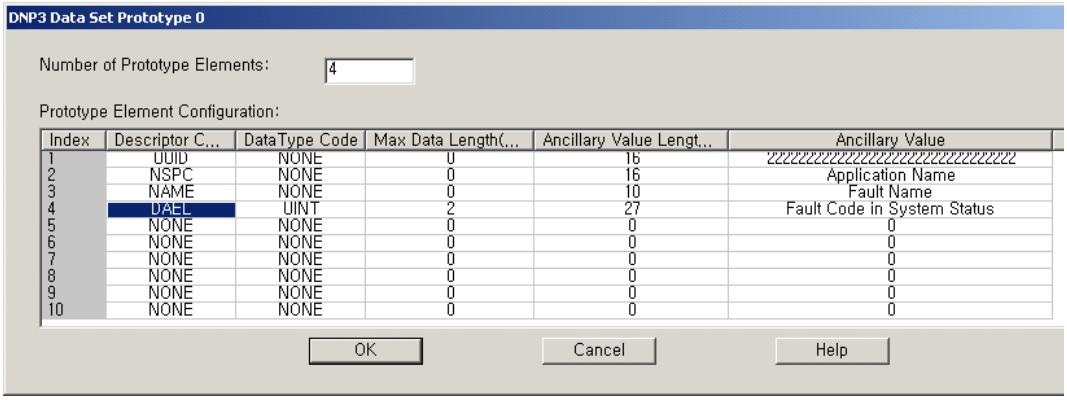
Point Address Type	Data Type Code	Maximum Data Length (bytes)	File Number	File Element	File Sub-Element
MicroLogix Data File	NONE = 0	0	0	0	0
	VSTR = 1	0…82	9…255 (ST)	9…255	0…40
	UINT = 2	0, 1, 2 or 4	2(S) 3, 9…255 (B) 7, 9…255 (N) 9…255 (L)	0…65 for S 0…255 for B, N, L	0 for S, N, L 0…15 for B
	INT = 3	0, 1, 2 or 4	2(S) 3, 9…255 (B) 7, 9…255 (N) 9…255 (L)	0…65 for S 0…255 for B, N, L	0 for S, N, L 0…15 for B
	FLT = 4	0 or 4	8, 9…255 (F)	0…255	0
	OSTR = 5	0…255	2(S) 3, 9…255 (B) 7, 9…255 (N)	0…65 for S 0…255 for B, N,	0 for S, N 0…15 for B
	BSTR = 6	0…255	2(S) 3, 9…255 (B) 7, 9…255 (N)	0…65 for S 0…255 for B, N,	0 for S, N 0…15 for B
	TIME = 7	0…6	2(S) 3, 9…255 (B) 7, 9…255 (N) 9…255 (L)	0…65 for S 0…255 for B, N, L	0 for S, N, L 0…15 for B

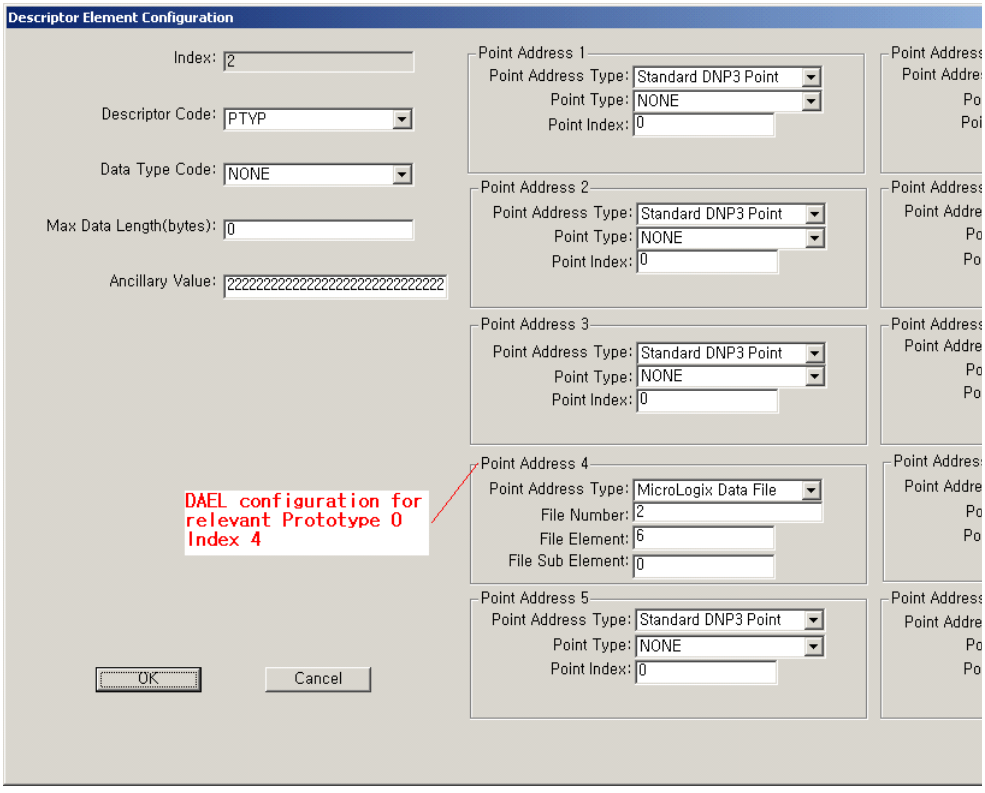
When the Descriptor Code is selected as PTYP, the Point Addressing parameters for the Descriptor element are replaced by 10 Point Addressing parameters. These should be configured in the same order of the DAEL elements in the relevant Prototypes.



For instance, if Prototype 0 includes a Namespace at Index 2 and Name at Index 3, then the first DAEL in the Prototype 0 is at Index 4. The Prototype DAEL at Index 4 matches Point Address 4 in the PTYP element configuration. Because of

this, Point Address 4 in the PTYP element configuration of the Descriptor should be configured properly.





Object Quality Flags

The object flag is composed of an 8 bit string for some DNP3 objects. The tables below show Flag Descriptions for each object. The ONLINE, RESTART, COMM_LOST, REMOTE_FORCED and LOCAL_FORCED flags are common to all object group types that contain flags.

There are some rules for the Object flag set or clear for each bit by the controller. The rules below are also applied to Event data.

- When the controller is in Non-Executing mode, the object flag is always all 0.
- When the controller is in Executing mode and there is no configuration file, only the Online flag in the object flag is set.
- When the controller is in Executing mode and there is a configuration file, the flags in the object flag are set according to the upper byte of the configuration files.

Object Flags for Binary Input

Bit Offset	Name	Description
0	ONLINE	In Series A controllers: 0 when the controller is or was in Non-Execting mode. 1 when the controller is or was in Executing mode. In Series B controllers: 0 when the controller is or was in Non-Execting mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is or was in Executing mode and the configuration file exists.
1	RESTART	Always 0. Not used.
2	COMM_LOST	Always 0. Not used.
3	REMOTE_FORCED	Always 0. Not used.
4	LOCAL_FORCED	Always 0. Not used.
5	CHATTER_FILTER	Always 0. Not used.
6	reserved	Always 0. Not used.
7	STATE	Reflects point state of Binary Input point.

Object Flags for Double Binary Input

Bit Offset	Name	Description
0	ONLINE	In Series A controllers: 0 when the controller is or was in Non-Execting mode. 1 when the controller is or was in Executing mode. In Series B controllers: 0 when the controller is or was in Non-Execting mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is or was in Executing mode and the configuration file exists.
1	RESTART	Always 0. Not used.
2	COMM_LOST	Always 0. Not used.
3	REMOTE_FORCED	Always 0. Not used.
4	LOCAL_FORCED	Always 0. Not used.
5	CHATTER_FILTER	Always 0. Not used.
6	STATE	Reflects point state of Double-Bit Binary Input point. Double-bit LSB.
7	STATE	Reflects point state of Double-Bit Binary Input point. Double-bit MSB

Object Flags for Binary Output

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
1	RESTART	Always 0. Not used.
2	COMM_LOST	Always 0. Not used.
3	REMOTE_FORCED	Always 0. Not used.
4	LOCAL_FORCED	Always 0. Not used.
5	reserved	Always 0. Not used.
6	reserved	Always 0. Not used.
7	STATE	Reflects point state of Binary Output point.

Object Flags for Counter

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
1	RESTART	0 when the controller is or was in Non-Executing mode. 0 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
2	COMM_LOST	
3	REMOTE_FORCED	
4	LOCAL_FORCED	
5	ROLLOVER	
6	DISCONTINUITY	
7	reserved	

Object Flags for Analog Input

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
1	RESTART	0 when the controller is or was in Non-Executing mode. 0 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
2	COMM_LOST	
3	REMOTE_FORCED	
4	LOCAL_FORCED	
5	OVER_RANGE	
6	REFERENCE_ERR	
7	reserved	

Object Flags for Analog Output

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode.
1	RESTART	Always 0. Not used.
2	COMM_LOST	Always 0. Not used.
3	REMOTE_FORCED	Always 0. Not used.
4	LOCAL_FORCED	Always 0. Not used.
5	reserved	Always 0. Not used.
6	reserved	Always 0. Not used.
7	reserved	Always 0. Not used.

Object Flags for Analog Output for Series A controllers

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode.
1	RESTART	Always 0. Not used.
2	COMM_LOST	Always 0. Not used.
3	REMOTE_FORCED	Always 0. Not used.
4	LOCAL_FORCED	Always 0. Not used.
5	reserved	Always 0. Not used.
6	reserved	Always 0. Not used.
7	reserved	Always 0. Not used.

Object Flags for Analog Output for Series B controllers

Bit Offset	Name	Description
0	ONLINE	0 when the controller is or was in Non-Executing mode. 1 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
1	RESTART	0 when the controller is or was in Non-Executing mode. 0 when the controller is or was in Executing mode and the configuration file does not exist. May be 1 when the controller is in Executing mode and the configuration file exists.
2	COMM_LOST	
3	REMOTE_FORCED	
4	LOCAL_FORCED	
5	reserved	
6	reserved	
7	reserved	

DNP3 Device Attribute Object

The Device Attribute object can be used to identify DNP3 Slave devices. With the MicroLogix 1400, some of the variations are written so that you can read or write your own strings in your application.

The object group of the Device Attribute object is 0. The supported range of the variation is 211...255.

The R/W property shows if the object is Read Only, Read, or Write. If the R/W property is writable, the value which was written by DNP3 master device is stored to non-volatile memory.

The object group of the Device Attribute is 0. The supported range of the variation is 211...255.

Object Group 0, Variations for Attribute Set 0

Variation	Read /Write	Attribute Data Type	Length in Bytes (Series A)	Max Length in Bytes (Series B)	Description	Value (Series A)	Value (Series B)
211	Read Only	VSTR	27	0 for DNP3	Identifier of support for user-specific attributes	Returns the identifier for user-specific attributes. "Rockwell Automation, Inc., 1"	Returns the identifier for user-specific attributes. "", NULL for DNP3.
212	Read Only	UINT	4	2	Number of master-defined data set prototypes	0	0
213	Read Only	UINT	4	2	Number of outstation-defined data set prototypes	0	The configured number in the DNP3 Slave Application Layer Configuration file. 10, max
214	Read Only	UINT	4	2	Number of master-defined data sets	0	0
215	Read Only	UINT	4	2	Number of outstation-defined data sets	0	The configured number in the DNP3 Slave Application Layer Configuration file. 10, max
216	Read Only	UINT	4	2	Max number of binary outputs per request	10	10
217	Read Only	UINT	4	2	Local timing accuracy	10,000 in microseconds	
218	Read Only	UINT	4	2	Duration of timing accuracy	0 in seconds	
219	Read Only	INT	1	1	Support for analog output events	0	0
220	Read Only	UINT	4	2	Max analog output index	256*3	
221	Read Only	UINT	4	2	Number of analog outputs	0…256*3	
222	Read Only	INT	1	1	Support for binary output events	0	
223	Read Only	UINT	4	2	Max binary output index	256*16	
224	Read Only	UINT	4	2	Number of binary outputs	0…256*16	
225	Read Only	INT	1	1	Support for frozen counter events	1	
226	Read Only	INT	1	1	Support for frozen counters	1	

Object Group 0, Variations for Attribute Set 0

Variation	Read /Write	Attribute Data Type	Length in Bytes (Series A)	Max Length in Bytes (Series B)	Description	Value (Series A)	Value (Series B)
227	Read Only	INT	1	1	Support for counter events	1	
228	Read Only	UINT	4	2	Max counter index	256*2	
229	Read Only	UINT	4	2	Number of counter points	0…256*2	
230	Read Only	INT	1	1	Support for frozen analog inputs	0	
231	Read Only	INT	1	1	Support for analog input events	1	
232	Read Only	UINT	4	2	Maximum analog input index	256*3	
233	Read Only	UINT	4	2	Number of analog input points	0…256*3	
234	Read Only	INT	1	1	Support for double-bit binary input events	1	
235	Read Only	UINT	4	2	Maximum double-bit binary input index	256*8	
236	Read Only	UINT	4	2	Number of double-bit binary input points	0…256*8	
237	Read Only	INT	1	1	Support for binary input events	1	
238	Read Only	UINT	4	2	Max binary input index	256*16	
239	Read Only	UINT	4	2	Number of binary input points	0…256*16	
240	Read Only	UINT	4	2	Max transmit fragment size	2048 (27…2048). When this value is written to the controller, the communication configuration file is changed to this value.	
241	Read Only	UINT	4	2	Max receive fragment size	2048	
242	Read Only	VSTR	length of the string value	length of the string value	Device manufacturer's software version	This variation returns firmware FRN. "FRN 1.00". Supported ranges: "FRN x.yy", "FRN x.yyy", "FRN xx.yy" or "FRN xx.yyy" where x, xx is 0 ~ 99 and yy, yyy 00 ~ 999. For example, "FRN 1.00", "FRN 1.05", "FRN 12.05", "FRN 102.27" or "FRN 103.117".	
243	Read Only	VSTR	length of the string value	length of the string value	Device manufacturer's hardware version	This variation returns hardware series and revision of the controller. "HW SER A/REV 01".	This variation returns hardware series and revision of the controller. "HW SER A/REV 03".
						Supported ranges: "HW SER x/REV yy" where x is A ~ F and yy is 00 ~ 31. For example, "HW SER A/REV 01", "HW SER B/REV 03", or "HW SER C/REV 31".	
244	-	-	-	-	Reserved for future assignment	-	-
245	Read /Write	VSTR	length of the string value, max 255 bytes	length of the string value, max 255 bytes	User-assigned location name	"". Non-NULL terminated.	

Object Group 0, Variations for Attribute Set 0

Variation	Read /Write	Attribute Data Type	Length in Bytes (Series A)	Max Length in Bytes (Series B)	Description	Value (Series A)	Value (Series B)
246	Read /Write	VSTR	length of the string value, max 255 bytes	length of the string value, max 255 bytes	User-assigned ID code/number	"". Non-NULL terminated.	
247	Read /Write	VSTR	length of the string value, max 255 bytes	length of the string value, max 255 bytes	User-assigned device name	"". Non-NULL terminated.	
248	Read Only	VSTR	12	12	Device serial number	This variation returns Ethernet MAC ID. "0000BCxxxxxx".	
249	Read Only	VSTR	6	6	DNP subset and conformance	This variation returns Subset level and Test procedure version. "2:2008".	This variation returns Subset level and Test procedure version. "2:2009".
250	Read Only	VSTR	length of the string value	length of the string value	Device manufacturer's product name and model	This variation returns Catalog Number and OS Series of the controller. "1766-L32BWA SER A".	This variation returns Catalog Number and OS Series of the controller. "1766-L32BWA SER B".
						Supported ranges: "1766-L32xxxa SER y" where xxxa is BWA, AWA, BXB, BWAA, AWAA, or BXBA and y is A ~ F. For example, "1766-L32BWA SER A", "1766-L32AWA SER B", "1766-L32BXB SER C", or "1766-L32BWAA SER A".	
251	-	-	-	-	Reserved for future assignment	-	-
252	Read Only	VSTR	13	19	Device manufacturer's name	This variation returns the Company name. "Allen-Bradley".	This variation returns the Company name. "Rockwell Automation" for DNP3.
253	Read Only	-	-	-	Reserved for future assignment	-	-
254	Read Only	-	-	-	Non-specific all attributes request	This variable returns all of the variations in this group except this variation.	
255	Read Only	-	-	-	List of attribute variations	This variation returns the R/W property for each variation. From g0v211 to g0v253. 0 for Read Only 1 for Read or Write	

Event Reporting

This section covers how to generate DNP3 events from DNP3 Data Objects and how to report the generated events by polled response or unsolicited response.

Generating Events

The MicroLogix 1400 has a separate buffer area that you can use to log DNP3 events internally.

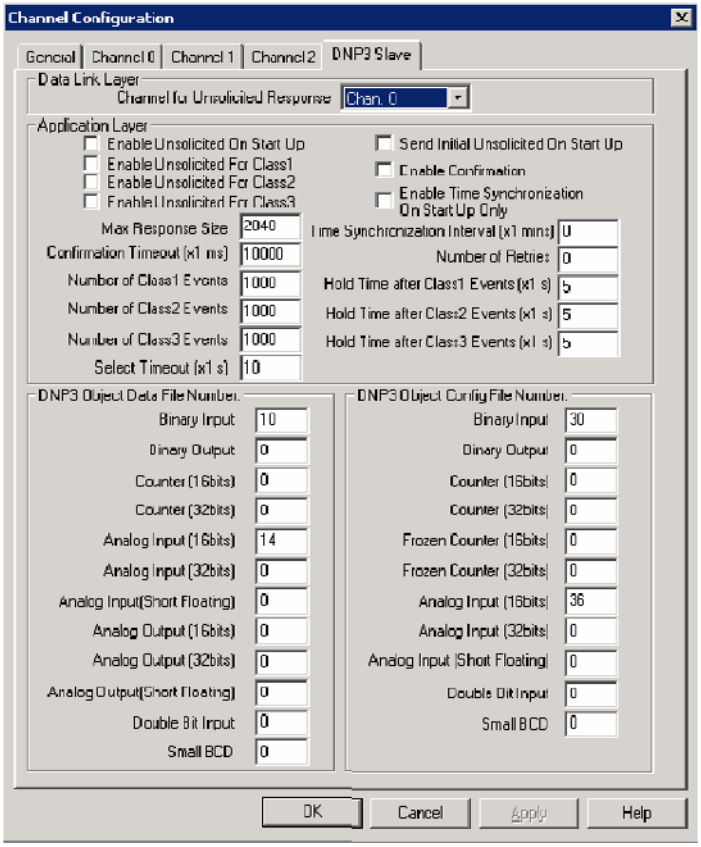
The maximum number of the Events that can be logged is 6013, regardless of the Event data type. With Series B controllers, a Data Set event can consume multiple numbers of the event buffers.

If the number of the generated events reaches this value, the MicroLogix 1400 sets IIN2.3 [EVENT_BUFFER_OVERFLOW]. Further events are not logged until the logged events are reported to DNP3 Master and the buffer is available.

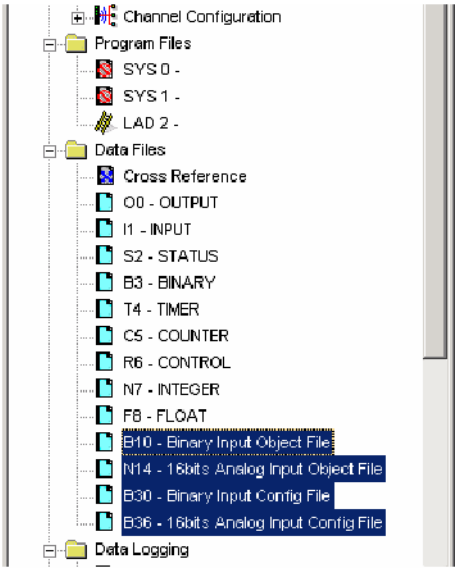
The elements CS0:67 or CS2:67 in the Communication status file show how many events are logged to the event buffer. The logged events are not removed until they are reported to DNP3 Master successfully. Logged event can also be cleared when one of the following events occur:

- New OS firmware upgrade
- New user program download.

The example below shows how to generate events for a Binary Input Object and a 16-bit Analog Input Object. In the DNP3 Slave configuration, Binary Input Object Data File Number was configured to 10 and its Configuration File Number was configured to 30. 16-bit Analog Input Object Data File Number was configured to 14 and its Configuration File Number was configured to 36.



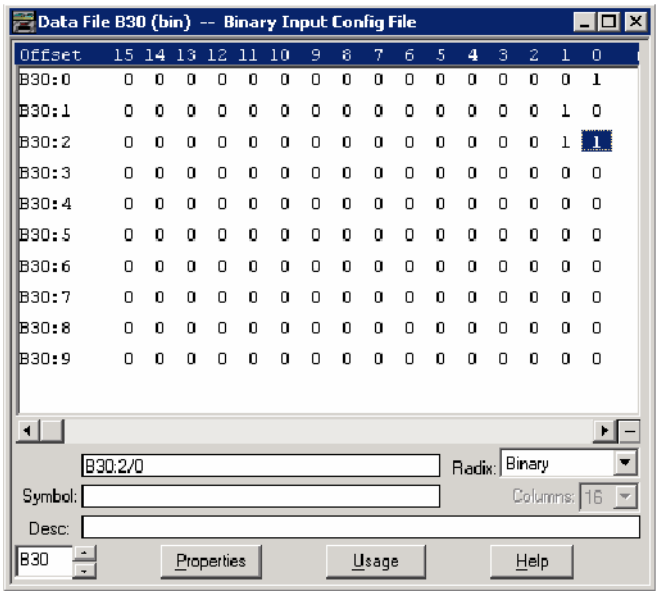
4 files will be automatically generated in the tree list of the Data Files.

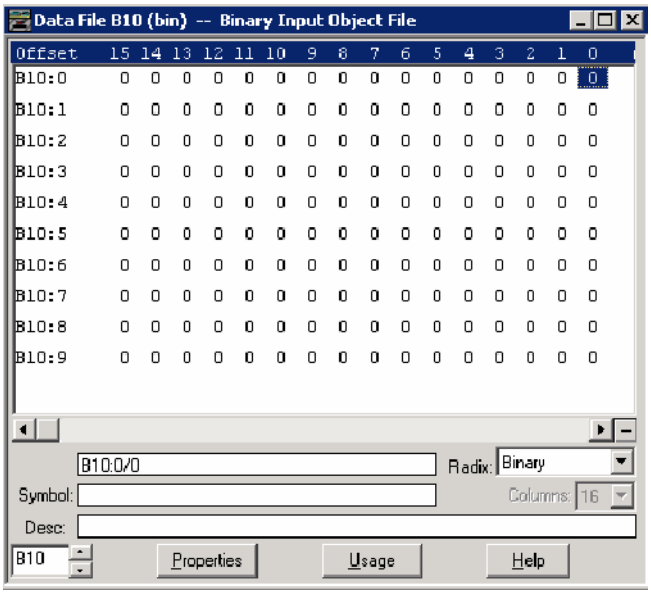


You need to adjust the number of the elements for each file according to your application. In this example, the number of the elements is 10 for Binary Input Object File and 10 for 16-bit Analog Input Object File.

In the Binary Input Config File, the bit 1/bit 0 of B30:0, B30:1 and B30:2 are configured to 0/1, 1/0 and 1/1 respectively. The event for the index 0 - 15 of Binary Input Object will be generated as a Class 1 event, the event for the index 16 - 31, as a Class 2 event and the event for the index 32 - 47, as a Class 3 event, if

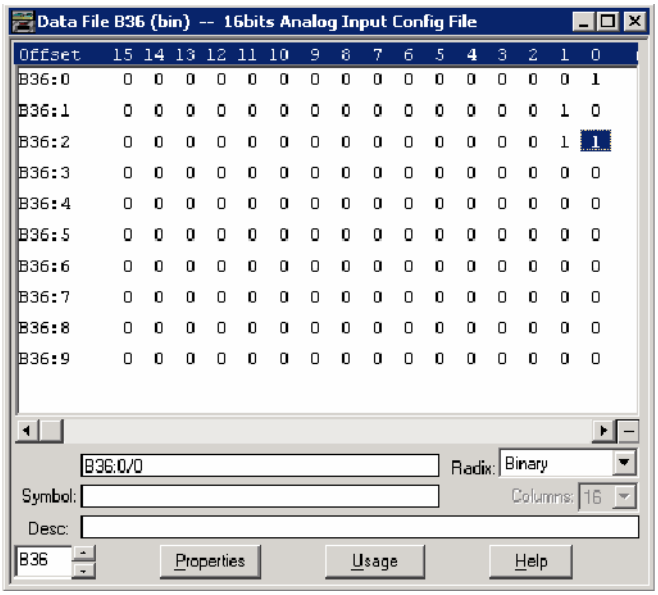
there are any changes for the points(B10:0, B10:1 or B10:2). For any other Binary Input points, the events will not be generated.

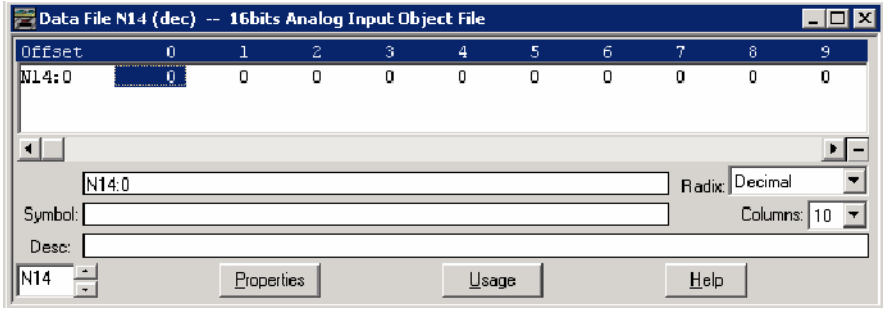




In the same manner, this 16-bit Analog Input Object File has bit 1/bit 0 of B36:0, B36:1 and B36:2 configured to 0/1, 1/0 and 1/1 respectively. The event for the index 0 of 16-bit Analog Input Object will be generated as a Class 1 event, the event for the index 1 as a Class 2 event, and the event for the index 2 as a Class 3

event, if there are any changes for the points(N14:0, N14:1 or N14:2). For any other 16-bit Analog Input points, the events will not be generated.





Control Generating Event

The MicroLogix 1400 checks all elements in the Object Data file for changes at the end of a scan and generates events where needed.

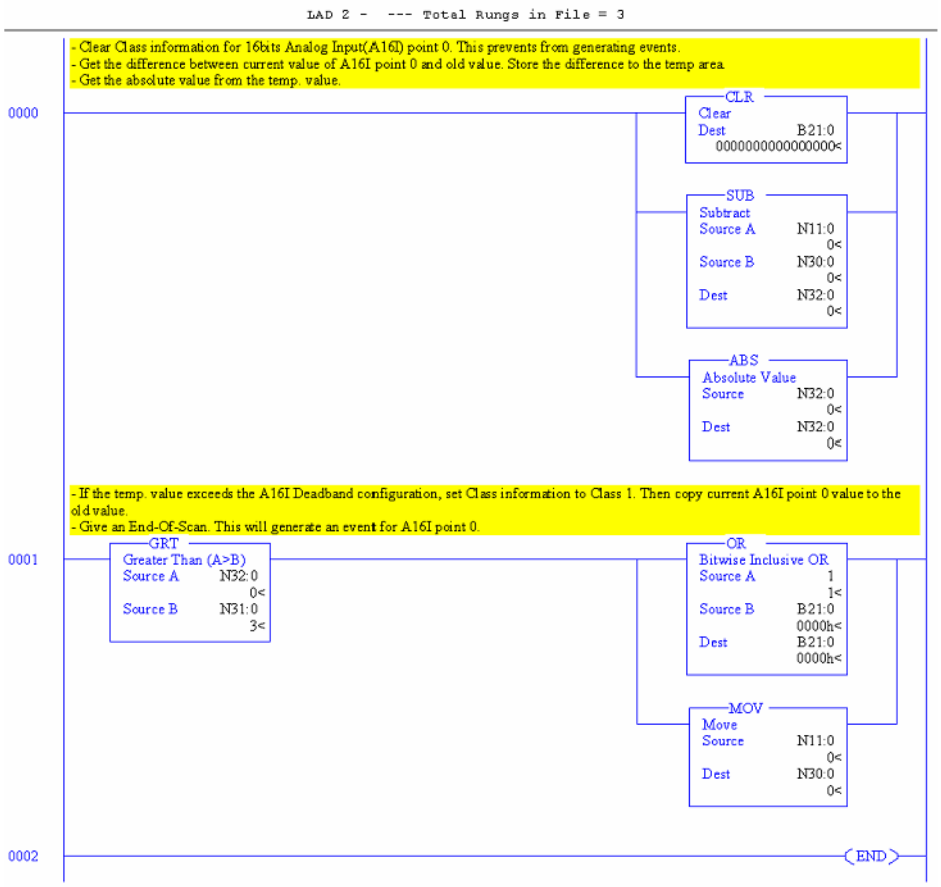
The key method to turn on and off event generating by ladder logic is to assign or un-assign the Class information bits in the Object Config Files.

The example below shows how to control the event generation condition by ladder logic and implements Deadband for Analog Input Objects (which is only necessary for Series A MicroLogix 1400)

In this example, for 16-bit Analog Input point 0(N11:0), if the absolute value of the difference between the present value of N11:0 and the value that was most recently queued as an event for that point exceeds the deadband value, then an event is generated for that point.

Data File List

Name	Number	Type	Scope	Debug	Words	Elements	Last
Output	0	O	Global	No	18	6	O:5
Input	1	I	Global	No	24	8	I:7
Status	2	S	Global	No	0	66	S:65
Binary	3	B	Global	No	1	1	B3:0
Timer	4	T	Global	No	3	1	T4:0
Counter	5	C	Global	No	3	1	C5:0
Control	6	R	Global	No	3	1	R6:0
Integer	7	N	Global	No	1	1	N7:0
Float	8	F	Global	No	2	1	F8:0
16-bit Analog Input Object File	11	N	Global	No	10	10	N11:9
Binary Output Object File	12	B	Global	No	10	10	B12:0
16-bit32-bit Analog Input Config File	21	B	Global	No	10	10	B21:9
A16I OLD	30	N	Global	No	10	10	N30:9
A16I DEADB	31	N	Global	No	10	10	N31:9
A16I Temp	32	N	Global	No	10	10	N32:9



In the MicroLogix 1400 Series B controllers, new configuration files are defined for the Deadband for Analog Input Objects and the Threshold for Counter Objects. The feature of the configuration files replaces the ladder program in this section.

Reporting Event By Polled Response

When a DNP3 Master sends a poll to read Class events, any events logged to the event buffer will be reported in the polled response.

When using both Channel 0 and Channel 2 Serial ports for DNP3 communication, event polling requests should be sent to one Channel at a time. This avoids mis-reporting of events to different DNP3 Masters on different Channels. For example, Master A and Master B are connected to Channel 0 and Channel 2 respectively, and 5000 events are logged in the event buffer. Master A sends an event polling request, and only 50 events can be fit in an application layer fragment. The first 50 events are sent to Master A and the next 50 events may be sent to Master B instead.

Reporting Event By Unsolicited Response

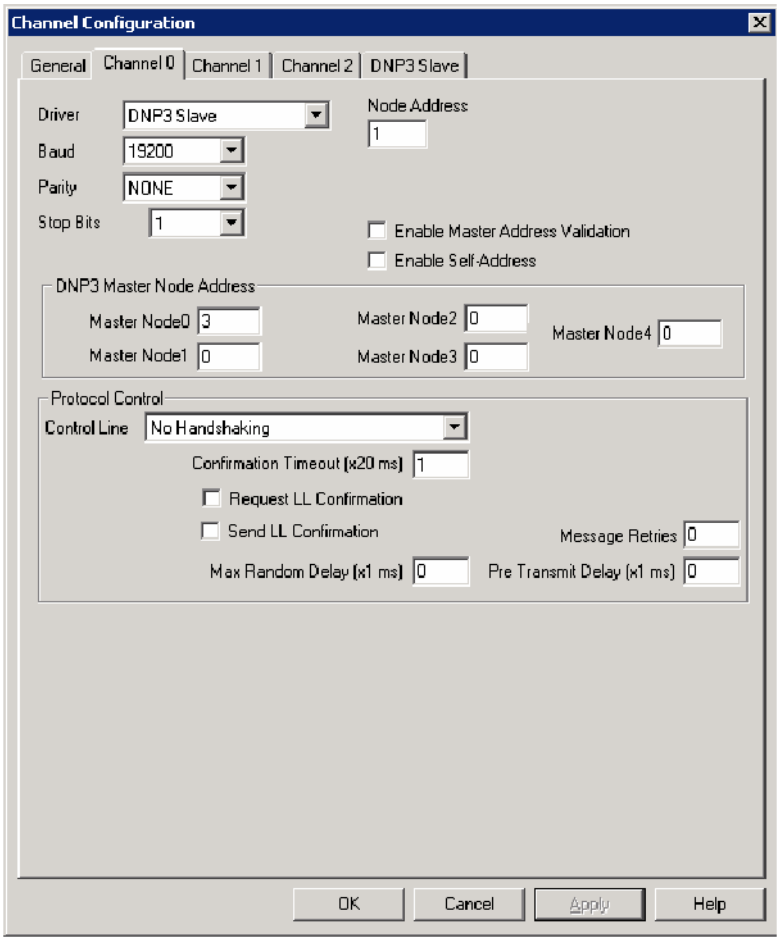
To initiate and send Unsolicited Responses to a DNP3 Master, the parameters below should be configured correctly. For more details, see DNP3 Slave Application Layer Configuration Parameters on page 213.

- Master Node0
- Channel for Unsolicited Response
- Enable Unsolicited On Start Up
- Enable Unsolicited For Class1
- Enable Unsolicited For Class2
- Enable Unsolicited For Class3
- Send Initial Unsolicited On Start Up
- Number of Class1 Events
- Hold Time after Class1 Events (x1s)
- Number of Class2 Events
- Hold Time after Class2 Events (x1s)
- Number of Class3 Events
- Hold Time after Class3 Events (x1s)
- DNP3 Object Data File Number
- DNP3 Object Config File Number
- content of the Config File

In some cases, MicroLogix 1400 may not send an Unsolicited Response even though the parameters are configured properly.

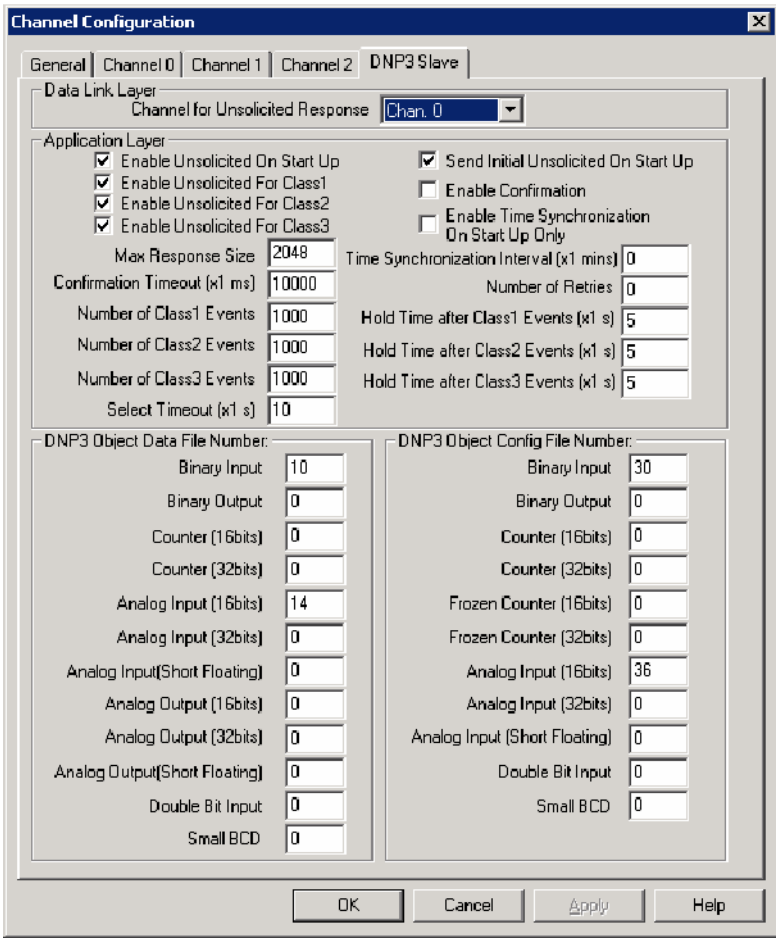
- Normally, when the parameter Enable Unsolicited On Start Up is checked, the MicroLogix 1400 initiates an Unsolicited Response with the function code ENABLE_UNSOLICITED(20), if there are any events logged into the event buffer. However, when a request with the function code DISABLE_UNSOLICITED(21) is received, an Unsolicited Response will not be sent.
- When the parameter Enable Unsolicited On Start Up is unchecked, the MicroLogix 1400 does not trigger the Unsolicited Response until a request with the function code ENABLE_UNSOLICITED(20) from the DNP3 Master is received.

The example below shows how to initiate and send the Unsolicited Response. Master Node0 in Channel 0 Configuration tab indicates that the Unsolicited Response is reported to the Master with the node address 3.



The parameter Channel for Unsolicited Response in the DNP3 Slave Configuration tab indicates that the Unsolicited Response is reported via Channel 0 only. In this example, Initial Unsolicited Response is sent on startup

and all events of class 1, 2 and 3 are reported. Since Hold Times are configured to 5 seconds, generated events will be reported after 5 seconds.



Collision Avoidance

The MicroLogix 1400 controller currently supports the first of the two methods listed below for collision avoidance.

- Detecting transmitted data (TX/RX line on RS485 communication).
- Detecting out-of-band carrier (DCD on RS232C communication).

When the MicroLogix 1400 is connected to RS485 network, it monitors all data on the link. If the MicroLogix 1400 is preparing to transmit a packet and finds the link busy, it waits for an interval defined by the Backoff_Time until it is no longer busy.

Backoff_Time = Pre Transmit Delay (x1 ms) + Max Random Delay (x1 ms)

The Pre Transmit Delay (x1 ms) in the Link Layer Channel Configuration file is a fixed delay and the Max Random Delay (x1 ms) in the Channel Configuration file is a maximum random delay for Channel 0 and Channel 2. You must specify those parameters to get the collision avoidance mechanism.

After the Backoff_Time, the MicroLogix 1400 tries again, either indefinitely, or up to a configurable maximum number of retries. If a maximum is used, the protocol considers this as a link failure.

Time Synchronization

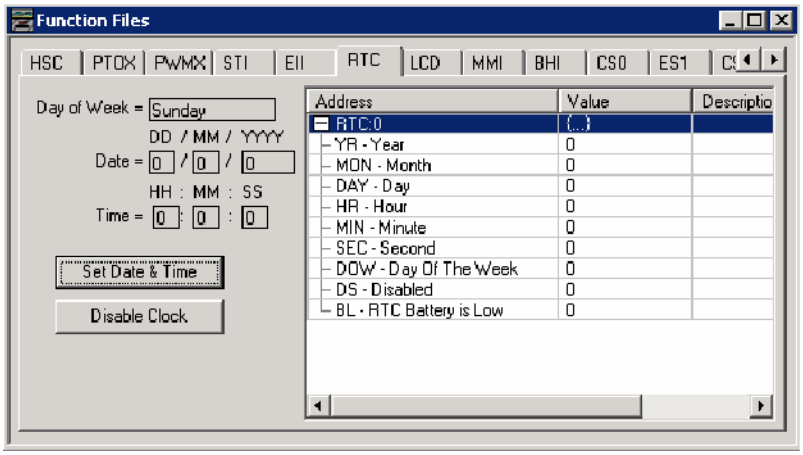
The time value in the embedded RTC module of the MicroLogix 1400 controller is updated by an RTC Function file every 2 seconds. This resolution is insufficient to log DNP3 events in a DNP3 subsystem. Another timer, incremented by 1 millisecond in the DNP3 Slave subsystem, serves to provide appropriate resolution.

These two timers are synchronized by the following conditions:

- power up
- a request for time synchronization from DNP3 Master.

At power up, the DNP3 subsystem gets the time from an RTC function file in the MicroLogix 1400. For the RTC function file to acquire the correct time, the RTC module should be enabled before a power cycle to acquire the correct time from the RTC function file.

In this example RTC function file, the RTC module is disabled. To enable it, click "Set Date & Time" while it is online.



When there is a write request for time synchronization from a DNP3 Master, DNP3 subsystem synchronizes its timer with the time from DNP3 Master and the time in RTC module is synchronized with the time from DNP3 Master.

This table shows RTC Accuracy. Configure the NEED_TIME IIN bit according to this table, so that a DNP3 Master can send the time synchronization request for more accurate times in the controller.

RTC Accuracy

Ambient Temperature	RTC Accuracy[1]
0 °C (32 °F)	-13...-121 seconds/month
25 °C (77 °F)	54...-5 seconds/month
40 °C (104 °F)	29...-78 seconds/month
55 °C (131 °F)	-43...-150 seconds/month

(1) These numbers are maximum worst case values over a 31-day month.

Download a User Program via DNP3 Network

Using File-Control/Status of Requested Operation objects, a user program can be downloaded/uploaded/initialized via DNP3 communication. Also, Serial Channel 0 Status File, Ethernet Channel 1 Status File, and Serial Channel 2 Status File can be uploaded from the MicroLogix 1400.

All File-Control/Status of Requested Operation objects and supported File-Control/Status of Requested Operation objects are listed in this section. Unsolicited Response for File-Control/Status of Requested Operation objects is not supported. All the responses are sent to DNP3 Master with Function Code 129(81h).

- g70v1 File-Control - File identifier : superseded, not supported
- g70v2 File-Control - Authentication : supported
- g70v3 File-Control - File command : supported
- g70v4 File-Control - File command status : supported
- g70v5 File-Control - File transport : supported
- g70v6 File-Control - File transport status : supported
- g70v7 File-Control - File descriptor : supported
- g70v8 File-Control - File specification string : not supported by Series A controllers, supported by Series B controllers
- g91v1 Status of Requested Operation - Activate configuration : not supported by Series A controllers, supported by Series B controllers

Default Directories and Files

The MicroLogix 1400 has default directories and files for file handling in a DNP3 subsystem.

The default directories and files can be read from the controller using the function code OPEN_FILE(25), Read(1), and CLOSE_FILE(26).

Currently supported directories are "/EXE" and "/DIAG". Supported files are listed in this section. These directories/files cannot be removed and cannot be created using DNP3 requests.

Supported Files and Directories

Root Level	Directory Level	File Level	Full name string to access
"/"			"/"
	"EXE"		"/EXE"
		"[processorName].IMG"	"/EXE/[processorName].IMG"
	"DIAG"		"/DIAG"
		"CH0.CSF"	"/DIAG/CH0.CSF"
		"CH1.ESF"	"/DIAG/CH1.ESF"
		"CH2.CSF"	"/DIAG/CH2.CSF"

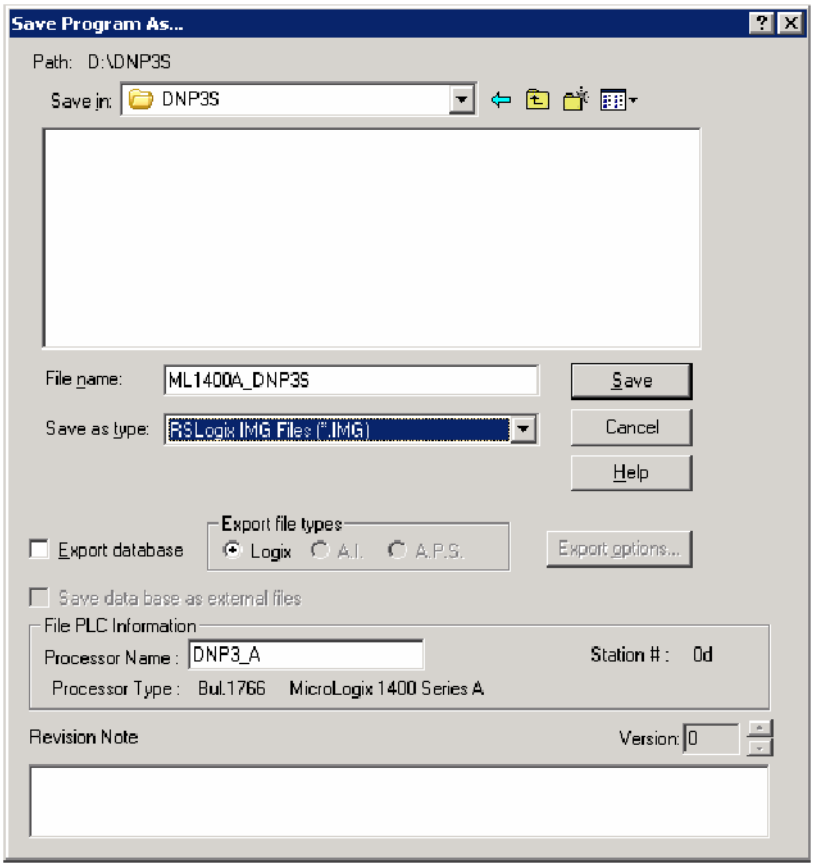
- The directory/file names must all be in capital letters.
- Root level can only be a directory marker. The directory marker is "/" for Series A, or "\" for Series B.
- Directory level can only contain directories.
- File level can only contain files.

Note that the directory marker is different in the MicroLogix 1400 Series A and Series B controllers. The directory marker is "/" for Series A and "\" for Series B controllers. In this document, "/" is used to explain File Object feature.

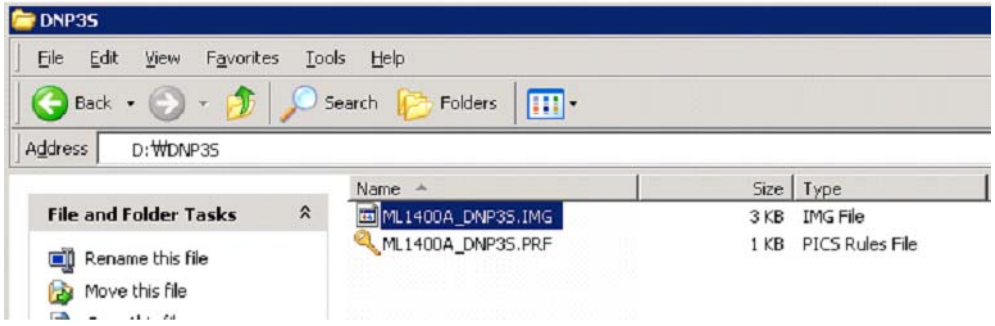
Generating *.IMG files using RSLogix 500/RSLogix Micro

Typically, RSLogix 500/RSLogix Micro stores the ladder program as "RSLogix Files (*.RSS)". However, to download a ladder program using a File Object via DNP3 network, you must save your ladder program in the "RSLogix IMG Files (*.IMG)" format.

After you write your ladder program, select "Save As ..." from the File menu of RSLogix 500/RSLogix Micro. Select the save type as "RSLogix IMG Files (*.IMG)"



After saving the file, you can see the file "ML1400A_DNP3S.IMG". This is the file to be used for download.



IMPORTANT RSLogix 500/RSLogix Micro v8.10.00 and the MicroLogix 1400 Series A controller do not support the opening of *.IMG files. Be sure to store your ladder program in the RSLogix Files (*.RSS) format before generating RSLogix IMG Files (*.IMG). Otherwise, you may lose the latest modifications to your ladder program.

IMPORTANT	RSLogix 500/RSLogix Micro v8.30.00 and the MicroLogix 1400 Series B controller support the opening of *.IMG files. However, some information is not stored into the IMG file, for example, rung comments. Be sure to store your ladder program in the RSLogix Files (*.RSS) format before generating RSLogix IMG Files (*.IMG).

Rules for File Authentication

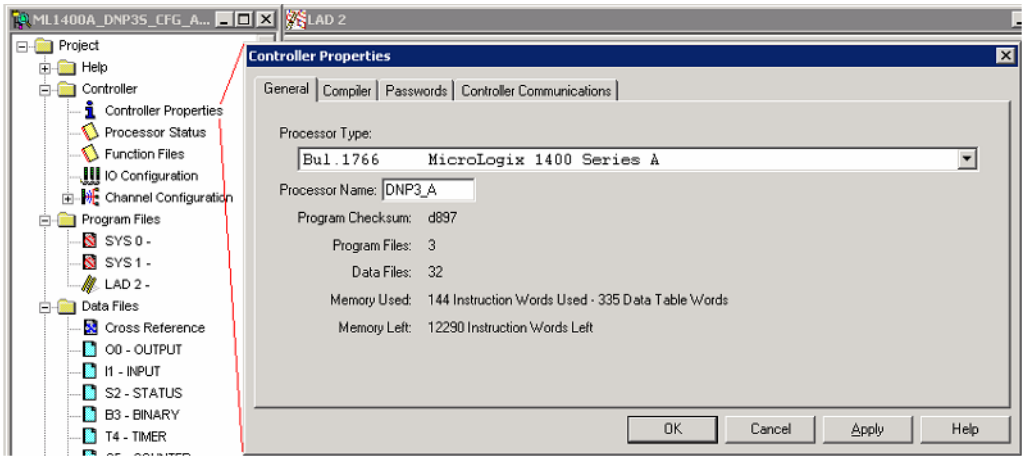
The File Authentication process is optional, and unnecessary when the master password of the downloaded ladder program is not configured.

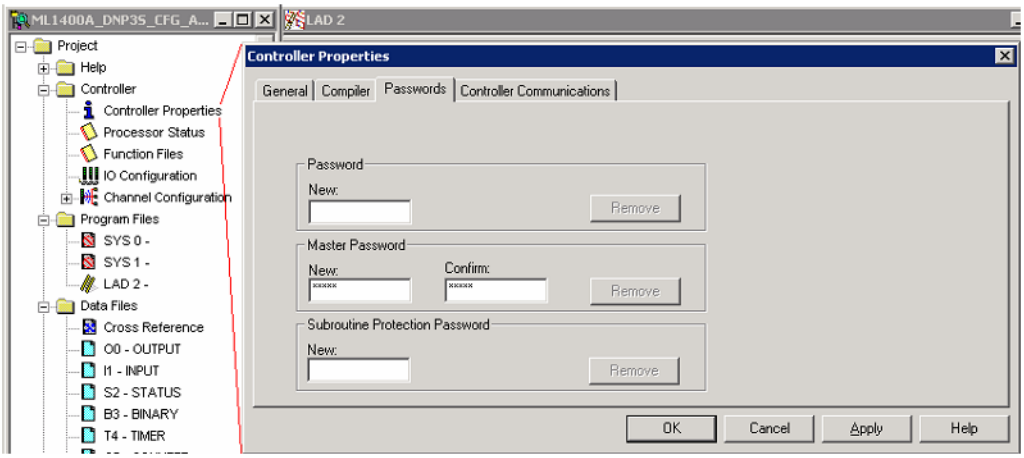
When the password in the ladder program is configured by RSLogix 500/RSLogix Micro, the DNP3 master sends a request with the function code AUTHENTICATE_FILE (29) to authenticate permission before file operation.

The object g70v2 is used for File Authentication, with two parameters:

- Username — from the Processor Name in the Controller Properties dialog in RSLogix 500/RSLogix Micro
- Password — from the Master Password in the Controller Properties dialog in RSLogix 500/RSLogix Micro.

In the example below, Username is "DNP3_A" and Password is "12345"(*****).





Once the DNP3 Master receives a proper Authentication Key (Non-zero value) from the MicroLogix 1400, the Authentication Key must be used for sending the request with the function code OPEN_FILE(25) or DELETE_FILE(27).

Rules for Downloading a User Program

A DNP3 master should send the function code OPEN_FILE(25), WRITE(2), and CLOSE_FILE(26) for downloading user programs.

When a master sends the function code OPEN_FILE(25) with the file command object, the file name string in File command object must be in this directory and file name format:

- /EXE/[processorName].IMG

The directory and file name extension string must all be in capital letters and the string size cannot be exceed 64 bytes. The file name [processorName] is from the Processor Name in the Controller Properties dialog in RSLogix 500/RSLogix Micro.

This ladder program [processorName].IMG is generated from RSLogix 500/RSLogix Micro. DNP3 Master should send the [processorName].IMG file without any modification.

When the MicroLogix 1400 Series A controller receives a request with the function code WRITE(2) for User Program download, the MicroLogix 1400 activates all configurations as well as channel configurations after the last application file segment is received. For the MicroLogix 1400 Series B controller, the function code Activate Configuration (0x1F) is supported.

Unlike Series A controller, the MicroLogix 1400 Series B controller does not activate all configurations as well as channel configurations after the last application file segment is received. To activate all configurations, you need to

send a command with the function code, Activate Configuration (0x1F) after downloading the user program.

Maximum file size is 384 Kbytes. The MicroLogix 1400 supports downloading up to 256Kbyte size of user program when Recipe is not configured. When Recipe is configured, Maximum file size is 384 Kbytes.

The first application segment of the ladder program should be larger than or equal to the size of System Exe File structure, 64 bytes.

An application segment of the ladder program cannot be exceed 2048 bytes.

When the MicroLogix 1400 receives the first application segment, it acquires Edit Resource from the system. If the last application segment is received properly, the MicroLogix 1400 returns Edit Resource to the system. After acquiring Edit Resource, each of the application segments should be received within the Edit Resource/Owner Timeout.

The MicroLogix 1400 controller checks the integrity of the program after receiving the last application segment. If the downloaded user program fails the integrity check, MicroLogix 1400 clears the downloaded user program and restores the default user program. In this case, the configured Channel configuration is not changed from the last valid configuration.

A user program cannot be downloaded while the controller is in Executing mode. Before downloading, send a mode change request with the function code STOP_APPL(18). See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294 for more details.

Executing modes include Run, Remote Run, Test Continuous Scan, and Test Single Scan modes. Any others are Non-Executing modes.

Rules for Uploading a User Program

A DNP3 master should send the function code OPEN_FILE(25), READ(1), and CLOSE_FILE(26) for uploading user programs.

When a master sends the function code OPEN_FILE(25) with the file command object, the file name string in File command object must be in this directory and file name format:

- /EXE/[processorName].IMG

The directory and file name extension string must all be in capital letters and the string size cannot be exceed 64 bytes. The file name [processorName] is from the Processor Name in the Controller Properties dialog in RSLogix 500/RSLogix Micro.

The maximum file size is 384 Kbytes. The MicroLogix 1400 supports uploading of user programs up to 256Kbyte in size when Recipe is not configured. When Recipe is configured, Maximum file size is 384 Kbytes.

The first application segment of the ladder program should be larger than or equal to the size of System Exe File structure, 64 bytes.

An application segment of the ladder program cannot be exceed 2048 bytes.

Rules for Initializing a User Program

A DNP3 master should send the function code DELETE_FILE(27) for initializing user programs.

When MicroLogix 1400 receives a request with the function code DELETE_FILE(27), it clears the current user program which was downloaded into the controller, and restores the default user program.

User programs cannot be initialized while the controller is in Executing mode. Before initializing programs, a mode change request should be sent with the function code STOP_APPL(18).

Rules for uploading Communication Status Files

A DNP3 master should send the function code OPEN_FILE(25), READ(1), and CLOSE_FILE(26) for uploading Communication Status Files.

The function code WRITE(2) for downloading Communication Status Files is not supported.

The file name should be "/DIAG/CH0.CSF", "/DIAG/CH1.ESF", and "/DIAG/CH2.CSF" for Channel 0, Channel 1, and Channel 2 respectively.

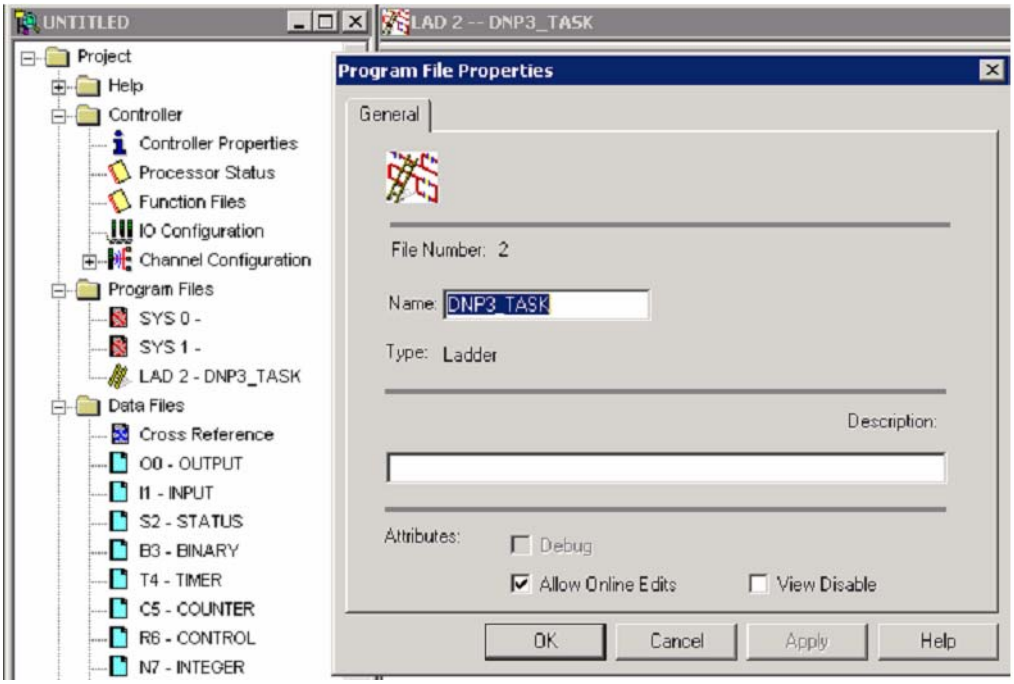
Starting and Stopping User Programs (Mode Change) via DNP3 Network

This section covers how to change the controller mode via DNP3 network.

To change the controller mode, use the function codes FC_INITIALIZE_APPL (16), FC_START_APPL (17) and FC_STOP_APPL (18).

If the qualifier code is 5Bh, the Application Identifier Object should be used. The Application Identifier is a string which cannot exceed 10 bytes. The string of Application Identifier is taken from the name in the Properties of the ladder file

#2 in RSLogix 500/RSLogix Micro. In this example, the Application Identifier is "DNP3_TASK".



If the qualifier code is 06h, the MicroLogix 1400 controller does not check the string of the Application Identifier.

Initialize User Program

If MicroLogix 1400 receives the function code FC_INITIALIZE_APPL (16) with the object Application Identifier (g90v1), it changes mode to Remote Program. If the controller is in a fault mode, the MicroLogix 1400 clears the fault before changing the mode to Remote Program.

Start User Program

If MicroLogix 1400 receives the function code FC_START_APPL (17) with the object Application Identifier (g90v1), it changes its mode to Remote Run. If the controller is in a fault mode, it sends the command with the function code FC_INITIALIZE_APPL (16) before the command with the function code FC_START_APPL (17).

Stop User Program

If MicroLogix 1400 receives the function code FC_STOP_APPL (18) with the object Application Identifier (g90v1), it changes its mode to Remote Program. If

the controller is in a fault mode, it sends the command with the function code FC_INITIALIZE_APPL (16) before sending the command with the function code FC_STOP_APPL (18).

Diagnostics

Errors in a DNP3 Slave subsystem are logged in the Communication Status File. There are 71 words for the troubleshooting.

This section shows the 71 words of the communication status file for each Channel 0 or Channel 2 port.

Communication Status File Words

Words Offset	File/Element Description for Channel 0	File/Element Description for Channel 2	Description
0	CS0:0	CS2:0	General Status Category Block ID
1	CS0:1	CS2:1	Length - 8 bytes (4 words including format code)
2	CS0:2	CS2:2	Format Code - Always 0
3	CS0:3	CS2:3	Communications Configuration Error Code
4	CS0:4	CS2:4	bit 15: Reserved - Always 0 bit 14: Modem Lost Bit bits 5…13: Reserved - Always 0 bit 4: Communications Active Bit bit 3: Selection Status Bit bit 2: Outgoing Message Command Pending bit 1: Incoming Message Reply Pending bit 0: Incoming Command Pending
5	CS0:5	CS2:5	bits 8…15: Baud Rate that the selected link layer driver is operating at out communication channel. bits 0…7: Node Address
6	CS0:6	CS2:6	Diagnostic Counters Category Identifier
7	CS0:7	CS2:7	Length
8	CS0:8	CS2:8	Format Code
9	CS0:9	CS2:9	bits 4…15: Reserved modem control line states - Always 0 bit 3: Data Carrier Detect bit 2: Reserved modem control line state - Always 0 bit 1: Request To Send bit 0: Clear To Send
10	CS0:10	CS2:10	Total Packets Sent
11	CS0:11	CS2:11	Total Packets Received for this node
12	CS0:12	CS2:12	Total Packets Observed
13	CS0:13	CS2:13	Undelivered Message Packets
14	CS0:14	CS2:14	Message Packets Retried
15	CS0:15	CS2:15	NAK Packets Received
16	CS0:16	CS2:16	Link Layer Error Count

Communication Status File Words

Words Offset	File/Element Description for Channel 0	File/Element Description for Channel 2	Description
17	CS0:17	CS2:17	Link Layer Error Codes 0: ERR_NO_ERROR 1: ERR_NO_RX_BUFFER 2: ERR_TOO_SHORT 3: ERR_TOO_LONG 4: ERR_UART_ERROR 5: ERR_BAD_CRC 6: ERR_CTS_TIMEOUT 7: ERR_CTS_DROP_MID_PKT 8: ERR_UNKNOWN_CHAR
18	CS0:18	CS2:18	Reserved - Always 0
19	CS0:19	CS2:19	Reserved - Always 0
20	CS0:20	CS2:20	Reserved - Always 0
21	CS0:21	CS2:21	Reserved - Always 0
22	CS0:22	CS2:22	Reserved - Always 0
23	CS0:23	CS2:23	Data Link Layer Active Node Table
24	CS0:24	CS2:24	Length
25	CS0:25	CS2:25	Format Code
26	CS0:26	CS2:26	Number of Nodes
27	CS0:27	CS2:27	Reserved - Always 0
28	CS0:28	CS2:28	Reserved - Always 0
29	CS0:29	CS2:29	Reserved - Always 0
30	CS0:30	CS2:30	Reserved - Always 0
31	CS0:31	CS2:31	Reserved - Always 0
32	CS0:32	CS2:32	Reserved - Always 0
33	CS0:33	CS2:33	Reserved - Always 0
34	CS0:34	CS2:34	Reserved - Always 0
35	CS0:35	CS2:35	Reserved - Always 0
36	CS0:36	CS2:36	Reserved - Always 0
37	CS0:37	CS2:37	Reserved - Always 0
38	CS0:38	CS2:38	Reserved - Always 0
39	CS0:39	CS2:39	Reserved - Always 0
40	CS0:40	CS2:40	Reserved - Always 0
41	CS0:41	CS2:41	Reserved - Always 0
42	CS0:42	CS2:42	Reserved - Always 0
43	CS0:43	CS2:43	List Category ID (10)
44	CS0:44	CS2:44	Length (14)
45	CS0:45	CS2:45	Format Code (2)
46	CS0:46	CS2:46	Pre-Send Time Delay
47	CS0:47	CS2:47	Node Address for this Slave
48	CS0:48	CS2:48	Reserved - always 0

Communication Status File Words

Words Offset	File/Element Description for Channel 0	File/Element Description for Channel 2	Description
17	CS0:17	CS2:17	Link Layer Error Codes 0: ERR_NO_ERROR 1: ERR_NO_RX_BUFFER 2: ERR_TOO_SHORT 3: ERR_TOO_LONG 4: ERR_UART_ERROR 5: ERR_BAD_CRC 6: ERR_CTS_TIMEOUT 7: ERR_CTS_DROP_MID_PKT 8: ERR_UNKNOWN_CHAR
18	CS0:18	CS2:18	Reserved - Always 0
19	CS0:19	CS2:19	Reserved - Always 0
20	CS0:20	CS2:20	Reserved - Always 0
21	CS0:21	CS2:21	Reserved - Always 0
22	CS0:22	CS2:22	Reserved - Always 0
23	CS0:23	CS2:23	Data Link Layer Active Node Table
24	CS0:24	CS2:24	Length
25	CS0:25	CS2:25	Format Code
26	CS0:26	CS2:26	Number of Nodes
27	CS0:27	CS2:27	Reserved - Always 0
28	CS0:28	CS2:28	Reserved - Always 0
29	CS0:29	CS2:29	Reserved - Always 0
30	CS0:30	CS2:30	Reserved - Always 0
31	CS0:31	CS2:31	Reserved - Always 0
32	CS0:32	CS2:32	Reserved - Always 0
33	CS0:33	CS2:33	Reserved - Always 0
34	CS0:34	CS2:34	Reserved - Always 0
35	CS0:35	CS2:35	Reserved - Always 0
36	CS0:36	CS2:36	Reserved - Always 0
37	CS0:37	CS2:37	Reserved - Always 0
38	CS0:38	CS2:38	Reserved - Always 0
39	CS0:39	CS2:39	Reserved - Always 0
40	CS0:40	CS2:40	Reserved - Always 0
41	CS0:41	CS2:41	Reserved - Always 0
42	CS0:42	CS2:42	Reserved - Always 0
43	CS0:43	CS2:43	List Category ID (10)
44	CS0:44	CS2:44	Length (14)
45	CS0:45	CS2:45	Format Code (2)
46	CS0:46	CS2:46	Pre-Send Time Delay
47	CS0:47	CS2:47	Node Address for this Slave
48	CS0:48	CS2:48	Reserved - always 0

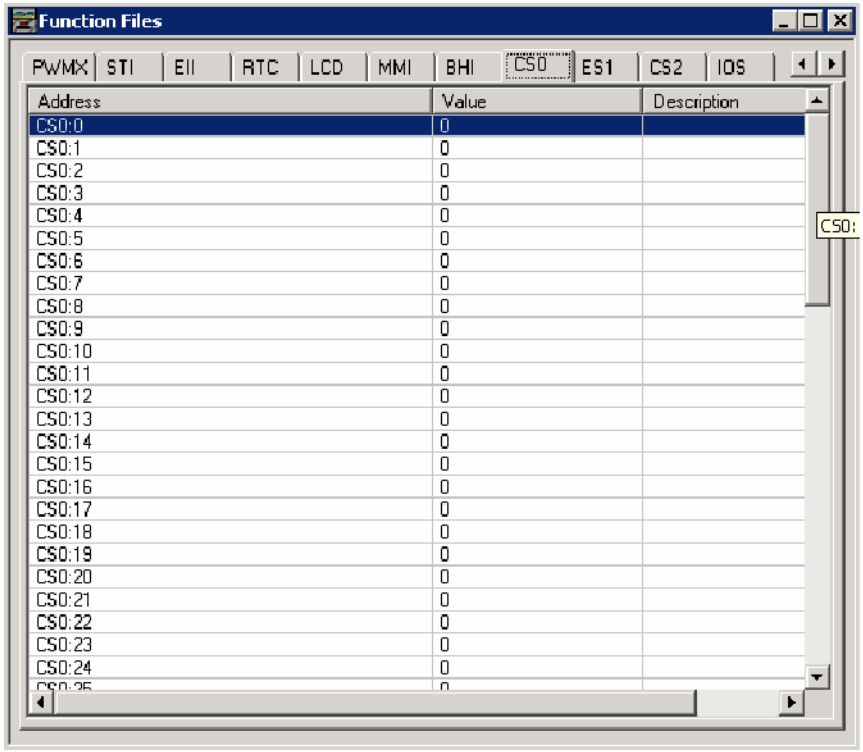
Communication Status File Words

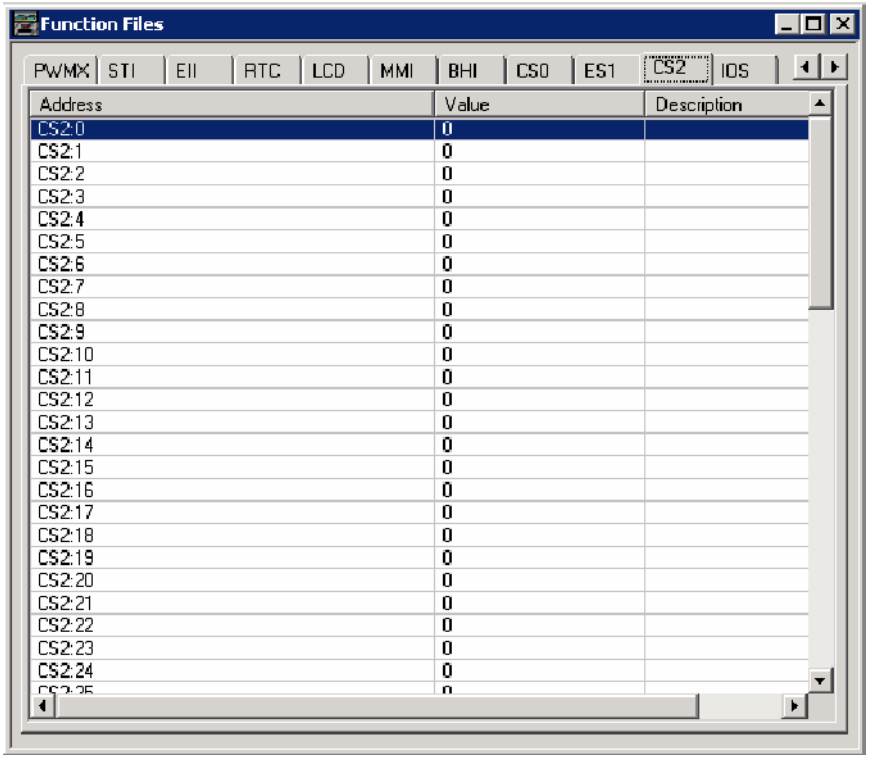
Words Offset	File/Element Description for Channel 0	File/Element Description for Channel 2	Description
49	CS0:49	CS2:49	RTS Send Delay
50	CS0:50	CS2:50	RTS Off Delay
51	CS0:51	CS2:51	bits 0-7: Baud Rate bits 8-9: Parity bits 10-15: Reserved - Always 0
52	CS0:52	CS2:52	List Category ID (6)
53	CS0:53	CS2:53	Length (32)
54	CS0:54	CS2:54	Format Code (2)
55	CS0:55	CS2:55	Application Layer Error Codes 0: NO_ERROR - No error found in the Application Layer. 1: FC_CANNOT_BROADCAST - Reserved 2: FC_NOT_SUPPORTED - The received packet has unsupported Function Code. 3: OBJ_NOT_SUPPORTED - The received packet has unsupported object(s). 4: BAD_REQUEST_LENGTH - Reserved 5: CONFIGURATION_ERROR - The error was caused by the invalid configuration during packet generating. E.g. invalid Data Set Configuration. 6: BAD_PARAMETER - The received packet has invalid parameters except Function Code and Object Codes. E.g. invalid Qualifier codes. 7: BAD_FILE_TYPE - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Type specified. 8: BAD_FILE_NUMBER - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Number specified. 9: BAD_DNP3_ADDRESS - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Number specified. 10: TABLE_WRITE_PROTECTED - The specified DNP3 object data file has been locked to be written. 11: TABLE_ACCESS_DENIED - The specified DNP3 object data file has been locked to be read or written. 12: TABLE_OWNERSHIP_ERROR - The specified DNP3 object data file has been locked to be read or written. If an error code is within 6 to 12, related file number and element number are shown in word 59 and 60.
56	CS0:56	CS2:56	Application Layer Error Count
57	CS0:57	CS2:57	Function Code that caused the last error
58	CS0:58	CS2:58	Last Transmitted IIN in the response
59	CS0:59	CS2:59	Data file number of last error request
60	CS0:60	CS2:60	Data element number of last error request
61	CS0:61	CS2:61	Received Confirm Function Code Counter
62	CS0:62	CS2:62	Received Read Function Code Counter
63	CS0:63	CS2:63	Received Write Function Code Counter
64	CS0:64	CS2:64	Received Etc Function Code Counter
65	CS0:65	CS2:65	Transmitted Solicited Response Function Code Counter
66	CS0:66	CS2:66	Transmitted Unsolicited Response Function Code Counter
67	CS0:67	CS2:67	Number of events to be reported

Communication Status File Words

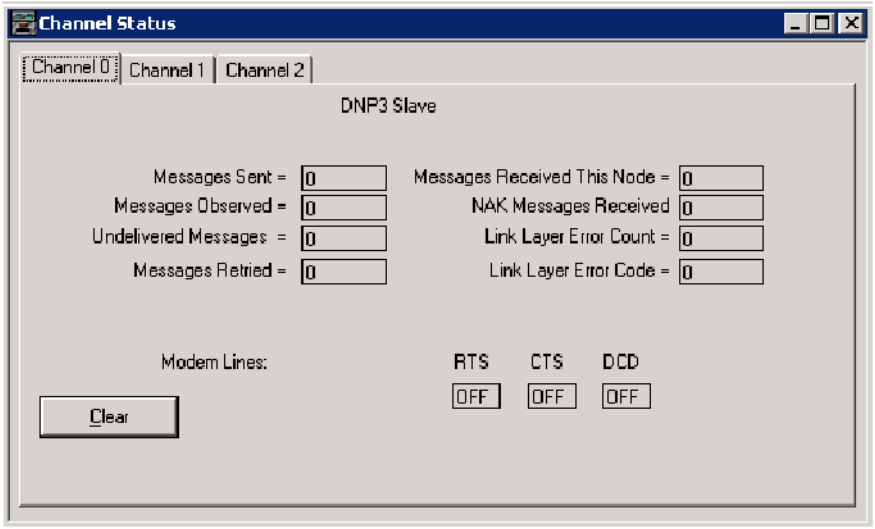
Words Offset	File/Element Description for Channel 0	File/Element Description for Channel 2	Description
68	CS0:68	CS2:68	Transport Function Layer Error Codes 0: NO_ERROR - No error found in the Transport Layer. 1: DISCARD_NOT_FIRST_SEG - The received packet was discarded since it was not a first segment. 2: DISCARD_DUPLICATED_AND_MORE_SEG - The received packet was discarded since it had the same sequence number as previous, more segments are expected. 3: DISCARD_DUPLICATED_AND_FINAL_SEG - The received packet was discarded since it had the same sequence number as previous, final segment received. 4: DISCARD_OUT_OF_ORDER_SEG - The received packet was discarded since the sequence number was out of order.
69	CS0:69	CS2:69	Transport Layer Error Count
70	CS0:70	CS2:70	End Of List Category ID (0)

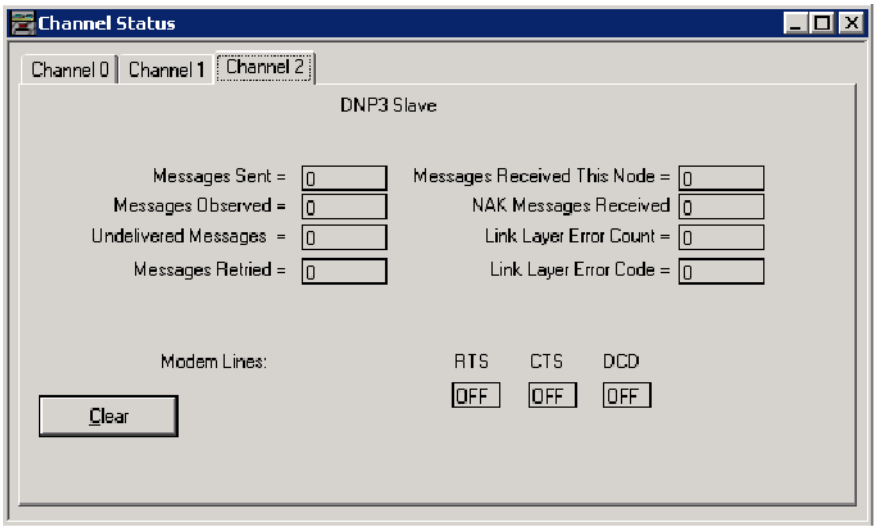
The elements can be seen in the Function Files for each Channel.



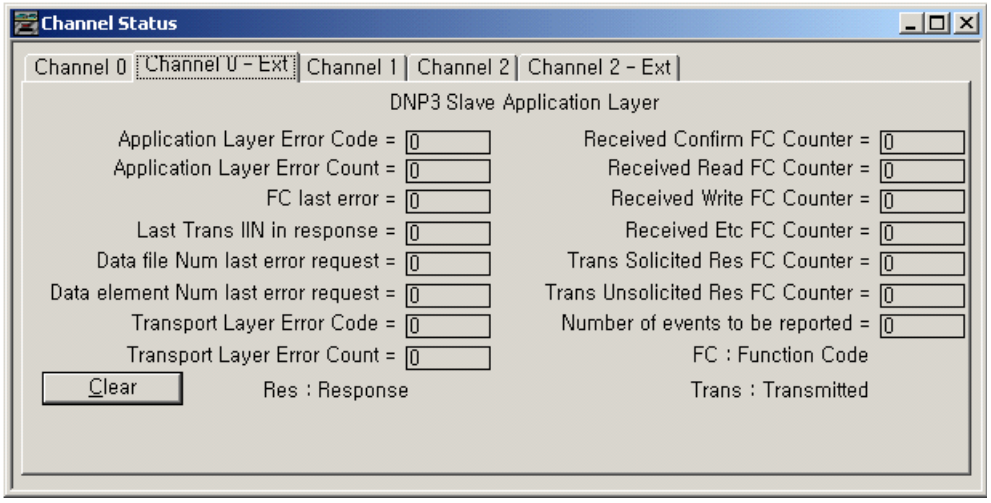


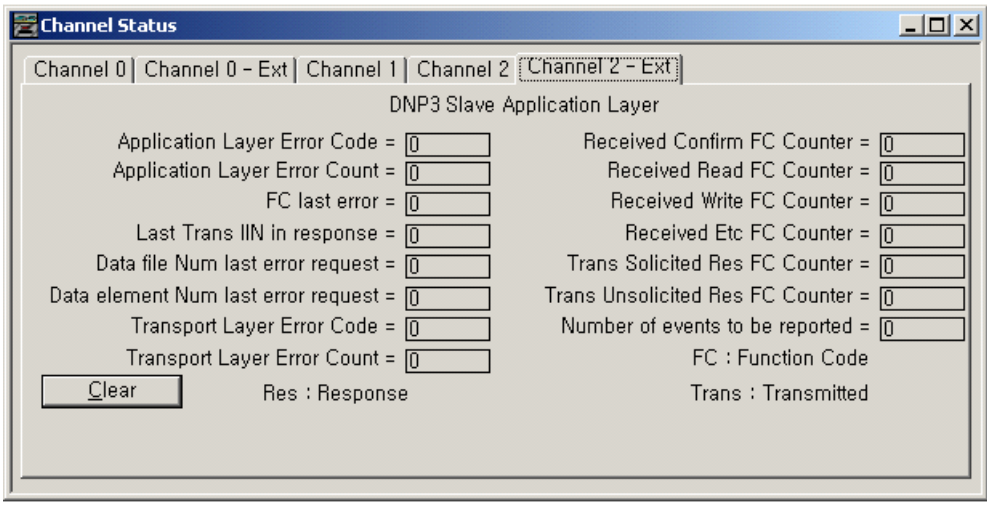
For the elements of the DNP3 Slave Link Layer diagnostic counter CS0:9 to CS0:17 and CS2:9 to CS2:17, the counter values are available with the structured display in RSLogix 500/RSLogix Micro as below.





For the elements of the DNP3 Slave Application Layer diagnostic counter CS0:55 to CS0:69 and CS2:55 to CS2:69, the counter values are available with the structured display in RSLogix 500/RSLogix Micro software as below.





Diagnostics for Ethernet Channel (Channel 1)

This feature is supported only in MicroLogix 1400 Series B controllers.

Diagnostic Counters and Errors in DNP3 Slave subsystem for the Ethernet channel are logged in the Data File. The data file is configured in the parameter

Diagnostic File Number. This table shows the 80 words of the data file for the troubleshooting.

Data File for Troubleshooting

Word Offset	Description	Category
0	Counter for Commands Received	TCP Server - Link Layer Diagnostics for DNP3 TCP Server.
1	Counter for Commands Received with Error	
2	Counter for Replies Sent	
3	Reserved	
4	Reserved	
5	Reserved	
6	Error Count in sessions	
7	Error Code in sessions*	
8	Incoming Message Connections	
9	Maximum Connections Allowed	
10	Counter for Commands Transmitted	
11	Reserved	
12	Counter for Replies Received	
13	Reserved	
14	Reserved	
15	Reserved	
16	Reserved	
17	Reserved	
18	Reserved	
19	Reserved	

Data File for Troubleshooting

Word Offset	Description	Category
20	Counter for Commands Received	UDP Datagram - Link Layer Diagnostics for DNP3 UDP.
21	Counter for Commands Received with Error	
22	Counter for Replies Sent	
23	Reserved	
24	Reserved	
25	Reserved	
26	Error Count in sessions	
27	Error Code in sessions*	
28	Number of Sockets in use	
29	Maximum Sockets Allowed	
30	Reserved	
31	Reserved	
32	Counter for Replies Received	
33	Reserved	
34	Reserved	
35	Reserved	
36	Reserved	
37	Reserved	
38	Reserved	
39	Reserved	

Data File for Troubleshooting

Word Offset	Description	Category
40	Counter for Commands Sent	TCP Client - Link Layer Diagnostics for DNP3 TCP Client.
41	Reserved	
42	Counter for Replies Received	
43	Counter for Replies Received with Error	
44	Counter for Replies Timed Out	
45	Reserved	
46	Error Count in sessions	
47	Error Code in sessions*	
48	Outgoing Message Connections	
49	Maximum Connections Allowed	
50	Counter for Commands Received	
51	Reserved	
52	Counter for Replies Transmitted	
53	Reserved	
54	Reserved	
55	Reserved	
56	Reserved	
57	Reserved, Firmware use only	
58	Reserved, Firmware use only	
59	Reserved, Firmware use only	

Data File for Troubleshooting

Word Offset	Description	Category
60	Application Layer Error Codes: 0: NO_ERROR - No error found in the Application Layer. 1: FC_CANNOT_BROADCAST - Reserved 2: FC_NOT_SUPPORTED - The received packet has unsupported Function Code. 3: OBJ_NOT_SUPPORTED - The received packet has unsupported object(s). 4: BAD_REQUEST_LENGTH - Reserved 5: CONFIGURATION_ERROR - The error was caused by the invalid configuration during packet generating. E.g. invalid Data Set Configuration. 6: BAD_PARAMETER - The received packet has invalid parameters except Function Code and Object Codes. E.g. invalid Qualifier codes. 7: BAD_FILE_TYPE - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Type specified. 8: BAD_FILE_NUMBER - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Number specified. 9: BAD_DNP3_ADDRESS - The error was caused by invalid configuration in DNP3 Slave Application Layer. Invalid File Number specified. 10: TABLE_WRITE_PROTECTED - The specified DNP3 object data file has been locked to be written. 11: TABLE_ACCESS_DENIED - The specified DNP3 object data file has been locked to be read or written. 12: TABLE_OWNERSHIP_ERROR - The specified DNP3 object data file has been locked to be read or written. If an error code is within 6 to 12, related file number and element number are shown in word 64 and 65.	DNP3 Slave - Application Layer Diagnostics for DNP3 Slave.
61	Application Layer Error Count	
62	Function Code that caused the last error	
63	Last Transmitted IIN in the response	
64	Data file number of last error request	
65	Data element number of last error request	
66	Received Confirm Function Code Counter	
67	Received Read Function Code Counter	
68	Received Write Function Code Counter	
69	Received Function Code Counter other than Confirm, Read and Write Function Codes.	
70	Transmitted Solicited Response Function Code Counter	
71	Transmitted Unsolicited Response Function Code Counter	
72	Number of events to be reported.	

Data File for Troubleshooting

Word Offset	Description	Category
73	Transport Function Layer Error Codes: 0: NO_ERROR - No error found in the Transport Layer. 1: DISCARD_NOT_FIRST_SEG - The received packet was discarded since it was not a first segment. 2: DISCARD_DUPLICATED_AND_MORE_SEG - The received packet was discarded since it had the same sequence number as previous, more segments are expected. 3: DISCARD_DUPLICATED_AND_FINAL_SEG - The received packet was discarded since it had the same sequence number as previous, final segment received. 4: DISCARD_OUT_OF_ORDER_SEG - The received packet was discarded since the sequence number was out of order.	
74	Transport Layer Error Count	
75	Reserved	
76	Reserved	
77	Reserved	
78	Reserved	
79	Reserved	
80	Reserved	

Word offset 7, 27 and 47 reflect the Error Codes that have been caused in the sessions for DNP3 TCP Server, UDP and TCP Client respectively. The following table lists the possible ranges of the Error Code. Any others are reserved.

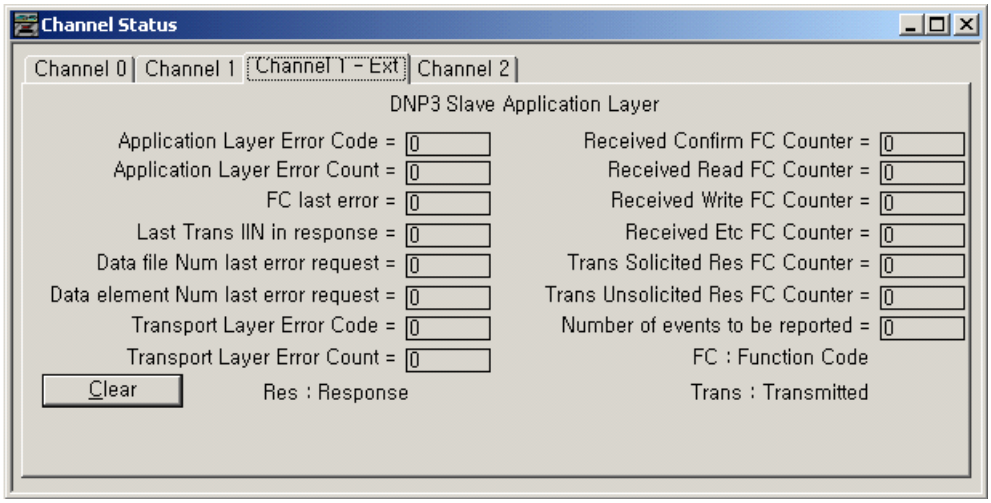
Error Codes

Value (DEC)	Mnemonic	Description
0	NO ERROR	No error found.
1	ERR_SOCKET_CREATE	Socket error during Create operation.
2	ERR_SOCKET_LISTEN	Socket error during Listen operation.
3	ERR_SOCKET_BIND	Socket error during Bind operation.
4	ERR_SOCKET_ACCEPT	Socket error during Accept operation.
5	ERR_SOCKET_CONNECT	Socket error during Connect operation.
6	ERR_SOCKET_SEND	Socket error during Send operation.
7	ERR_SOCKET_RECEIVE	Socket error during Receive operation.
8	ERR_SOCKET_UNLISTEN	Socket error during Unlisten operation.
9	ERR_SOCKET_UNBIND	Socket error during Unbind operation.
10	ERR_SOCKET_UNACCEPT	Socket error during Unaccept operation.
11	ERR_SOCKET_DISCONNECT	Socket error during Disconnect operation.
12	ERR_SOCKET_DELETE	Socket error during Delete operation.
13-14	Reserved	-
15	ERR_QUE_FULL	Firmware use only
16	ERR_BUFFER_ALLOC	Firmware use only
17	ERR_PACKET_ALLOC	Firmware use only

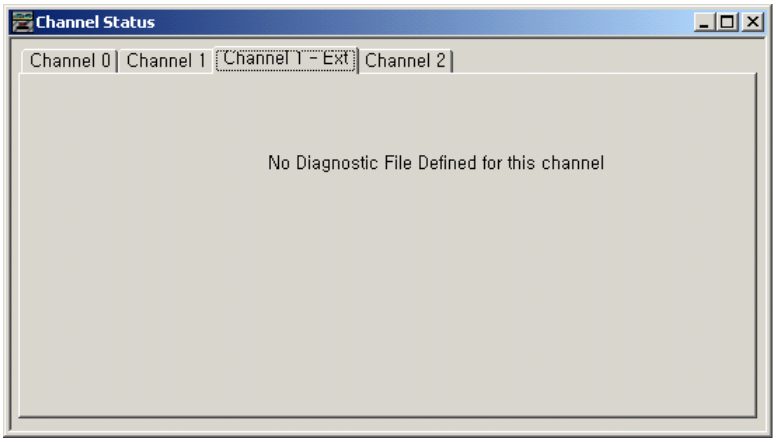
Error Codes

Value (DEC)	Mnemonic	Description
18	ERR_PACKET_RELEASE	Firmware use only
19-29	Reserved	-
30	ERR_CONN_REJECTED	Incoming Connection is rejected by the IP address validation.
31	ERR_INVALID_HEADER_CRC	Received packet header has invalid CRC.
32	ERR_INVALID_HEADER	Received packet header has invalid packet format.
33	ERR_INVALID_PACKET_CRC	Received packet has invalid CRC.
34	ERR_BAD_PACKET_RECEIVED	Received packet is unknown.
35	ERR_PACKET_REJECTED	Received packet is rejected.
36	ERR_CONNECTION_BROKEN	The connection has been broken for some reason.
37-49	Reserved	-
50	ERR_INVALID_IP_ADDRESS	Target IP Address is invalid.
51	ERR_INVALID_PORT	Target Port Number is invalid.
52-	Reserved	-

For the elements of the DNP3 Slave Application Layer diagnostic counter element offset 60 to 74, the counter values available with the structured display in RSLogix 500/RSLogix Micro software as below.



If the data file is not configured in the parameter Diagnostic File Number of the "Chan. 1 - DNP3" configuration, the "Channel 1 - Ext" dialog box will be shown as below.



Diagnostics for Secure Authentication

This feature is supported only in MicroLogix 1400 Series B controllers.

Counters in DNP3 Slave Secure Authentication subsystem are logged in the Data File. The data file is configured in the parameter Diagnostic File Number in Secure Authentication. The following table shows the 150 words of the data file for the troubleshooting.

The 50 words are used to log the counters for each channel. Word offset 0 to 49 is for Channel 0, word offset 50 to 99 is for Channel 1 and word offset 100 to 149 is for Channel 2.

Words 6 to 49, 56 to 99, and 106 to 149 are the event counter for Challenger State Machine which is stated in the DNP3 Specification, Supplement to Volume 2, Secure Authentication, Version 2.00.

Word Offset			Current State	Description
CH0	CH1	CH2		
0	50	100	Security Idle/Wait for Reply	Authentication Error Counter
1	51	101	Security Idle/Wait for Reply	Reserved
2	52	102	Security Idle/Wait for Reply	Reserved
3	53	103	Security Idle/Wait for Reply	Reserved
4	54	104	Security Idle/Wait for Reply	Reserved
5	55	105	Security Idle/Wait for Reply	Reserved
6	56	106	Security Idle	Event Counter for Rx Unsolicited Non-Critical ASDU
7	57	107	Security Idle	Event Counter for Rx Non-Critical ASDU
8	58	108	Security Idle	Event Counter for Rx Critical ASDU

Word Offset			Current State	Description
CH0	CH1	CH2		
9	59	109	Security Idle	Event Counter for Rx Critical ASDU
10	60	110	Security Idle	Event Counter for Rx Valid Reply
11	61	111	Security Idle	Event Counter for Rx Invalid Reply
12	62	112	Security Idle	Event Counter for Reply Timeout
13	63	113	Security Idle	Event Counter for Max Invalid Replies Or Comm Failure Detected
14	64	114	Security Idle	Event Counter for Max Invalid Replies Or Comm Failure Detected
15	65	115	Security Idle	Event Counter for Rx Error Message
16	66	116	Security Idle	Event Counter for Key Change Timeout
17	67	117	Security Idle	Event Counter for Expected Key Change Timeout
18	68	118	Security Idle	Event Counter for Expected Key Change Timeout
19	69	119	Security Idle	Event Counter for Rx Key Status Request
20	70	120	Security Idle	Event Counter for Rx Valid Aggressive Mode Request
21	71	121	Security Idle	Event Counter for Rx Valid Aggressive Mode Request
22	72	122	Security Idle	Event Counter for Rx Invalid Aggressive Mode Request
23	73	123	Security Idle	Event Counter for Rx Valid Key Change
24	74	124	Security Idle	Event Counter for Rx Invalid Key Change
25	75	125	Security Idle	Event Counter for Rx Challenge
26	76	126	Security Idle	Reserved
27	77	127	Security Idle	Counter for Ignored events
28	78	128	Wait for Reply	Event Counter for Rx Unsolicited Non-Critical ASDU
29	79	129	Wait for Reply	Event Counter for Rx Non-Critical ASDU
30	80	130	Wait for Reply	Event Counter for Rx Critical ASDU
31	81	131	Wait for Reply	Event Counter for Rx Critical ASDU
32	82	132	Wait for Reply	Event Counter for Rx Valid Reply
33	83	133	Wait for Reply	Event Counter for Rx Invalid Reply
34	84	134	Wait for Reply	Event Counter for Reply Timeout
35	85	135	Wait for Reply	Event Counter for Max Invalid Replies Or Comm Failure Detected
36	86	136	Wait for Reply	Event Counter for Max Invalid Replies Or Comm Failure Detected
37	87	137	Wait for Reply	Event Counter for Rx Error Message
38	88	138	Wait for Reply	Event Counter for Key Change Timeout
39	89	139	Wait for Reply	Event Counter for Expected Key Change Timeout
40	90	140	Wait for Reply	Event Counter for Expected Key Change Timeout
41	91	141	Wait for Reply	Event Counter for Rx Key Status Request
42	92	142	Wait for Reply	Event Counter for Rx Valid Aggressive Mode Request
43	93	143	Wait for Reply	Event Counter for Rx Valid Aggressive Mode Request
44	94	144	Wait for Reply	Event Counter for Rx Invalid Aggressive Mode Request
45	95	145	Wait for Reply	Event Counter for Rx Valid Key Change
46	96	146	Wait for Reply	Event Counter for Rx Invalid Key Change

Word Offset			Current State	Description
CH0	CH1	CH2		
47	97	147	Wait for Reply	Event Counter for Rx Challenge
48	98	148	Wait for Reply	Reserved
49	99	149	Wait for Reply	Counter for Ignored events

Function Codes

These tables show the Application Layer Function codes implemented in MicroLogix 1400.

Function Codes for MicroLogix 1400 Series A Controllers

Message Type	Function Code	Name	MicroLogix 1400 Support	Description
Confirmation	0 (0x00)	FC_CONFIRM	Yes	MicroLogix 1400 parses/sends
Request	1 (0x01)	FC_READ	Yes	MicroLogix 1400 parses
Request	2 (0x02)	FC_WRITE	Yes	MicroLogix 1400 parses
Request	3 (0x03)	FC_SELECT	Yes	MicroLogix 1400 parses
Request	4 (0x04)	FC_OPERATE	Yes	MicroLogix 1400 parses
Request	5 (0x05)	FC_DIRECT_OPERATE	Yes	MicroLogix 1400 parses
Request	6 (0x06)	FC_DIRECT_OPERATE_NR	Yes	MicroLogix 1400 parses
Request	7 (0x07)	FC_IMMED_FREEZE	Yes	MicroLogix 1400 parses
Request	8 (0x08)	FC_IMMED_FREEZE_NR	Yes	MicroLogix 1400 parses
Request	9 (0x09)	FC_FREEZE_CLEAR	Yes	MicroLogix 1400 parses
Request	10 (0x0A)	FC_FREEZE_CLEAR_NR	Yes	MicroLogix 1400 parses
Request	11 (0x0B)	FC_FREEZE_AT_TIME	No	
Request	12 (0x0C)	FC_FREEZE_AT_TIME_NR	No	
Request	13 (0x0D)	FC_COLD_RESTART	Yes	MicroLogix 1400 parses. MicroLogix 1400 should not be in the executing mode and any program and files should not be in open state.
Request	14 (0x0E)	FC_WARM_RESTART	No	
Request	15 (0x0F)	FC_INITIALIZE_DATA	No	Obsolete
Request	16 (0x10)	FC_INITIALIZE_APPL	Yes	MicroLogix 1400 parses. Clears fault and changes the controller mode to Remote Program. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	17 (0x11)	FC_START_APPL	Yes	MicroLogix 1400 parses. Clears fault and changes the controller mode to Remote Run. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	18 (0x12)	FC_STOP_APPL	Yes	MicroLogix 1400 parses. Changes the controller mode to Remote Program. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	19 (0x13)	FC_SAVE_CONFIG	No	Deprecated.
Request	20 (0x14)	FC_ENABLE_UNSOLICITED	Yes	MicroLogix 1400 parses

Function Codes for MicroLogix 1400 Series A Controllers

Message Type	Function Code	Name	MicroLogix 1400 Support	Description
Request	21 (0x15)	FC_DISABLE_UNSOLICITED	Yes	MicroLogix 1400 parses
Request	22 (0x16)	FC_ASSIGN_CLASS	No	
Request	23 (0x17)	FC_DELAY_MEASURE	Yes	MicroLogix 1400 parses. Used for non-LAN
Request	24 (0x18)	FC_RECORD_CURRENT_TIME	No	Used for LAN
Request	25 (0x19)	FC_OPEN_FILE	Yes	MicroLogix 1400 parses
Request	26 (0x1A)	FC_CLOSE_FILE	Yes	MicroLogix 1400 parses
Request	27 (0x1B)	FC_DELETE_FILE	Yes	MicroLogix 1400 parses
Request	28 (0x1C)	FC_GET_FILE_INFO	No	
Request	29 (0x1D)	FC_AUTHENTICATE_FILE	Yes	MicroLogix 1400 parses
Request	30 (0x1E)	FC_ABORT_FILE	No	
Request	31 (0x1F)	FC_ACTIVATE_CONFIG	No	
Request	32 (0x20)	FC_AUTHENTICATE_REQ	No	
Request	33 (0x21)	FC_AUTHENTICATE_ERR	No	
	34 (0x22) to 128 (0x80)		No	Reserved.
Response	129 (0x81)	FC_RESPONSE	Yes	MicroLogix 1400 sends
Response	130 (0x82)	FC_UNSOLICITED_RESPONSE	Yes	MicroLogix 1400 sends
Response	131 (0x83)	FC_AUTHENTICATE_RESP	No	
	132 (0x84) to 255 (0xFF)		No	Reserved.

Function Codes for MicroLogix 1400 Series B Controllers

Message Type	Function Code	Name	MicroLogix 1400 Support	Description
Confirmation	0 (0x00)	FC_CONFIRM	Yes	MicroLogix 1400 parses/sends
Request	1 (0x01)	FC_READ	Yes	MicroLogix 1400 parses
Request	2 (0x02)	FC_WRITE	Yes	MicroLogix 1400 parses
Request	3 (0x03)	FC_SELECT	Yes	MicroLogix 1400 parses
Request	4 (0x04)	FC_OPERATE	Yes	MicroLogix 1400 parses
Request	5 (0x05)	FC_DIRECT_OPERATE	Yes	MicroLogix 1400 parses
Request	6 (0x06)	FC_DIRECT_OPERATE_NR	Yes	MicroLogix 1400 parses
Request	7 (0x07)	FC_IMMED_FREEZE	Yes	MicroLogix 1400 parses
Request	8 (0x08)	FC_IMMED_FREEZE_NR	Yes	MicroLogix 1400 parses
Request	9 (0x09)	FC_FREEZE_CLEAR	Yes	MicroLogix 1400 parses
Request	10 (0x0A)	FC_FREEZE_CLEAR_NR	Yes	MicroLogix 1400 parses
Request	11 (0x0B)	FC_FREEZE_AT_TIME	No	
Request	12 (0x0C)	FC_FREEZE_AT_TIME_NR	No	
Request	13 (0x0D)	FC_COLD_RESTART	Yes	MicroLogix 1400 parses. MicroLogix 1400 should not be in the executing mode and any program and files should not be in open state.

Function Codes for MicroLogix 1400 Series B Controllers

Message Type	Function Code	Name	MicroLogix 1400 Support	Description
Request	14 (0x0E)	FC_WARM_RESTART	No	MicroLogix 1400 parses
Request	15 (0x0F)	FC_INITIALIZE_DATA	No	Obsolete
Request	16 (0x10)	FC_INITIALIZE_APPL	Yes	MicroLogix 1400 parses. Clears fault and changes the controller mode to Remote Program. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	17 (0x11)	FC_START_APPL	Yes	MicroLogix 1400 parses. Clears fault and changes the controller mode to Remote Run. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	18 (0x12)	FC_STOP_APPL	Yes	MicroLogix 1400 parses. Changes the controller mode to Remote Program. See Starting and Stopping User Programs (Mode Change) via DNP3 Network on page 294.
Request	19 (0x13)	FC_SAVE_CONFIG	No	Deprecated.
Request	20 (0x14)	FC_ENABLE_UNSOLICITED	Yes	MicroLogix 1400 parses
Request	21 (0x15)	FC_DISABLE_UNSOLICITED	Yes	MicroLogix 1400 parses
Request	22 (0x16)	FC_ASSIGN_CLASS	No	
Request	23 (0x17)	FC_DELAY_MEASURE	Yes	MicroLogix 1400 parses. Used for non-LAN
Request	24 (0x18)	FC_RECORD_CURRENT_TIME	No	MicroLogix 1400 parses.Used for LAN
Request	25 (0x19)	FC_OPEN_FILE	Yes	MicroLogix 1400 parses
Request	26 (0x1A)	FC_CLOSE_FILE	Yes	MicroLogix 1400 parses
Request	27 (0x1B)	FC_DELETE_FILE	Yes	MicroLogix 1400 parses
Request	28 (0x1C)	FC_GET_FILE_INFO	No	MicroLogix 1400 parses
Request	29 (0x1D)	FC_AUTHENTICATE_FILE	Yes	MicroLogix 1400 parses
Request	30 (0x1E)	FC_ABORT_FILE	No	MicroLogix 1400 parses
Request	31 (0x1F)	FC_ACTIVATE_CONFIG	No	MicroLogix 1400 parses
Request	32 (0x20)	FC_AUTHENTICATE_REQ	No	MicroLogix 1400 parses
Request	33 (0x21)	FC_AUTHENTICATE_ERR	No	MicroLogix 1400 parses
	34 (0x22) to 128 (0x80)		No	Reserved.
Response	129 (0x81)	FC_RESPONSE	Yes	MicroLogix 1400 sends
Response	130 (0x82)	FC_UNSOLICITED_RESPONSE	Yes	MicroLogix 1400 sends
Response	131 (0x83)	FC_AUTHENTICATE_RESP	No	MicroLogix 1400 sends
	132 (0x84) to 255 (0xFF)		No	Reserved.

Implementation Table

MicroLogix 1400 supports DNP3 Certification Subset Level 2.

The implementation table in this section identifies which object groups and variations, function codes and qualifiers the device supports in both requests and responses. The Request and Response columns identify all requests and responses

that may be sent/parsed by a DNP3 Master, or must be parsed/sent by the MicroLogix 1400.

The implementation table lists all functionality required by either DNP3 Master or MicroLogix 1400 as defined within the DNP3 IED Conformance Test Procedures. Any functionality beyond the highest subset level supported is indicated by grayed table cells.

Implementation Table for Series A controllers

DNP Object Group & Variation			**Request** DNP3 Master may issue MicroLogix 1400 must parse		**Response** DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
0	211-239 241-243 248-250 252	Device Attribute	1 (read)	00 (start-stop)	129 (response)	00 (start-stop)
0	240 245-247	Device Attribute	1 (read)	00 (start-stop)	129 (response)	00 (start-stop)
			2 (write)	00 (start-stop)		
0	254	Device Attribute - Non-specific all attributes request	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
0	255	Device Attributes - List of attribute variations	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00 (start-stop)
1	0	Binary Input - Any Variation	1 (read)	06 (no range, or all)		
1	1	Binary Input - Packed format	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
1	2	Binary Input - With flags	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
2	0	Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	1	Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	2	Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	3	Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
3	0	Double-bit Binary Input - Any Variation	1 (read)	06 (no range, or all)		
3	1	Double-bit Binary Input - Packed format	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
3	2	Double-bit Binary Input - With flags	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
4	0	Double-bit Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
4	1	Double-bit Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)

Implementation Table for Series A controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
4	2	Double-bit Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
4	3	Double-bit Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
10	0	Binary Output - Any Variation	1 (read)	06 (no range, or all)		
10	2	Binary Output - Output status with flags	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
12	1	Binary Command - Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request
20	0	Counter - Any Variation	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)		
20	1	Counter - 32-bit with flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	2	Counter - 16-bit with flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	5	Counter - 32-bit without flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	6	Counter - 16-bit without flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	0	Frozen Counter - Any Variation	1 (read)	06 (no range, or all)		
21	1	Frozen Counter - 32-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	2	Frozen Counter - 16-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	5	Frozen Counter - 32-bit with flag and time	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	6	Frozen Counter - 16-bit with flag and time	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	9	Frozen Counter - 32-bit without flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)

Implementation Table for Series A controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
21	10	Frozen Counter - 16-bit without flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
22	0	Counter Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1	Counter Event - 32-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	2	Counter Event - 16-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	0	Frozen Counter Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
23	1	Frozen Counter Event - 32-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	2	Frozen Counter Event - 16-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	5	Frozen Counter Event - 32-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	6	Frozen Counter Event - 16-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
30	0	Analog Input - Any Variation	1 (read)	06 (no range, or all)		
30	1	Analog Input - 32-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	2	Analog Input - 16-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	3	Analog Input - 32-bit without flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	4	Analog Input - 16-bit without flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	5	Analog Input - Single-prec flt-pt with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
32	0	Analog Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1	Analog Input Event - 32-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	2	Analog Input Event - 16-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	3	Analog Input Event - 32-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	4	Analog Input Event - 16-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	5	Analog Input Event - Single-prec flt-pt without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	7	Analog Input Event - Single-prec flt-pt with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)

Implementation Table for Series A controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
40	0	Analog Output Status - Any Variation	1 (read)	06 (no range, or all)		
40	1	Analog Output Status - 32-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
40	2	Analog Output Status - 16-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
40	3	Analog Output Status - Single-prec flt-pt with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
41	1	Analog Output - 32-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request
41	2	Analog Output - 16-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request
41	3	Analog Output - Single-prec flt-pt	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request
50	1	Time and Date - Absolute time	1 (read)	07 (limited qty = 1)	129 (response)	07 (limited qty) (qty = 1)
			2 (write)	07 (limited qty = 1)		
50	3	Time and Date - Absolute time at last recorded time				
51	1	Time and Date CTO - Absolute time, synchronized			129 (response) 130 (unsol. resp)	07 (limited qty) (qty = 1)
51	2	Time and Date CTO - Absolute time, unsynchronized			129 (response) 130 (unsol. resp)	07 (limited qty) (qty = 1)
52	1	Time Delay - Coarse			129 (response)	07 (limited qty) (qty = 1)
52	2	Time Delay - Fine			129 (response)	07 (limited qty) (qty = 1)
60	1	Class Objects - Class 0 data	1 (read)	06 (no range, or all)		
60	2	Class Objects - Class 1 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.)	06 (no range, or all)		
60	3	Class Objects - Class 2 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	4	Class Objects - Class 3 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.)	06 (no range, or all)		

Implementation Table for Series A controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
70	2	File-Control - authentication	29 (authenticate file)	5B (free format)	129 (response)	5B (free format)
70	3	File Control - file command	25 (open file)	5B (free format)		
70	3	File Control - file command	27 (delete file)	5B (free format)		
70	4	File Control - file command status	26 (close file)	5B (free format)	129 (response)	5B (free format)
70	5	File Control - file transport	1 (read file)	5B (free format)		
70	5	File Control - file transport	2 (write file)	5B (free format)		
70	6	File Control - file transport status			129 (response)	5B (free format)
70	7	File-Control - file descriptor			129 (response)	5B (free format)
80	1	Internal Indications - Packed format	1 (read file)	00, 01 (start-stop)	129 (response)	00, 01 (start-stop)
			2 (write file)	00 (start-stop) index=7		
90	1	Application - Identifier	16 (init. appl.) 17 (start appl.) 18 (stop appl.)	5B (free format) 06 (no range, or all)		
101	1	Binary Coded Decimal Integers - small	1 (read file)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
					130 (unsol. resp)	17, 28 (index)
101	2	Binary Coded Decimal Integers - medium				
No Object (function code only)			13 (cold restart)			
No Object (function code only)			23 (delay meas.)			

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
0	211-239 241-243 248-250 252	Device Attribute	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00 (start-stop)
0	240 245-247	Device Attribute	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00 (start-stop)
			2 (write)	00, 01 (start-stop)		
0	254	Device Attribute - Non-specific all attributes request	1 (read)	00, 01 (start-stop) 06 (no range, or all)		

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
0	255	Device Attributes - List of attribute variations	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00 (start-stop)
1	0	Binary Input - Any Variation	1 (read)	00, 01 (start-stop)		
				06 (no range, or all)		
1	1	Binary Input - Packed format	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
1	2	Binary Input - With flags	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
2	0	Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	1	Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	2	Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	3	Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
3	0	Double-bit Binary Input - Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
3	1	Double-bit Binary Input - Packed format	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
3	2	Double-bit Binary Input - With flags	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
4	0	Double-bit Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
4	1	Double-bit Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
4	2	Double-bit Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
4	3	Double-bit Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
10	0	Binary Output - Any Variation	1 (read)	00, 01 (start-stop)		
				06 (no range, or all)		
10	2	Binary Output - Output status with flags	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
12	1	Binary Command - Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	echo of request
20	0	Counter - Any Variation	1 (read)	00, 01 (start-stop)		
				06 (no range, or all)		
20	1	Counter - 32-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
20	1	Counter - 32-bit with flag	7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)		
20	2	Counter - 16-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	2	Counter - 16-bit with flag	7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)		
20	5	Counter - 32-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	5	Counter - 32-bit without flag	7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)		
20	6	Counter - 16-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
20	6	Counter - 16-bit without flag	7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)		
21	0	Frozen Counter - Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
21	1	Frozen Counter - 32-bit with flag	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	2	Frozen Counter - 16-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	5	Frozen Counter - 32-bit with flag and time	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	6	Frozen Counter - 16-bit with flag and time	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	9	Frozen Counter - 32-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
21	10	Frozen Counter - 16-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
22	0	Counter Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1	Counter Event - 32-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	2	Counter Event - 16-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	5	Counter Event - 32-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	6	Counter Event - 16-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	0	Frozen Counter Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
23	1	Frozen Counter Event - 32-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	2	Frozen Counter Event - 16-bit with flag	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	5	Frozen Counter Event - 32-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	6	Frozen Counter Event - 16-bit with flag and time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
30	0	Analog Input - Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
30	1	Analog Input - 32-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	2	Analog Input - 16-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	3	Analog Input - 32-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	4	Analog Input - 16-bit without flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
30	5	Analog Input - Single-prec flt-pt with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
32	0	Analog Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1	Analog Input Event - 32-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	2	Analog Input Event - 16-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	3	Analog Input Event - 32-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	4	Analog Input Event - 16-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	5	Analog Input Event - Single-prec flt-pt without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	7	Analog Input Event - Single-prec flt-pt with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
40	0	Analog Output Status - Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all)		
40	1	Analog Output Status - 32-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
40	2	Analog Output Status - 16-bit with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)
40	3	Analog Output Status - Single-prec flt-pt with flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop)

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
41	1	Analog Output - 32-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 27, 28 (index)	129 (response)	echo of request
41	2	Analog Output - 16-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 27, 28 (index)	129 (response)	echo of request
41	3	Analog Output - Single-prec flt-pt	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 27, 28 (index)	129 (response)	echo of request
50	1	Time and Date - Absolute time	1 (read)	07 (limited qty = 1)	129 (response)	07 (limited qty) (qty = 1)
			2 (write)	07 (limited qty = 1)		
50	3	Time and Date - Absolute time at last recorded time	2 (write)	07 (limited qty = 1)		
51	1	Time and Date CTO - Absolute time, synchronized			129 (response) 130 (unsol. resp)	07 (limited qty) (qty = 1)
51	2	Time and Date CTO - Absolute time, unsynchronized			129 (response) 130 (unsol. resp)	07 (limited qty) (qty = 1)
52	2	Time Delay - Fine			129 (response)	07 (limited qty) (qty = 1)
60	1	Class Objects - Class 0 data	1 (read)	06 (no range, or all)		
60	2	Class Objects - Class 1 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.)	06 (no range, or all)		
60	3	Class Objects - Class 2 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	4	Class Objects - Class 3 data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.)	06 (no range, or all)		
70	2	File-Control - authentication	29 (authenticate file)	5B (free format)	129 (response)	5B (free format)
70	3	File Control - file command	25 (open file)	5B (free format)		
70	3	File Control - file command	27 (delete file)	5B (free format)		
70	4	File Control - file command status	26 (close file)	5B (free format)	129 (response)	5B (free format)
70	4	File Control - file command status	30 (abort file)	5B (free format)	129 (response)	5B (free format)
70	5	File Control - file transport	1 (read file)	5B (free format)	129 (response)	5B (free format)
70	5	File Control - file transport	2 (write file)	5B (free format)	129 (response)	5B (free format)
70	6	File Control - file transport status			129 (response)	5B (free format)

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
70	7	File-Control - file descriptor	28 (get file info)	5B (free format)	129 (response)	5B (free format)
70	8	File-Control - file specification string	31 (activate config)	5B (free format)		
80	1	Internal Indications - Packed format	1 (read)	00, 01 (start-stop)	129 (response)	00, 01 (start-stop)
			2 (write)	00 (start-stop) index=7		
85	0	Data Set Prototype	1 (read)	06 (no range, or all)		
85	1	Data Set Prototype	1 (read)	00, 01 (start-stop) 06 (no range, or all) 17, 28 (index)	129 (response)	5B (free format)
86	1	Data Set Descriptor - Contents	1 (read)	00, 01 (start-stop) 06 (no range, or all) 17, 28 (index)	129 (response)	5B (free format)
86	2	Data Set Descriptor - Characteristics	1 (read)	00, 01 (start-stop) 06 (no range, or all) 17, 28 (index)	129 (response)	5B (free format)
87	0	Data Set - Present Value	1 (read)	00, 01 (start-stop) 06 (no range, or all) 17, 28 (index)		
87	1	Data Set - Present Value	1 (read)	00, 01 (start-stop) 06 (no range, or all) 17, 28 (index)	129 (response)	5B (free format)
88	0	Data Set Event	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
88	1	Data Set Event - Snapshot	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	5B (free format)
90	1	Application - Identifier	16 (init. appl.) 17 (start appl.) 18 (stop appl.)	06 (no range, or all) 5B (free format)		
91	1	Status of Requested Operation			129 (response)	07 (limited qty) (qty = 1)
101	0	Binary Coded Decimal Integers - Any Variation	1 (read)	06 (no range, or all)		
101	1	Binary Coded Decimal Integers - small	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
					130 (unsol. resp)	17, 28 (index)
120	1	Authentication - Challenge	32 (Auth Request)	5B (free format)	131 (Auth. resp)	5B (free format)
120	2	Authentication - Reply	32 (Auth Request)	5B (free format)	131 (Auth. resp)	5B (free format)
120	3	Authentication - Aggressive Mode Request	Any requests	07 (limited qty)	129 (response)	07 (limited qty)
120	3	Authentication - Aggressive Mode Request			130 (unsol. resp)	07 (limited qty)
120	4	Authentication - Session Key Status Request	32 (Auth Request)	07 (limited qty)		

Implementation Table for Series B controllers

DNP Object Group & Variation			Request DNP3 Master may issue MicroLogix 1400 must parse		Response DNP3 Master must parse MicroLogix 1400 may issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
120	5	Authentication - Session Key Status			131 (Auth. resp)	5B (free format)
120	6	Authentication - Session Key Change	32 (Auth Request)	5B (free format)		
120	7	Authentication - Error	33 (Auth Request, no ack)	5B (free format)	131 (Auth. resp)	5B (free format)
120	7	Authentication - Error	1 (read)	06 (no range, or all)	129 (response)	5B (free format)
120	9	Authentication - HMAC	Any requests	5B (free format)	129 (response)	5B (free format)
120	9	Authentication - HMAC			130 (unsol. resp)	5B (free format)
No Object (function code only)			13 (cold restart)			
No Object (function code only)			14 (warm restart)			
No Object (function code only)			23 (delay meas.)			
No Object (function code only)			24 (record current time)			

Notes:

Connecting to Networks via Ethernet Interface

This appendix:

- describes MicroLogix 1400 controllers and Ethernet communication.
- describes MicroLogix 1400 performance considerations.
- describes Ethernet network connections and media.
- explains how the MicroLogix 1400 establishes node connections.
- lists Ethernet configuration parameters and procedures.
- describes configuration for subnet masks and gateways.

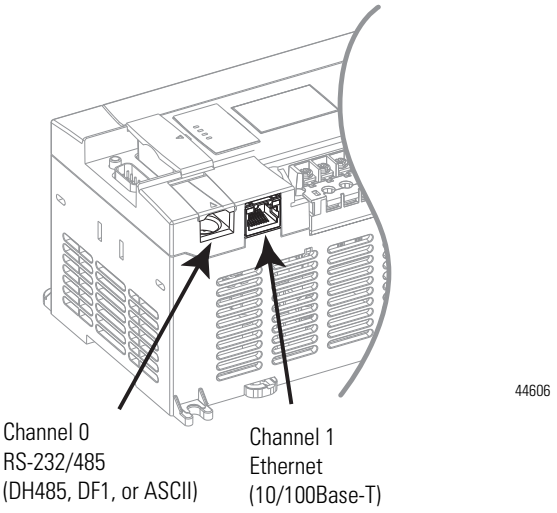
MicroLogix 1400 Controllers and Ethernet Communication

Ethernet is a local area network that provides communication between various devices @ 10...100 Mbps. The physical communication media options for the MicroLogix 1400 are:

- built-in
  - twisted-pair (10/100Base-T)
- with media converters or hubs
  - fiber optic
  - broadband
  - thick-wire coaxial cable (10Base-5)
  - thin-wire coaxial cable (10Base-2)

See the following page for more information on Ethernet physical media.

The MicroLogix 1400 supports Ethernet communication via the Ethernet communication channel 1 shown in the drawing below.



MicroLogix 1400 Performance Considerations

Actual performance of an MicroLogix 1400 controller varies according to:

- size of Ethernet messages.
- frequency of Ethernet messages.
- network loading.
- the implementation of and performance of your processor application program.

Optimal Performance: Micrologix 1400 controller to Micrologix 1100 Series B OS FRN 4 controller (2-node Ethernet network)

Operation	Words	MSG per Second	Words per Second
Single Typed Read	1	20	20
Single Typed Reads	20	20	400
Single Typed Reads	100	20	2000

Optimal Performance: MicroLogix 1400 controller to RSLinx

Operation	Words	MSG per Second	Words per Second
Single Typed Read	1	25	25
Single Typed Reads	20	25	500
Single Typed Reads	100	25	2,500

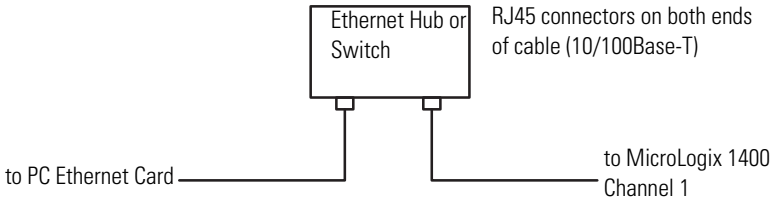
Optimal Performance: MicroLogix 1400 to MicroLogix 1400 controller

Operation	Words	MSG per Second	Words per Second
Single Typed Read	1	20	20
Single Typed Reads	20	20	400
Single Typed Reads	100	20	2,000

MicroLogix 1400 and PC Connections to the Ethernet Network

The MicroLogix 1400 Ethernet connector conforms to ISO/IEC 8802-3 STD 802.3 and utilizes 10/100Base-T media. Connections are made directly from the MicroLogix 1400 to an Ethernet hub or switch. The network setup is simple and cost effective. Typical network topology is pictured below.

Ethernet Network Topology



IMPORTANT The MicroLogix 1400 controller contains a 10/100Base-T, RJ45 Ethernet connector which connects to standard Ethernet hubs or switchs via 8-wire twisted-pair straight-through cable. To access other Ethernet mediums, use 10/100Base-T media converters or Ethernet hubs or switchs that can be connected together via fiber, thin-wire, or thick-wire coaxial cables, or any other physical media commercially available with Ethernet hubs or switchs.

Connecting an Ethernet switch on the Ethernet Network

The MicroLogix 1400 Ethernet port supports the following Ethernet settings:

- 10 Mbps half duplex or full duplex
- 100 Mbps half duplex or full duplex

Mode selection can be automatic, based on the IEEE 802.3 auto negotiation protocol. In most cases, using the auto negotiation function results in proper operation between a switch port and MicroLogix 1400 Ethernet port.

With RSLogix500/RSLogix Micro programming software version 8.10.00 or later, you can manually set the communication rate and duplex mode of an Ethernet port you have connected to the switch port. The settings of the Ethernet port and the switch port must match.

IMPORTANT When connecting the MicroLogix 1400 Ethernet port to a 10/100Base-T Ethernet switch, note the following recommendations:

- Use the auto negotiation function for both the switch port and the MicroLogix 1400 Ethernet port
- If you want to force to a specific speed/duplex mode, you must force both the MicroLogix 1400 Ethernet port and the switch port to the same setting.

Cables

Shielded and non-shielded twisted-pair 10/100Base-T cables with RJ45 connectors are supported. The maximum cable length between an MicroLogix 1400 Ethernet port and a 10/100Base-T port on an Ethernet hub or switch (without repeaters or fiber) is 100 m (323 ft). However, in an industrial application, cable length should be kept to a minimum.

TIP The Ethernet cabling with straight-through method is recommended as below. Do *not* make the incorrect connection.

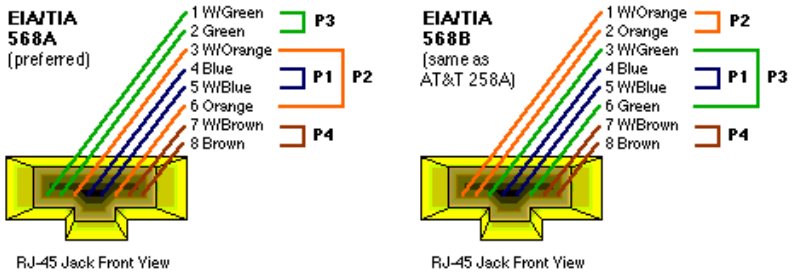
Straight-through cabling

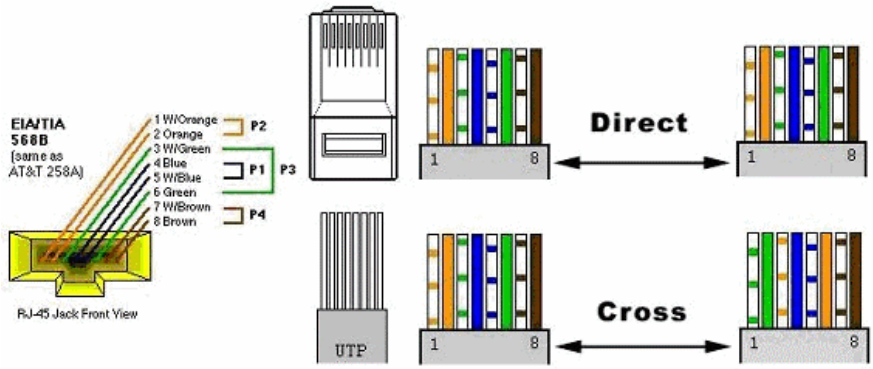
Pin	Pin Name	Cable color
1	Tx+	Orange/White
2	Tx-	Orange
3	Rx+	Green/White
4	No used by 10/100Base-T	Blue
5	No used by 10/100Base-T	Blue/White
6	Rx-	Green
7	No used by 10/100Base-T	Brown/White
8	No used by 10/100Base-T	Brown

The standard Ethernet cable is terminated in accordance with EIA/TIA 568B on both ends. The crossover cable is terminated to EIA/TIA 568B at one end and EIA/TIA 568A at the other, exactly as shown in the two color coded plugs below.

The following figures show how the TIA/EIA 568A and 568B are to be terminated. There are four pairs of wires contained in a CAT5 UTP cable. These pairs of cables are color coded white blue/blue, white orange/orange, white

green/green, white brown/brown, they are also numbered one to four in the order shown.





TIP

The most common wiring for RJ45 cables is the "straight through" cable which means that pin 1 of the plug on one end is connected to pin 1 of the plug on the other end. The straight through RJ45 cable is commonly used to connect network cards with hubs on 10Base-T and 100Base-Tx networks. On network cards, pair 1-2 is the transmitter, and pair 3-6 is the receiver. The other two pairs are not used. On hubs pair 1-2 is the receiver and 3-6 the transmitter. It may be best to wire your cables with the same color sequence. In this cable layout, all pins are wired one-to-one to the other side. The pins on the RJ45 connector are assigned in pairs, and every pair carries one differential signal. Each line pair has to be twisted.

In small networks where only two Ethernet devices need to be connected together point-to-point, a "cross over" RJ45 cable may be necessary, where the transmit and receive lines on both JR45 connectors are cross connected. The color coding for the cross over RJ45 cable have been defined in the EIA/TIA 568A standard. In a cross-over cable layout, you should remember that one end is normal, and the other end has the cross-over configuration.

However, because the MicroLogix 1400 Ethernet port implements "auto-crossover" (also called Automatic MDI/MDI-X Configuration), a straight through cable may be used even for direct point-to-point connections between the MicroLogix 1400 and another Ethernet device.

Ethernet Connections

TCP/IP is the mechanism used to transport Ethernet messages. On top of TCP, Ethernet/IP and/or Modbus TCP protocol is required to establish sessions and to send the MSG commands. Connections can be initiated by either a client program (RSLinx application) or a processor.

The client program or processor must first establish a connection to the MicroLogix 1400 to enable the MicroLogix 1400 to receive solicited messages from a client program or another processor.

In order to *send* an outgoing message, the MicroLogix 1400 must first establish a connection with the destination node at a specified IP address on the Ethernet network. A connection is established when a MSG instruction executes and no previous connection exists.

When a MSG instruction executes, the MicroLogix 1400 checks to see whether a connection has been established with the destination node. If a connection has not been established, the MicroLogix 1400 attempts to establish a connection of the peer type.

In order to *receive* messages from another device on Ethernet, an “incoming” connection must be established. This incoming connection is made by the sending processor and uses one incoming connection in the receiving processor.

The MicroLogix 1400 supports a maximum of 32 EtherNet/IP connections and 32 Modbus TCP connections, allowing a maximum of 32 outgoing and a maximum of 32 incoming simultaneous connections with up to 64 other devices or applications.. The connections are dedicated as follows:

Number of Connections[1]	Dedicated to:
16	Incoming EtherNet/IP Connections
16 (Series B only)	Incoming Modbus TCP Connections
16	Outgoing EtherNet/IP Connections
16 (Series B only)	OutgoingModbus TCP Connections

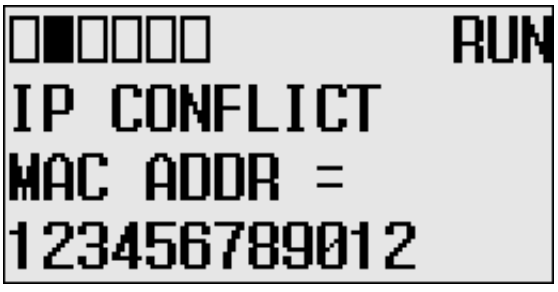
(1) Connections established by an INTERCHANGE client, RSLinx client, and peers are all included when counting the number of connections.

IMPORTANT For outgoing connections, no more that one connection per destination node is established. If multiple MSG instructions use the same destination node, they share the same connection.

Duplicate IP address Detection

The MicroLogix 1400 firmware supports duplicate IP address detection. In Series B, duplicate IP address detection can be disabled in the Channel 1 configuration in order to eliminate this source of broadcast traffic for low bandwidth applications.

When you change the IP address or connect one of the MicroLogix to an EtherNet/IP network, the MicroLogix 1400 controller checks to make sure that the IP address assigned to this device does not match the address of any other network device. The MicroLogix 1400 will check every 2 minutes for a duplicate IP address on the network. If the MicroLogix 1400 determines that there is a conflict (another device on the network with a matching IP address), the following message gets posted on the LCD display.



To correct this conflict, use the instructions in this chapter to change the IP address of the Ethernet/IP device. Then cycle power to the device or reset the device (such as disconnecting the ethernet cable and reconnecting the cable). There is also the possibility that two Ethernet/IP device can detect a conflict simultaneously. If this occurs, remove the device with the incorrect IP address or correct its conflict. To get the second device out of conflict mode, cycle power to the module or disconnect its ethernet cable and reconnect the cable.

The MicroLogix 1400 will check every 2 minutes for a duplicate IP address on the network.

Configuring the Ethernet Channel on the MicroLogix 1400

There are three ways to configure the MicroLogix 1400 Ethernet channel 1.

- via a BOOTP or DHCP request at controller powerup
- manually setting the configuration parameters using RSLogix 500/RSLogix Micro Programming Software
- via LCD display (see Configuring the Ethernet Port on page 100 and Configuring Ethernet Protocol Setup on page 102)

The configuration parameters are shown on the following page, and the configuration procedures follow.

Configuration Parameters

Parameter	Description	Default	Status
Hardware Address	The MicroLogix 1400 Ethernet hardware address.	Ethernet hardware address	read only
IP Address	The MicroLogix 1400 internet address (in network byte order). The internet address must be specified to connect to the TCP/IP network.	0 (undefined)	read/write
Subnet Mask	The MicroLogix 1400 subnet mask (in network byte order). The Subnet Mask is used to interpret IP addresses when the internet is divided into subnets. A Subnet Mask of all zeros indicates that no subnet mask has been configured. In this case, the controller assumes a Subnet Mask of 255.255.255.0.	0 (undefined)	read/write
Gateway Address	The address of a gateway (in network byte order) that provides connection to another IP network. A Gateway Address of all zeros indicates that no gateway has been configured. In this case, the controller assumes a Gateway Address of aaa.bbb.ccc.001, where aaa.bbb.ccc are the first three octets of the configured IP Address.	0 (undefined)	read/write
Default Domain Name	The default domain name can have the following formats: 'a.b.c', 'a.b' or 'a', where a, b, c must start with a letter, end with a letter or digit, and have as interior characters only letters, digits or hyphens. Maximum length is 63 characters.	NULL (undefined)	read/write
Primary Name Server	This is the IP address of the computer acting as the local Ethernet network Primary Domain Name System (DNS) server.	0 (undefined)	read/write
Secondary Name Server	This is the IP address of the computer acting as the local Ethernet network Secondary Domain Name System (DNS) server.	0 (undefined)	read/write
BOOTP Enable	The BOOTP enable switch. When BOOTP is enabled, the MicroLogix 1400 attempts to learn its network related parameters at powerup via a BOOTP request. There must be a BOOTP server on the network capable of responding to this BOOTP request. When both BOOTP and DHCP are disabled, the MicroLogix 1400 uses the locally configured network related parameters (IP Address, Subnet Mask, Broadcast Address, etc.).	1 (enabled)	read/write
DHCP Enable	The DHCP auto configuration enable switch. When DHCP is enabled, a DHCP server automatically assigns network related parameters to the MicroLogix 1400 when it logs into a TCP/IP network. There must be a DHCP server on the network capable of allocating network addresses and configuring parameters to newly attached device. When both BOOTP and DHCP are disabled, the MicroLogix 1400 uses the locally configured network related parameters (IP Address, Subnet Mask, Broadcast Address, etc.).	0 (disabled)	read/write
SNMP Server Enable	SNMP enable switch. Check this to enable SNMP (Simple Network Management Protocol).	1 (enabled)	read/write
SMTP Client Enable	The SMTP Client service enable switch. When SMTP is enabled, MicroLogix 1400 is capable of transmitting e-mail messages generated by a 485CIF write message with a string element. There must be a SMTP server on the network capable of processing e-mail service. This provides an extremely versatile mechanism to report alarms, status, and other data-related functions.	0 (disabled)	read/write
Auto Negotiate and Port Setting	When Auto Negotiate is disabled (unchecked), the Ethernet speed/duplex is forced to either 10 Mbps/Half-duplex, 10 Mbps/Full-duplex, 100 Mbps/Half-duplex, or 100 Mbps/Full-duplex, as selected in the Port Setting field. When Auto Negotiate is enabled (checked), the Port Setting Field allows you to select the range of speed/duplex settings that the MicroLogix 1400 will negotiate.	Auto Negotiate enabled and Port Setting. 10/100 Mbps Full Duplex/Half Duplex	read/write
MSG Connection Timeout	The amount of time (in ms) allowed for a MSG instruction to establish a connection with the destination node. The MSG Connection Timeout has 250 ms resolution and a range from 250 to 65,500.	15,000 ms	read/write
MSG Reply Timeout	The amount of time (in ms) that the MicroLogix 1400 will wait for a reply to a command that it has initiated via a MSG instruction. The MSG Reply Timeout has 250 ms resolution and a range from 250…65,500.	3,000 ms	read/write
Inactivity Timeout	The amount of time (in minutes) that a MSG connection may remain inactive before it is terminated. The Inactivity Timeout has a 1 minute resolution and a range from 1…65,500 minutes.	30 minutes.	read/write

Configuration Parameters

Parameter	Description	Default	Status
Contact	The Contact string which is specified by the SNMP client. The maximum length is 63 characters.		read only
Location	The Location string which is specified by the SNMP client. The maximum length is 63 characters.		read only
Network Link ID	The Link ID assigned to the MicroLogix 1400 by either an RSLinx OPC topic or by the routing table in a 1756-DHRIO or 1756-DH485 module. The range is 0…199.	0	read/write
Starting Data File Number	The first ASCII (A) file number in a contiguous block of 4-32 ASCII files (4 per User Provided Web Page). The range is 9…252 (or 0 for disable).	0	read/write
Number of Pages	The number of User Provided Web Pages, provided the Starting Data File Number is non-zero. The range is 1…8.	1	read/write
DNP3 over IP Enable	When DNP3 over IP is enabled (checked), the MicroLogix 1400 enables DNP3 over IP feature on Ethernet channel. Power cycle is required for changes to take effect.	0 (disable)	read/write
Modbus TCP Enable	When Modbus TCP is enabled(checked), the MicroLogix 1400 enables Modbus TCP feature on Ethernet channel. Power cycle is required for changes to take effect.	0 (disable)	read/write
Disable EtherNet/IP Incoming Connections	When EtherNet/IP Incoming Connections is disabled (checked), the MicroLogix 1400 does not allow the incoming EtherNet/IP connection. However, MicroLogix 1400 can send the outgoing EtherNet/IP commands to other EtherNet/IP devices. Power cycle is required for changes to take effect.	0 (disable)	read/write
Disable Duplicate IP Address Detection	When Duplicate IP Address Detection is disabled(checked), the MicroLogix 1400 does not send any packets to the network to detect Duplicate IP on the same network.	0 (disable)	read/write

Configuration Using RSLogix 500/RSLogix Micro Programming Software

Refer to the online documentation provided with your programming software.

Configuration Via BOOTP

BOOTP (bootstrap protocol) is a low-level protocol that TCP/IP nodes use to obtain start-up information. By default, the MicroLogix 1400 broadcasts BOOTP requests at powerup. The BOOTP Valid parameter remains clear until a BOOTP reply has been received. BOOTP lets you dynamically assign IP Addresses to processors on the Ethernet Link.

To use BOOTP, a BOOTP Server must exist on the local Ethernet subnet. The server is a computer that has BOOTP Server software installed and reads a text file containing network information for individual nodes on the network.

The host system's BOOTP configuration file must be updated to service requests from MicroLogix 1400 controllers. The following parameters must be configured:

Configuration Parameters

Parameter	Description
IP Address	A unique IP Address for the MicroLogix 1400 controller.
Subnet Mask	Specifies the net and local subnet mask as per the standard on subnetting RFC 950, Internet Standard Subnetting Procedure.
Gateway	Specifies the IP address of a gateway on the same subnet as the MicroLogix 1400 that provides connections to another IP network.

TIP You can use any commercially available BOOTP server. If you do not have BOOTP Server capabilities on your network, and you want to dynamically configure Channel 1, you can download the free Rockwell Automation BOOTP server from the Rockwell Automation website. Go to http://www.ab.com/networks/ethernet/bootp.html .

When BOOTP is enabled, the following events occur at power-up:

- The processor broadcasts a BOOTP-request message containing its hardware address over the local network or subnet.
- The BOOTP server compares the hardware address with the addresses in its look-up table.
- The BOOTP server sends a message back to the processor with the IP address and other network information that corresponds to the hardware address it received.

With all hardware and IP addresses in one location, you can easily change IP addresses in the BOOTP configuration file if your network needs to be changed.

The BOOTP request can be disabled by clearing the BOOTP Enable parameter in the channel configuration file. When both BOOTP Enable and DHCP are cleared (disabled), the MicroLogix 1400 uses the existing channel configuration data.

IMPORTANT If BOOTP is disabled, or no BOOTP server exists on the network, you must use RSLogix 500/RSLogix Micro programming software to enter/change the IP address for each processor or you must use DHCP instead of it.

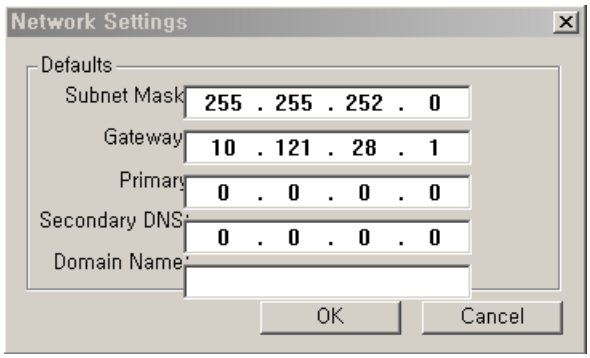
Using the Rockwell Automation BOOTP/DHCP Utility

The Rockwell Automation BOOTP/DHCP server utility is a standalone program that incorporates the functionality of standard BOOTP software with a user-friendly graphical interface. It is located in the **Utils** directory on the RSLogix 500/RSLogix Micro installation CD.

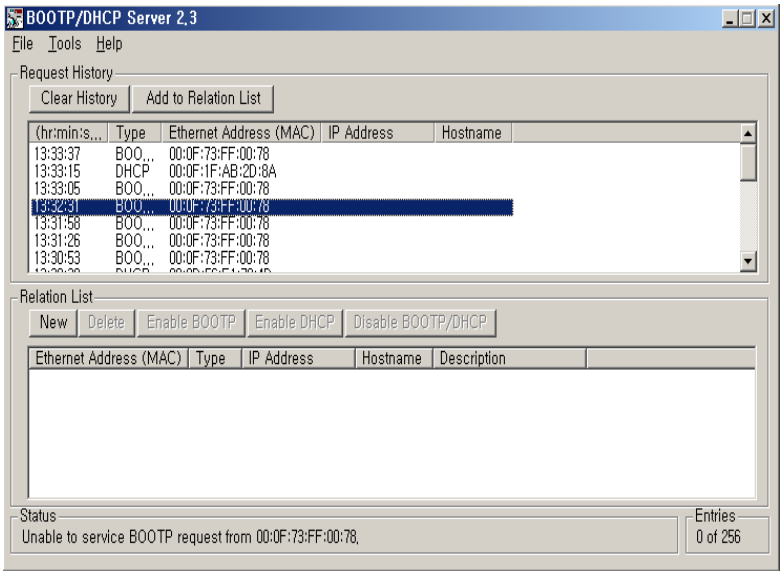
The newest version of the utility can be downloaded from http://www.ab.com/networks/ethernet/bootp.html . The device must have BOOTP enabled (factory default) or DHCP enabled to use the utility.

To configure your device using the BOOTP utility, perform the following steps.

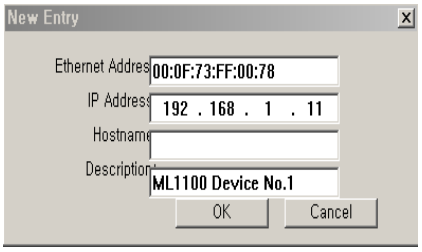
1. Run the BOOTP/DHCP server utility software. It will ask you to configure your network settings before using the BOOTP/DHCP server tool. Enter your Ethernet settings for Subnet Mask and Gateway. If you are not sure about it, get a help from your system administrator. Just leave Primary DNS, Secondary DNS, and Domain Name (If corresponding information is allocated to the PC where BOOTP/DHCP server utility is installed, enter the same information.)



2. In the **Request History** panel you will see the hardware addresses of devices issuing BOOTP or DHCP requests.

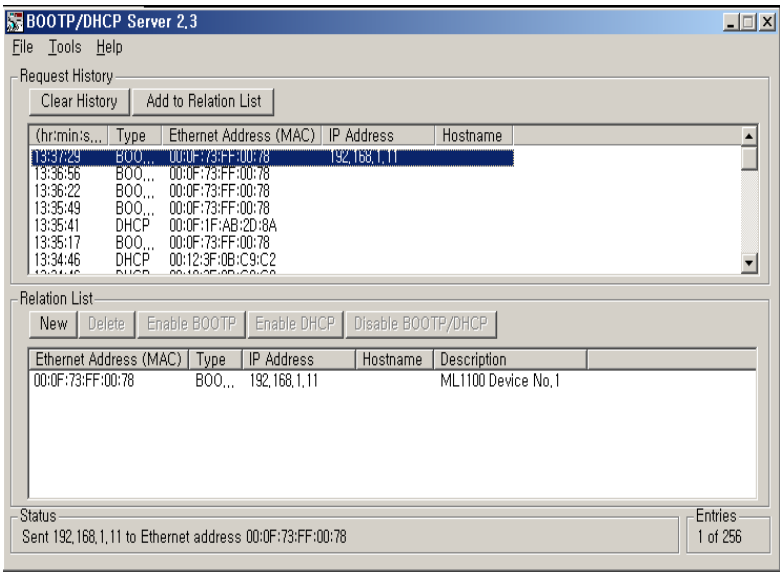


3. Double-click on the hardware address of the device you want to configure. You will see the **New Entry** pop-up window with the device's Ethernet Address (MAC).



4. Enter the **IP Address and Description** you want to assign to the device, and click **OK**. Leave Hostname blank.

   The device will be added to the **Relation List**, displaying the Ethernet Address (MAC) and corresponding IP Address, Subnet Mask, and Gateway (if applicable).



Using a DHCP Server To Configure Your Processor

A DHCP server automatically assigns IP addresses to client stations logging onto a TCP/IP network. DHCP is based on BOOTP and maintains some backward compatibility. The main difference is that BOOTP was designed for manual configuration, while DHCP allows for dynamic allocation of network addresses and configurations to newly attached devices.



ATTENTION: The processor must be assigned a fixed network address. The IP address of the processor must not be dynamically provided. *Failure to observe this precaution may result in unintended machine motion or loss of process control.*

Using Subnet Masks and Gateways

Configure subnet masks and gateways using the Ethernet channel 1 configuration screen.

IMPORTANT If BOOTP is enabled, you can't change any of the advanced Ethernet communications characteristics.

If your network is divided into subnetworks that use gateways or routers, you must indicate the following information when configuring channel 1:

- subnet mask
- gateway address

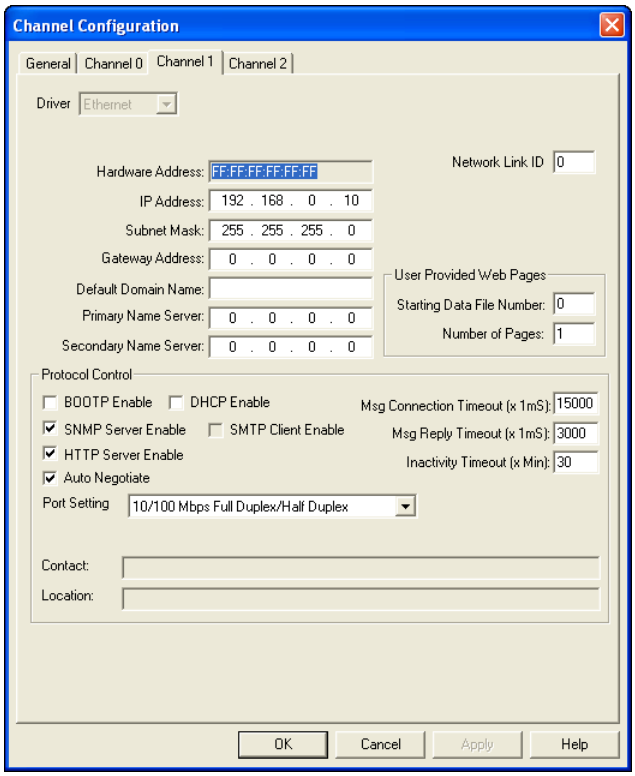
A *subnet mask* is a filter that a node applies to IP addresses to determine if an address is on the local subnet or on another subnet. If an address is located on another subnetwork, messages are routed through a local gateway to be transferred to the destination subnetwork.

If your network is not divided into subnets, then leave the subnet mask field at the default.

If you are	Then
manually configuring channel 1 and have a network with subnets	• be sure the BOOTP enable field is disabled • use your programming software to enter the subnet mask and gateway address.
using BOOTP to configure channel 1 and have a network with subnets	• be sure BOOTP is enabled • include the subnet mask(s) and gateway address(es)

Manually Configuring Channel 1 for Controllers on Subnets

If you are manually configuring channel 1 for a MicroLogix 1400 controller located on a subnet, deselect both of the "BOOTP Enable" and "DHCP Enable" options by clicking on the checked box, as shown in the figure below.



See the table below to configure the subnet mask and gateway address fields for each controller via your programming software.

This field:	Specifies:	Configure by doing the following:
Subnet Mask	The controller's subnet mask. The subnet mask is used to interpret IP addresses when the internet is divided into subnets.	Enter an address of the following form: a.b.c.d Where: a, b, c, d are between 0...255 (decimal) If your network is not divided into subnets, then leave the subnet mask field at the default. If you change the default and need to reset it, type 0.0.0.0.
Gateway Address	The IP address of the gateway that provides a connection to another IP network. This field is required when you communicate with other devices not on a local subnet.	Enter an address of the following form: a.b.c.d Where: a, b, c, d are between 0...255 (decimal) The default address is No Gateway.

MicroLogix 1400 Embedded Web Server Capability

MicroLogix 1400 controllers include not only the embedded web server which allows viewing of module information, TCP/IP configuration, and diagnostic information, but the capabilities that also allow viewing of the data file via Ethernet using a standard web browser.

For more information on MicroLogix 1400 embedded web server capability, refer to the *MicroLogix 1400 Embedded Web Server User Manual*, publication 1766-UM002.

System Loading and Heat Dissipation

TIP A maximum of seven 1762 I/O modules, in *any* combination, can be connected to a MicroLogix 1400 controller. You can use this appendix to determine the power supply load and heat dissipation for your system.

System Loading Calculations

The MicroLogix 1400 controller is designed to support up to any seven 1762 expansion I/O modules.

When you connect MicroLogix accessories and expansion I/O, an electrical load is placed on the controller power supply. This section shows how to calculate the load of your control system.

The following example is provided to illustrate system loading calculation. The system calculation procedure accounts for the amount of 5V DC and 24V DC current consumed by controller, expansion I/O, and user-supplied equipment. Use the System Loading Worksheet on page 345 to calculate your controller configuration.

System Loading Example Calculations

Current Loading

Calculating the Current for Expansion I/O

Catalog Number[1]	n	A	B	n x A	n x B
	Number of Modules	Device Current Requirements (max)		Calculated Current	
		at 5V DC (mA)	at 24V DC (mA)	at 5V DC (mA)	at 24V DC (mA)
1762-IA8	2	50	0	100	0
1762-IF4		40	50		
1762-IF2OF2		40	105		
1762-IQ8		50	0		
1762-IQ16		70 [2]	0		
1762-IQ32T		170	0		
1762-IR4		40	50		
1762-IT4		40	50		
1762-OA8		115	0		
1762-OB8		115	0		
1762-OB16		175	0		
1762-OB32T		175	0		
1762-OF4		40	165		
1762-OV32T		175	0		
1762-OW8	2	80	90	160	180
1762-OW16		140 [2]	180[2]		
1762-OX6I		110	110		
1762-IQ8OW6		110	80		
Total Modules (7 maximum):	**4**	**Subtotal:**		**260**	**180**

(1) Refer to your expansion I/O Installation Instructions for Current Requirements not listed in this table.

(2) Only applicable to Series B I/O modules.

Validating the System

The example systems shown in the tables below are verified to be acceptable configurations. The systems are valid because:

- *Calculated Current Values* < *Maximum Allowable Current Values*
- *Calculated System Loading* < *Maximum Allowable System Loading*

Validating Systems using 1766-L32AWA, or 1766-L32BXB

Maximum Allowable Values		**Calculated Values**	
Current:		Current (Subtotal from Table on page 344.):	
1225 mA @ 5V DC	1155 mA @ 24V DC	0 mA + 260 mA = 260 mA @ 5V DC	0 mA + 180 mA = 180 mA @ 24V DC
System Loading:		System Loading:	
33.845 W		= (260 mA x 5V) + (180 mA x 24V) = (1,300 mW) + (4,320 mW) = 5,620 mW = 5.62 W	

Validating Systems using 1766-L32BWA

Maximum Allowable Values		**Calculated Values**	
Current for Devices Connected to the +24V DC Sensor Supply:		Sum of all sensor currents	
250 mA @ 24V DC		140 mA @ 24V DC (example sensor value)	
Current for MicroLogix Accessories and Expansion I/O:		Current Values (Subtotal from Table):	
1225 mA @ 5V DC	1155 mA @ 24V DC	0 mA + 260 mA = 260 mA @ 5V DC	0 mA + 180 mA = 180 mA @ 24V DC
System Loading:		System Loading:	
39.845 W		= (140 mA x 24V) + (260 mA x 5V) + (180 mA x 24V) = (3,360 mW) + (1,300 mW) + (4,320 mW) = 8,980 mW = 8.98 W	

System Loading Worksheet

The tables below are provided for system loading validation. See System Loading Example Calculations on page 344.

Current Loading

Calculating the Current for Expansion I/O

Catalog Number(1)	**n**	**A**	**B**	**n x A**	**n x B**
	Number of Modules	**Device Current Requirements**		**Calculated Current**	
		@ 5V DC (mA)	**@ 24V DC (mA)**	**@ 5V DC (mA)**	**@ 24V DC (mA)**
1762-IA8		50	0		
1762-IF4		40	50		
1762-IF2OF2		40	105		

Calculating the Current for Expansion I/O

1762-IQ8		50	0		
1762-IQ16		70	0		
1762-IQ32T		170	0		
1762-IR4		40	50		
1762-IT4		40	50		
1762-OA8		115	0		
1762-OB8		115	0		
1762-OB16		175	0		
1762-OB32T		175	0		
1762-OF4		40	165		
1762-OV32T		175	0		
1762-OW8		80	90		
1762-OW16		140 (2)	180 (2)		
1762-OX6I		110	110		
1762-IQ8OW6		110	80		
Total Modules (7 maximum):		**Subtotal:**			

(1) Refer to your expansion I/O Installation Instructions for Current Requirements not listed in this table.

(2) Only applicable to Series B I/O modules.

Validating Systems using 1766-L32AWA or 1766-L32BXB

Maximum Allowable Values		Calculated Values	
Current:		Current (Subtotal from Table .):	
1225 mA at 5V DC	1155 mA at 24V DC	mA @ 5V DC	mA @ 24V DC
System Loading:		System Loading:	
33.845 W		= (_____ mA x 5V) + (_____ mA x 24V) = _____ mW + _____ mW = _____ mW = _____ W	

Validating Systems using 1766-L32BWA

Maximum Allowable Values		Calculated Values	
Current for Devices Connected to the +24V DC Sensor Supply:		Sum of all sensor currents	
250 mA @ 24V DC		mA @ 24V DC	
Current for MicroLogix Accessories and Expansion I/O:		Current (Subtotal from Table .)	
1225 mA @ 5V DC	1155 mA @ 24V DC	mA @ 5 V DC	mA @ 24V DC
System Loading:		System Loading:	
39.845 W		= (_____ mA x 24V) + (_____ mA x 5V) + (_____ mA x 24V) = _____ mW + _____ mW + _____ mW = _____ mW = _____ W	

Calculating Heat Dissipation

Use the following table when you need to determine the heat dissipation of your system for installation in an enclosure. For System Loading, take the value from the appropriate system loading worksheets on pages 345 or 347.

Heat Dissipation

Catalog Number	Heat Dissipation		
	Equation or Constant	Calculation	Sub-Total
1766-L32AWA	15.2 W + (0.4 x System Loading)	15.2 W + (0.4 x _____ W)	W
1766-L32BWA	15.7 W + (0.4 x System Loading)	15.7 W + (0.4 x _____ W)	W
1766-L32BXB	17.0 W + (0.3 x System Loading)	17.0 W + (0.3 x _____ W)	W
1762-IA8	2.0 W x number of modules	2.0 W x _____	W
1762-IF4	2.0 W x number of modules	2.0 W x _____	W
1762-IF2OF2	2.6 W x number of modules	2.6 W x _____	W
1762-IQ8	3.7 W x number of modules	3.7 W x _____	W
1762-IQ16	5.4 W[(1)] x number of modules	5.4 W[(1)] x _____	W
1762-IQ32T	6.8 W x number of modules (@ 30.0V DC) 5.4 W x number of modules (@ 26.4V DC)	6.8 W x _____ (@ 30.0V DC) 5.4 W x _____ (@ 26.4V DC)	W W
1762-IR4	1.5 W x number of modules	1.5 W x _____	W
1762-IT4	1.5 W x number of modules	1.5 W x _____	W
1762-OA8	2.9 W x number of modules	2.9 W x _____	W

Heat Dissipation

1762-OB8	1.6 W x number of modules	1.6 W x _____	W
1762-OB16	2.9 W x number of modules	2.9 W x _____	W
1762-OB32T	3.4 W x number of modules	3.4 W x _____	W
1762-OF4	3.8 W x number of modules	3.8 W x _____	W
1762-OV32T	2.7 W x number of modules	2.7 W x _____	W
1762-OW8	2.9 W x number of modules	2.9 W x _____	W
1762-OW16	6.1 W(1) x number of modules	6.1 W(1) x _____	W
1762-OX6I	2.8 W x number of modules	2.8 W x _____	W
1762-IQ8OW6	4.4 W x number of modules	4.4 W x _____	W
Add Sub-Totals to determine Heat Dissipation			**W**

(1) Only applicable to Series B I/O modules.

The following terms are used throughout this manual. Refer to the *Allen-Bradley Industrial Automation Glossary*, publication AG-7.1, for a complete guide to Allen-Bradley technical terms.

address

A character string that uniquely identifies a memory location. For example, I:1/0 is the memory address for the data located in the Input file location word1, bit 0.

AIC+ Advanced Interface Converter

A device that provides a communication link between various networked devices. (Catalog Number 1761-NET-AIC.)

application

1) A machine or process monitored and controlled by a controller.
2) The use of computer- or processor-based routines for specific purposes.

baud rate

The speed of communication between devices. All devices must communicate at the same baud rate on a network.

bit

The smallest storage location in memory that contains either a 1 (ON) or a 0 (OFF).

block diagrams

A schematic drawing.

Boolean operators

Logical operators such as AND, OR, NAND, NOR, NOT, and Exclusive-OR that can be used singularly or in combination to form logic statements or circuits. Can have an output response of T or F.

branch

A parallel logic path within a rung of a ladder program.

communication scan

A part of the controller's operating cycle. Communication with other devices, such as software running on a personal computer, takes place.

controller

A device, such as a programmable controller, used to monitor input devices and control output devices.

controller overhead

An internal portion of the operating cycle used for housekeeping and set-up purposes.

control profile

The means by which a controller determines which outputs turn on under what conditions.

counter

1) An electro-mechanical relay-type device that counts the occurrence of some event. May be pulses developed from operations such as switch closures or interruptions of light beams.
2) In controllers, a software counter eliminates the need for hardware counters. The software counter can be given a preset count value to count up or down whenever the counted event occurs.

CPU (Central Processing Unit)

The decision-making and data storage section of a programmable controller.

data table

The part of processor memory that contains I/O values and files where data is monitored, manipulated, and changed for control purposes.

DIN rail

Manufactured according to Deutsche Industrie Normenausshus (DIN) standards, a metal railing designed to ease installation and mounting of your controller.

download

Data is transferred from a programming or storage device to another device.

DTE (Data Terminal Equipment)

Equipment that is attached to a network to send or receive data, or both.

embedded I/O

Embedded I/O is the controller's on-board I/O.

EMI

Electromagnetic interference.

encoder

1) A rotary device that transmits position information.
2) A device that transmits a fixed number of pulses for each revolution.

executing mode

Any run or test mode.

expansion I/O

Expansion I/O is I/O that is connected to the controller via a bus or cable. MicroLogix 1400 controllers use Bulletin 1762 expansion I/O.

false

The status of an instruction that does not provide a continuous logical path on a ladder rung.

FIFO (First-In-First-Out)

The order that data is entered into and retrieved from a file.

file

A collection of information organized into one group.

full-duplex

A bidirectional mode of communication where data may be transmitted and received simultaneously (contrast with half-duplex).

half-duplex

A communication link in which data transmission is limited to one direction at a time.

hard disk

A storage area in a personal computer that may be used to save processor files and reports for future use.

high byte

Bits 8 to 15 of a word.

input device

A device, such as a push button or a switch, that supplies signals to the input circuits of the controller.

inrush current

The temporary surge current produced when a device or circuit is initially energized.

instruction

A mnemonic and data address defining an operation to be performed by the processor. A rung in a program consists of a set of input and output instructions. The input instructions are evaluated by the controller as being true or false. In turn, the controller sets the output instructions to true or false.

instruction set

The set of general purpose instructions available with a given controller.

I/O (Inputs and Outputs)

Consists of input and output devices that provide and/or receive data from the controller.

jump

Change in normal sequence of program execution, by executing an instruction that alters the program counter (sometimes called a branch). In ladder programs a JUMP (JMP) instruction causes execution to jump to a labeled rung.

ladder logic

A program written in a format resembling a ladder-like diagram. The program is used by a programmable controller to control devices.

least significant bit (LSB)

The digit (or bit) in a binary word (code) that carries the smallest value of weight.

LED (Light Emitting Diode)

Used as status indicator for processor functions and inputs and outputs.

LIFO (Last-In-First-Out)

The order that data is entered into and retrieved from a file.

low byte

Bits 0 to 7 of a word.

logic

A process of solving complex problems through the repeated use of simple functions that can be either true or false. General term for digital circuits and programmed instructions to perform required decision making and computational functions.

Master Control Relay (MCR)

A mandatory hard-wired relay that can be de-energized by any series-connected emergency stop switch. Whenever the MCR is de-energized, its contacts open to de-energize all application I/O devices.

mnemonic

A simple and easy to remember term that is used to represent a complex or lengthy set of information.

modem

Modulator/demodulator. Equipment that connects data terminal equipment to a communication line.

modes

Selected methods of operation. Example: run, test, or program.

negative logic

The use of binary logic in such a way that “0” represents the voltage level normally associated with logic 1 (for example, 0 = +5V, 1 = 0V). Positive is more conventional (for example, 1 = +5V, 0 = 0V).

network

A series of stations (nodes) connected by some type of communication medium. A network may be made up of a single link or multiple links.

nominal input current

The current at nominal input voltage.

normally closed

Contacts on a relay or switch that are closed when the relay is de-energized or the switch is deactivated; they are open when the relay is energized or the switch is activated. In ladder programming, a symbol that allows logic continuity (flow) if the referenced input is logic "0" when evaluated.

normally open

Contacts on a relay or switch that are open when the relay is de-energized or the switch is deactivated. (They are closed when the relay is energized or the switch is activated.) In ladder programming, a symbol that allows logic continuity (flow) if the referenced input is logic "1" when evaluated.

off-delay time

The OFF delay time is a measure of the time required for the controller logic to recognize that a signal has been removed from the input terminal of the controller. The time is determined by circuit component delays and by any filter adjustment applied.

offline

Describes devices not under direct communication.

offset

The steady-state deviation of a controlled variable from a fixed point.

off-state leakage current

When an ideal mechanical switch is opened (off-state) no current flows through the switch. Practical semiconductor switches, and the transient suppression components which are sometimes used to protect switches, allow a small current to flow when the switch is in the off state. This current is referred to as the off-state leakage current. To ensure reliable operation, the off-state leakage current rating of a switch should be less than the minimum operating current rating of the load that is connected to the switch.

on-delay time

The ON delay time is a measure of the time required for the controller logic to recognize that a signal has been presented at the input terminal of the controller.

one-shot

A programming technique that sets a bit for only one program scan.

online

Describes devices under direct communication. For example, when RSLogix 500/RSLogix Micro is monitoring the program file in a controller.

operating voltage

For inputs, the voltage range needed for the input to be in the On state. For outputs, the allowable range of user-supplied voltage.

output device

A device, such as a pilot light or a motor starter coil, that is controlled by the controller.

processor

A Central Processing Unit. (See CPU.)

processor file

The set of program and data files used by the controller to control output devices. Only one processor file may be stored in the controller at a time.

program file

The area within a processor file that contains the ladder logic program.

program mode

When the controller is not executing the processor file and all outputs are de-energized.

program scan

A part of the controller's operating cycle. During the scan the ladder program is executed and the output data file is updated based on the program and the input data file.

programming device

Executable programming package used to develop ladder diagrams.

protocol

The packaging of information that is transmitted across a network.

read

To acquire data from a storage place. For example, the processor READs information from the input data file to solve the ladder program.

relay

An electrically operated device that mechanically switches electrical circuits.

relay logic

A representation of the program or other logic in a form normally used for relays.

restore

To download (transfer) a program from a personal computer to a controller.

reserved bit

A status file location that the user should not read or write to.

retentive data

Information associated with data files (timers, counters, inputs, and outputs) in a program that is preserved through power cycles.

RS-232

An EIA standard that specifies electrical, mechanical, and functional characteristics for serial binary communication circuits. A single-ended serial communication interface.

run mode

This is an executing mode during which the controller scans or executes the ladder program, monitors input devices, energizes output devices, and acts on enabled I/O forces.

rung

Ladder logic is comprised of a set of rungs. A rung contains input and output instructions. During Run mode, the inputs on a rung are evaluated to be true or false. If a path of true logic exists, the outputs are made true. If all paths are false, the outputs are made false.

save

To upload (transfer) a program stored in memory from a controller to a personal computer; OR to save a program to a computer hard disk.

scan time

The time required for the controller to execute the instructions in the program. The scan time may vary depending on the instructions and each instruction's status during the scan.

sinking

A term used to describe current flow between an I/O device and controller I/O circuit — typically, a sinking device or circuit provides a path to ground, low, or negative side of power supply.

sourcing

A term used to describe current flow between an I/O device and controller I/O circuit — typically, a sourcing device or circuit provides a path to the source, high, or positive side of power supply.

status

The condition of a circuit or system, represented as logic 0 (OFF) or 1 (ON).

terminal

A point on an I/O module that external I/O devices, such as a push button or pilot light, are wired to.

throughput

The time between when an input turns on and the corresponding output turns on.

true

The status of an instruction that provides a continuous logical path on a ladder rung.

upload

Data is transferred to a programming or storage device from another device.

watchdog timer

A timer that monitors a cyclical process and is cleared at the conclusion of each cycle. If the watchdog runs past its programmed time period, it causes a fault.

workspace

The main storage available for programs and data and allocated for working storage.

write

To copy data to a storage device. For example, the processor WRITEs the information from the output data file to the output modules.

Numerics

1747-BA battery 17
1762 expansion I/O dimensions 24
1762-24AWA wiring diagram 36
1762-IA8 wiring diagram 42
1762-IF2OF2
input type selection 50
output type selection 52
terminal block layout 53
wiring 52
1762-IF4
input type selection 54
terminal block layout 55
1762-IQ16 wiring diagram 43
1762-IQ32T wiring diagram 44
1762-IQ8 wiring diagram 43
1762-IQ8OW6 wiring diagram 50
1762-OA8 wiring diagram 44
1762-OB16 wiring diagram 45
1762-OB32T wiring diagram 46
1762-OB8 wiring diagram 45
1762-OV32T wiring diagram 47
1762-OW16 wiring diagram 48
1762-OW8 wiring diagram 47
1762-OX6I wiring diagram 49
5/05 processors
Ethernet communications 355

A

address 377
Advanced Interface Converter. See AIC+
advanced LCD configuration 119
agency certifications 7
AIC+
applying power to 82
attaching to the network 81
connecting 76
definition 377
installing 81
recommended user supplied components 80
safety consideration 81
selecting cable 78
analog cable grounding 42
analog channel wiring guidelines 40
analog expansion I/O 190
diagnostics 190
module operation vs. channel operation 190
power-up diagnostics 190
system wiring guidelines 50
troubleshooting 190
analog inputs
analog channel wiring guidelines 40
application 377

B

battery 148
processor battery life expectancy 179
processor replacement battery 179
baud rate 377
before calling for assistance 193
bit 377
bit file monitoring 98
block diagrams 377
Boolean operators 377
BOOTP
configuring SLC 5/05 364–367
using the Rockwell Utility 365
branch 377
buttons 93

C

cable pinout
MicroLogix controller channel 0 to modem cable 66, 76
cables
planning routes for DH485 connections 218
selection guide for the AIC+ 78
selection guide for the DeviceNet network 83
calling for assistance 193
CE mark 7, 8
changing communication configuration 61
changing mode switch position 115
collision avoidance 315
common mode rejection ratio
specification 173
common techniques used in this manual 18
communication
DeviceNet 83, 84
Ethernet 84
communication connections 59
communication options 5
communication protocols
ASCII 223
DF1 Full-Duplex 211
DF1 Half-Duplex 212
DH485 215
DNP3 223
Ethernet 355
Modbus 223
supported 59
communication scan 377
communications toggle push button
using 60

component descriptions 2
1762 expansion I/O 3
communication cables 4
memory module 2
real-time clock 2
configuration errors 192
configure processor with DHCP server 367
configuring
Ethernet network 122
IP address 124
configuring the Ethernet channel 362
connecting expansion I/O 26
connecting the system
AIC+ 76, 81
DeviceNet network 83, 84
DF1 Full-Duplex protocol 63
DF1 isolated point-to-point connection 64
DH485 network 70
connecting to DF1 Half-Duplex network 68
connecting to networks via Ethernet interface 355
connecting to networks via RS-232/RS-485 interface 211
connections to the Ethernet network 357
control profile 378
ControlFLASH
error messages 207
firmware upgrade 197
missing or corrupt OS state 209
using 195
controller 378
grounding 31
I/O wiring 38
installation 7
LED status error conditions 187
LED status normal operation 187
minimizing electrical noise 38
mounting 20
mounting dimensions 20
mounting on DIN rail 22
mounting on panel 23
preventing excessive heat 12
status indicators 185
controller modes 115
controller overhead 378
controller spacing 20
counter 378
CPU (Central Processing Unit) 378
cursor display 94

D

data table 378
default communication configuration 60
DeviceNet Communications 83, 84
DeviceNet network
connecting 83, 84
selecting cable 83
DF1 Full-Duplex protocol
connecting 63, 64
description 211
example system configuration 212
using a modem 65, 214
DF1 Half-Duplex protocol
description 212
DH485 communication protocol
configuration parameters 71, 216
DH485 network
configuration parameters 218
connecting 70
devices that use the network 216
example system configuration 221
installation 73
planning considerations 217
DIN rail 378
disconnecting main power 10
Distributed Network Protocol (DNP3) 223
DNP3
analog input object 281
analog output object 285
BCD object 287
binary input object 269
binary output object 271
counter object 276
device attribute object 303
diagnostics 326
double bit binary input object 274
frozen counter object 279
objects 260
slave application layer 254
slave application layer configuration parameters 241
double integer file monitoring 107
download 378
download a user program via DNP3 network 317
DTE (Data Terminal Equipment) 378
duplicate IP address detection 361

E

Electronics Industries Association (EIA) 211
EMC Directive 7, 8
EMI 379
encoder 379
error recovery model 188

errors
configuration 192
critical 191
extended error information field 192
hardware 192
module error field 192
non-critical 191
Ethernet
advanced functions 368
messaging 356
processor performance 356
using the SLC 5/05 processors 355
Ethernet communication 355
Ethernet connections 360
Ethernet network configuration 122
Ethernet protocol setup 130
European Union Directive compliance 7
EMC Directive 7
low voltage directive 8
event generation control 311
executing mode 379
expansion I/O
1762-IF2OF2 input type selection 50
1762-IF2OF2 output type selection 52
expansion I/O mounting 24, 25
mounting on DIN rail 24
expansion I/O specifications 162
expansion I/O wiring 42
1762-IA8 wiring diagram 42
1762-IF2OF2 wiring 52
1762-IF4 terminal block layout 55
1762-IQ16 wiring diagram 43
1762-IQ32T wiring diagram 44
1762-IQ8 wiring diagram 43
1762-IQ8OW6 wiring diagram 50
1762-OA8 wiring diagram 44
1762-OB16 wiring diagram 45
1762-OB32T wiring diagram 46
1762-OB8 wiring diagram 45
1762-OV32T wiring diagram 47
1762-OW16 wiring diagram 48
1762-OW8 wiring diagram 47
1762-OX6I wiring diagram 49
analog wiring guidelines 50
extended error information field 192

F

false 379
FIFO (First-In-First-Out) 379
file 379
file authentication rules 320
full-duplex 64, 379

G

general considerations 8
generating DNP3 events 307
grounding the controller 31

H

half-duplex 69, 379
hard disk 379
hardware errors 192
hardware features 1
heat dissipation
calculating 375
heat protection 12
high byte 380

I

I/O (Inputs and Outputs) 380
I/O status indicators 95
implementation table 344
initialize user program 325
input device 380
input states on power down 12
inrush current 380
installing
battery wire connector 19
ControlFLASH software 195
memory module 16
your controller 7
instruction 380
instruction set 380
isolated link coupler
installing 73
isolation transformers
power considerations 11

J

jump 380

L

ladder logic 380

LCD
configuring advanced settings 119
I/O status indicators 95, 187
loading communication EEPROM 138
main menu 91
menu structure tree 88
saving communication EEPROM 138
setup 141
status indicators 186
user defined screen 117
viewing fault code 137
viewing system information 136
least significant bit (LSB) 380
LED (Light Emitting Diode) 380
LIFO (Last-In-First-Out) 381
link layer configuration parameters 232
lithium battery (1747-BA)
disposing 183
handling 181
installing 179
manufacturer 183
storing 181
transporting 181
loading communication EEPROM 138
logic 381
low byte 381

M

manually configuring channel 1 for controllers on subnets 369
manuals
related 18
master control relay 13
emergency-stop switches 14
using ANSI/CSA symbols schematic 16
using IEC symbols schematic 15
Master Control Relay (MCR) 381
master control relay circuit
periodic tests 11
memory module 2
data file protection 149
information file 150
operation 148
program and data download 150
program and data upload 150
program compare 149
program/data/recipe backup 149
removal/installation under power 150
write protection 149
menu structure 88
menu structure tree 88
minimizing electrical noise 38
minimizing electrical noise on analog channels 41
mnemonic 381
Modbus communication protocol 223
mode switch 114
modem 381
modem cable
constructing your own 66
modems
using with MicroLogix controllers 214
modes 381
module error field 192
monitoring user defined target files 97
motor starters (bulletin 509)
surge suppressors 30

N

negative logic 381
network 381
nominal input current 381
normally closed 382
normally open 382
null modem cable 67

O

object quality flags 299
oerformance considerations 356
offline 382
offset 382
off-state leakage current 382
one-shot 382
online 383
online editing 151
directions and cautions 151
edit functions in program online editing 153
edit functions in runtime online editing 153
types 152
operating buttons 93
operating voltage 383
output device 383

P

performance
Ethernet processor 356
planning considerations for a network 217

power considerations
input states on power down 12
isolation transformers 11
loss of power source 12
other line conditions 12
overview 11
power supply inrush 11
power distribution 10
power source
loss of 12
power supply inrush
power considerations 11
preparing for upgrade 195
preventing excessive heat 12
processor 383
processor file 383
program file 383
program mode 383
program scan 383
programming 5
programming device 383
protocol 383
publications
related 18
purpose of this manual 17

R

read 384
real-time clock 2
battery operation 148
operation 147
removal/installation under power 147
writing data 147
related documentation 18
related publications 18
relay 384
relay logic 384
remote packet support 220
replacement battery 179
disposing 183
handling 181
installing 179
storing 181
transporting 181
replacement kits 179
replacement parts 179
reporting event by polled response 312
reporting event by unsolicited response 313
reserved bit 384
restore 384
retentive data 384
RS-232 384
RS-232 communication interface 211
RS-485 communication interface 211
rules for downloading a user program 321
rules for file authentication 320
rules for initializing a user program 324
rules for uploading a user program 322
rules for uploading communication status files 324
run mode 384
rung 384

S

safety circuits 10
safety considerations 9
disconnecting main power 10
hazardous location 9
master control relay circuit
periodic tests 11
periodic tests of master control relay circuit 11
power distribution 10
safety circuits 10
save 384
saving communication EEPROM 138
scan time 385
sinking 385
sinking and sourcing wiring diagrams 36
sinking wiring diagram
1762-24BWA 36
sourcing 385
sourcing wiring diagram
1762-24BWA 37, 38
1766-L32BWA 37
specifications 155
specifications for outputs in (non-hazardous) locations 158
specifications for outputs in hazardous locations 157
starting and stopping user programs (mode change) via DNP3 network 324
status 385
status indicators 185
supported communication protocols 59
surge suppressors
for motor starters 30
recommended 30
using 29
system configuration
DF1 Full-Duplex examples 212
DH485 connection examples 221

system loading
example calculations 372
limitations 371
worksheet 373
system loading and heat dissipation 371

T

target user defined file number 97
terminal 385
terminal block layouts
1762-IF2OF2 53
1762-IF4 55
controllers 33
terminal groupings 36
throughput 385
time synchronization 316
trim pot information function file 134
trim pot operation 133
trim pots 133
changing values 134
configuring in LCD function file 135
error conditions 135
location 133
using 133
troubleshooting 185
true 385
TUF 97

U

unsupported connections 4, 64
upload 385
user defined LCD screen 117
using communications toggle functionality 60
using communications toggle push button 60
using emergency-stop switches 14
using memory modules 147
using real-time clock 147
using the battery 17
using trim pots 133

V

viewing fault code 137
viewing system information 136

W

wiring analog channels 39
wiring diagram
1762-IA8 42
1762-IF2OF2 differential sensor 53
1762-IF2OF2 single-ended sensor 54
1762-IQ16 43
1762-IQ32T 44
1762-IQ8 43
1762-IQ8OW6 50
1762-OA8 44
1762-OB16 45
1762-OB32T 46
1762-OB8 45
1762-OV32T 47
1762-OW16 48
1762-OW8 47
1762-OX6I 49
1766-L32AWA input 36
1766-L32AWA output 38
1766-L32BWA output 38
1766-L32BWA sinking 37
1766-L32BWA sourcing 37
1766-L32BXB output 38
1766-L32BXB sinking 37
1766-L32BXB sourcing 38
terminal block layouts 33, 53, 55
wiring diagrams 32
wiring recommendation 27
wiring with spade lugs 28
wiring without spade lugs 28
wiring your controller 27
working voltage 161
workspace 386
write 386

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BULLETIN 855T

Dual Tone Sound Module
Elément Sonore Deux Tons
Schallgeber-Modul (Zweiton)
Modulo Bitonale
Módulo Sonoro Duplo Som
Módulo de Sonido de Doble Tono

Use Bulletin 855T Components Only

FOR USE ON A FLAT SURFACE OF INDICATED TYPE ENCLOSURE

À UTILISER SUR UNE SURFACE PLANE DE L'ENCEINTE DU TYPE INDIQUÉ

ZUR VERWENDUNG AUF EINER FLACHEN OBERFLÄCHE DES ANGEGEBENEN GEHÄUSETYPS

DA UTILIZZARE SU UNA SUPERFICIE PIANA DEL TIPO DI CUSTODIA INDICATO

PARA USO SOBRE LA SUPERFICIE PLANA DE UN ENVOLVENTE DEL TIPO INDICADO

PARA USO EM SUPERFÍCIE PLANA NO TIPO DE PROTEÇÃO INDICADA

ATTENTION: Check power supply voltage and frequency. Use only modules and lamps with the same voltage and frequency ratings. Disconnect from power source to prevent electrical shock before installing or servicing.

ATTENTION: Controler la tension et la fréquence d'alimentation. Utiliser seulement des éléments et des lampes de meme tension et de meme fréquence. Déconnecter l'alimentation avant toute opération d'installation ou de maintenance, afin d'éviter les décharges électriques.

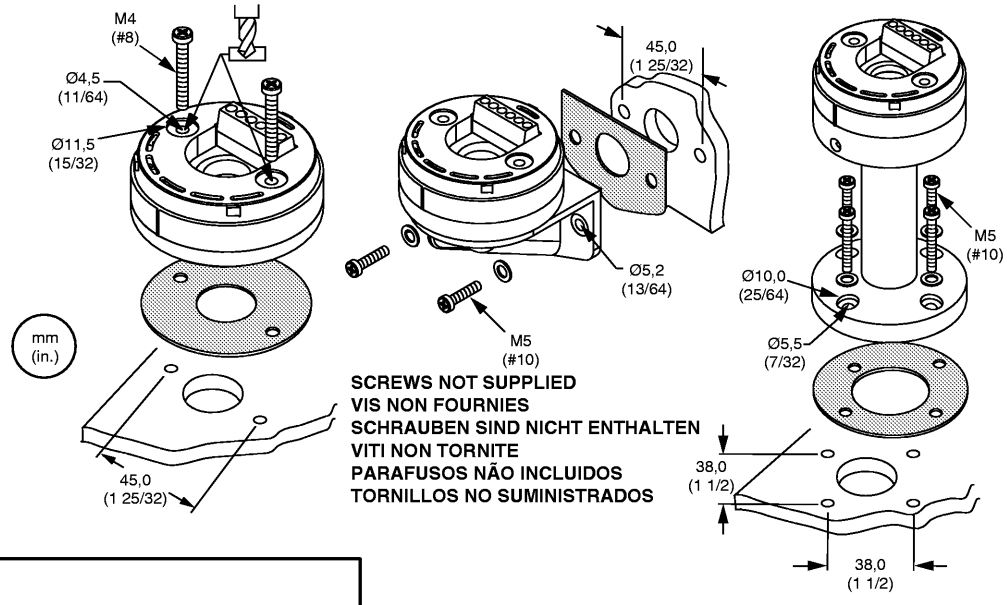
ACHTUNG: Prüfen Sie die Spannung und Frequenz. Benützen Sie ausschließlich Module und Glühlampen die die selbe Spannung und Frequenzen angeben. Strom abschalten um einen elektrischen Schock zu vermeiden während der Installation oder Wartungsarbeit.

ATTENZIONE: Controllare la tensione di alimentazione e la frequenza. Usare solo moduli e lampadas con la stessa tensione e frequenza. Scollegare dall'alimentazione prima dell'installazione e della messa in servizio.

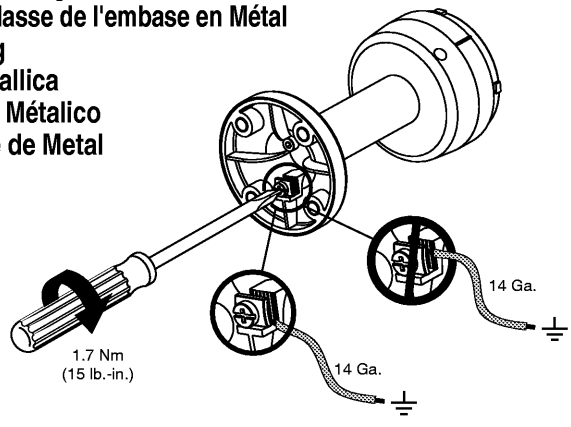
ATENÇÃO: Verificar a tensão e frequência da alimentação. Só utilizar módulos e lâmpadas com as mesmas tensões e frequências. Desligar a alimentação antes de realizar qualquer intervenção.

ATENCION: Comprobar tensión y frecuencia de alimentación. Utilizar módulos y lámparas con la misma tensión y frecuencia. Durante el proceso de instalación o mantenimiento desconectar la tensión de alimentación para evitar descargas eléctricas.

Base Mounting Procedure
Montage du Socle de Fixation
Basis-Modul Montage
Montaggio della Base
Procedimentos de Montagem da Base
Montaje de la Base de Fijación



Metal Foot Grounding
Connecteur de Masse de l'embase en Métal
Metaltfußerdung
Fondazione Metallica
Suporte con pie Métalico
Fondação do pé de Metal



Important: Do not adjust setscrew on pole base. Ingress rating will be lost.

Important: Ne pas modifier le réglage de la vis. Le système ne serait plus étanche.

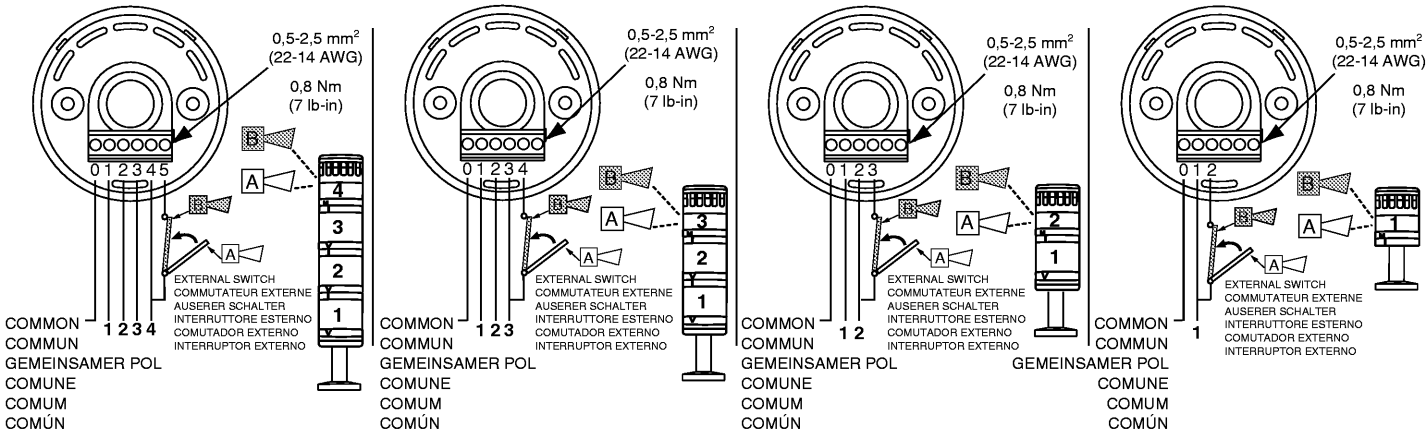
Wichtig: Die Fixierschraube des Rohrständer-Basis-Modules darf nicht verändert werden, da dies zur Beeinträchtigung der Schutzart-Klassifikation führt.

Importante: Non regolare la vite di fissaggio della base a tubo. Le caratteristiche d'ingresso verrebbero perse.

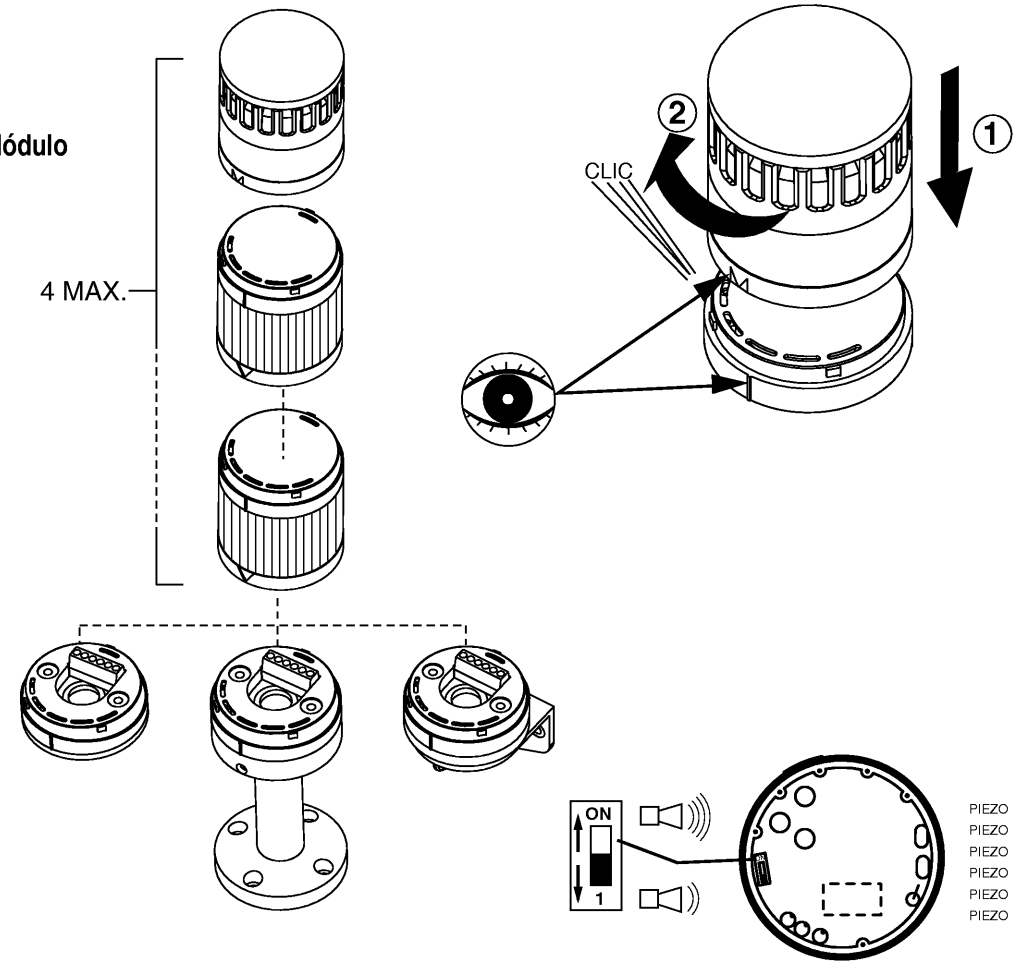
Importante: Não ajustar os parafusos na base do pólo. Pode perder a capacidade de encaixe.

Importante: No aflojar los tornillos de la base. El valor de entrada se perderá.

Electrical Connection
Raccordement Electrique
Elektrischer Anschluß
Collegamento Elettrico
Ligações Eléctricas
Conexiones Eléctricas



Module Mounting Procedure
Montage des Eléments
Modul-Montage
Montaggio dei Moduli
Procedimento de Montagem do Módulo
Montaje del Módulo de Fijación



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Printed in U.S.A.

Rockwell Automation

User Manual

Allen-Bradley

PowerFlex 520-Series Adjustable Frequency AC Drive

PowerFlex 523 Catalog Number 25A
PowerFlex 525 Catalog Number 25B






Original Instructions

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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This manual contains new and updated information.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Combined Fuses and Circuit Breakers tables for PowerFlex 523 and PowerFlex 525 and updated information	23...26
Updated Power Terminal Block description for DC Bus Connection	34
Updated 3 Wire SRC Control Non-Reversing example	43
Updated Start Souce and Speed Reference Selection diagram	46
Update Accel/Decel Selection diagram	48
Updated certifcation for standard EN 61800-3:2004	49, 153
Corrected options for P30 [Languages] under Smart Start-Up with Basic Program Group Parameters	61
Updated section on LCD Display with QuickView	63
Updated section on Using the USB Port with MainsFree Programming	63
Added new parameter A573 [Mtr Options Cfg]	67, 129, 140
Added footnote to clarify option “Network Opt”	72, 79, 80
Added tables to P053 [Reset to Defalts], and updated description for option 1 “Param Reset”	81
Updated default value for A435 [DC Brake Level]	109
Updated minimum value for A536 [Encoder PPR]	122
Updated description for AppView Parameter Groups	137
Updated description for CustomView Parameter Groups	138
Updated description and action for fault F106 “Incompat C-P”	147
Updated description and action for fault F107 “Replaced C-P”	
Updated action for F109 “Mismatch C-P”	
Added footnote to some drive catalogs under Product Selection to clarify no heatsink fan for certain drive ratings	161
Removed duplicate Important table for encoder wiring notes	200
Updated Important table for encoder wiring notes	200
Updated description for Safety Reaction Time	222
Replaced Appendix on motor control diagrams	233

Notes:

Preface

Overview

Who Should Use this Manual 9
Recommended Documentation 9
Manual Conventions 10
Drive Frame Sizes 11
General Precautions 12
Catalog Number Explanation 13

Chapter 1

Installation/Wiring

Mounting Considerations. 15
AC Supply Source Considerations 19
General Grounding Requirements 20
Fuses and Circuit Breakers 22
Power and Control Module 27
Control Module Cover 30
Power Module Terminal Guard 30
Power Wiring. 31
Power Terminal Block 34
Common Bus/Precharge Notes 35
I/O Wiring 35
Control I/O Terminal Block 36
Start and Speed Reference Control 46
CE Conformity 49

Chapter 2

Start Up

Prepare for Drive Start-Up 55
Display and Control Keys 58
Viewing and Editing Parameters 59
Drive Programming Tools 60
Language Support 60
Smart Start-Up with Basic Program Group Parameters 61
LCD Display with QuickView 63
Using the USB Port 63

Chapter 3

Programming and Parameters

About Parameters 65
Parameter Groups 66
Basic Display Group 71
Basic Program Group 76
Terminal Block Group. 82
Communications Group 94
Logic Group 100
Advanced Display Group 103
Advanced Program Group 107

Network Parameter Group 129
Modified Parameter Group 129
Fault and Diagnostic Group 130
AppView Parameter Groups 137
CustomView Parameter Group 138
Parameter Cross Reference by Name 139

Chapter 4

Troubleshooting

Drive Status 143
Faults 143
Fault Descriptions 145
Common Symptoms and Corrective Actions 148

Appendix A

Supplemental Drive Information

Certifications 153
Environmental Specifications 154
Technical Specifications 155
Power Specifications 158

Appendix B

Accessories and Dimensions

Product Selection 161
Product Dimensions 170
Optional Accessories and Kits 183

Appendix C

RS485 (DSI) Protocol

Network Wiring 185
Parameter Configuration 186
Supported Modbus Function Codes 187
Writing (06) Logic Command Data 187
Writing (06) Comm Frequency Command 189
Reading (03) Logic Status Data 189
Reading (03) Drive Error Codes 191
Reading (03) Drive Operational Values 192
Reading (03) and Writing (06) Drive Parameters 192
Additional Information 192

Appendix D

Velocity StepLogic, Basic Logic and Timer/Counter Functions

Velocity StepLogic Using Timed Steps 194
Velocity StepLogic Using Basic Logic Functions 194
Timer Function 195
Counter Function 196
Velocity StepLogic Parameters 197

Appendix E

Encoder/Pulse Train Usage and Position StepLogic Application

Encoder and Pulse Train Usage 199
Wiring Notes 200
Positioning Overview 201
Common Guidelines for All Applications 201
Positioning Operation 202
Homing Routine 206
Encoder and Position Feedback 207
Use Over Communications 208
Setup Notes 209

Appendix F

PID Set Up

PID Loop 211
PID Reference and Feedback 213
Analog PID Reference Signals 214

Appendix G

Safe-Torque-Off Function

PowerFlex 525 Safe-Torque-Off Overview 219
EC Type Examination Certification 220
EMC Instructions 220
Using PowerFlex 525 Safe-Torque-Off 220
Safety Concept 221
Enabling PowerFlex 525 Safe-Torque-Off 223
Wiring 223
PowerFlex 525 Safe-Torque-Off Operation 223
Verify Operation 224
Connection Examples 225
PowerFlex 525 Certification for Safe-Torque-Off 229

Appendix H

EtherNet/IP

Establishing A Connection With EtherNet/IP 231

Appendix I

Control Diagrams

Induction Motor Tuning Diagrams 233
Adjusting Speed Control Parameters 234

Index

Notes:

Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex® 520-Series Adjustable Frequency AC Drive.

For information on…	See page…
Who Should Use this Manual	9
Recommended Documentation	9
Manual Conventions	10
Drive Frame Sizes	11
General Precautions	12
Catalog Number Explanation	13

Who Should Use this Manual

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices. In addition, you must have an understanding of the parameter settings and functions.

Recommended Documentation

All the recommended documentation listed in this section is available online at http://www.rockwellautomation.com/literature/.

The following publications provide general drive information:

Title	Publication
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1
A Global Reference Guide for Reading Schematic Diagrams	100-2.10
Guarding Against Electrostatic Damage	8000-4.5.2

The following publications provide specific PowerFlex 520-Series information on drive installation, features, specifications, and service:

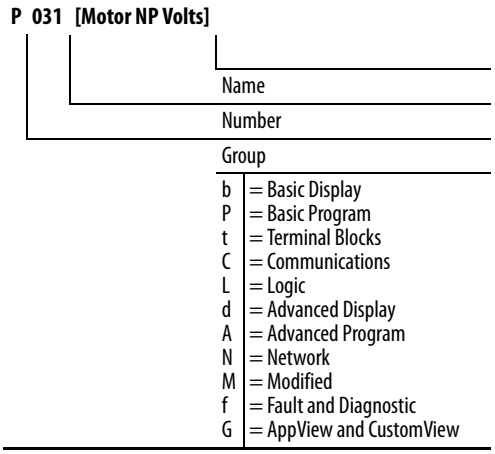
Title	Publication
PowerFlex 520-Series AC Drive Specifications	520-TD001
PowerFlex Dynamic Braking Resistor Calculator	PFLEX-AT001
PowerFlex AC Drives in Common Bus Configurations	DRIVES-AT002

The following publications provide specific Network Communications information:

Title	Publication
PowerFlex 525 Embedded EtherNet/IP Adapter	520COM-UM001
PowerFlex 25-COMM-D DeviceNet Adapter	520COM-UM002
PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter	520COM-UM003
PowerFlex 25-COMM-P PROFIBUS DPV1 Adapter	520COM-UM004

Manual Conventions

- In this manual we refer to PowerFlex 520-Series Adjustable Frequency AC Drive as; drive, PowerFlex 520-series, PowerFlex 520-series drive or PowerFlex 520-series AC drive.
- Specific drives within the PowerFlex 520-series may be referred to as:
  – PowerFlex 523, PowerFlex 523 drive or PowerFlex 523 AC drive.
  – PowerFlex 525, PowerFlex 525 drive or PowerFlex 525 AC drive.
- Parameter numbers and names are shown in this format:



- The following words are used throughout the manual to describe an action:

Words	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not Recommended

- The Studio 5000™ Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Logix Designer application is the rebranding of RSLogix 5000 software and will continue to be the product to program Logix 5000 controllers for discrete, process, batch, motion, safety, and drive-based solutions. The Studio 5000 environment is the foundation for the future of Rockwell Automation engineering design tools and capabilities. It is the one place for design engineers to develop all the elements of their control system.

Drive Frame Sizes

Similar PowerFlex 520-series drive sizes are grouped into frame sizes to simplify spare parts ordering, dimensioning, etc. A cross reference of drive catalog numbers and their respective frame sizes is provided in Appendix B.

General Precautions



ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. Before working on drive, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.
Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, "Guarding Against Electrostatic Damage" or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: The bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.
1. Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes;
2. Actual deceleration times can be longer than commanded deceleration times However, a "Stall Fault" is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, the bus regulator must be disabled (see parameter A550 [Bus Reg Enable]). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases.

ATTENTION: Risk of injury or equipment damage exists. Drive does not contain user-serviceable components. Do not disassemble drive chassis.

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12	13	14
25B	**–**	**B**	**2P3**	**N**	**1**	**1**	**4**	**–**	**–**
Drive	Dash	Voltage Rating	Rating	Enclosure	Reserved	Emission Class	Reserved	Dash	Dash

Code	Type
25A	PowerFlex 523
25B	PowerFlex 525

Code	Voltage	Phase
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Enclosure
N	IP20 NEMA / Open

Code	Interface Module
1	Standard

Code	EMC Filter
0	No Filter
1	Filter

Code	Braking
4	Standard

Output Current @ 1 Phase, 100...120V Input						
Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6[1]	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	B	1.0	0.75	1.0	0.75
6P0	6.0	B	1.5	1.1	1.5	1.1

Output Current @ 1 Phase, 200...240V Input						
Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6[1]	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
4P8	4.8	A	1.0	0.75	1.0	0.75
8P0	8.0	B	2.0	1.5	2.0	1.5
011	11.0	B	3.0	2.2	3.0	2.2

Output Current @ 3Phase, 200...240V Input						
Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P6[1]	1.6	A	0.25	0.2	0.25	0.2
2P5	2.5	A	0.5	0.4	0.5	0.4
5P0	5.0	A	1.0	0.75	1.0	0.75
8P0	8.0	A	2.0	1.5	2.0	1.5
011	11.0	A	3.0	2.2	3.0	2.2
017	17.5	B	5.0	4.0	5.0	4.0
024	24.0	C	7.5	5.5	7.5	5.5
032	32.2	D	10.0	7.5	10.0	7.5
048[2]	48.3	E	15.0	11.0	10.0	7.5
062[2]	62.1	E	20.0	15.0	15.0	11.0

Output Current @ 3 Phase, 380...480V Input						
Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
1P4	1.4	A	0.5	0.4	0.5	0.4
2P3	2.3	A	1.0	0.75	1.0	0.75
4P0	4.0	A	2.0	1.5	2.0	1.5
6P0	6.0	A	3.0	2.2	3.0	2.2
010	10.5	B	5.0	4.0	5.0	4.0
013	13.0	C	7.5	5.5	7.5	5.5
017	17.0	C	10.0	7.5	10.0	7.5
024	24.0	D	15.0	11.0	15.0	11.0
030[2]	30.0	D	20.0	15.0	15.0	11.0
037[2]	37.0	E	25.0	18.5	20.0	15.0
043[2]	43.0	E	30.0	22.0	25.0	18.5

Output Current @ 3 Phase, 525...600V Input						
Code	Amps	Frame	ND		HD	
			HP	kW	HP	kW
0P9	0.9	A	0.5	0.4	0.5	0.4
1P7	1.7	A	1.0	0.75	1.0	0.75
3P0	3.0	A	2.0	1.5	2.0	1.5
4P2	4.2	A	3.0	2.2	3.0	2.2
6P6	6.6	B	5.0	4.0	5.0	4.0
9P9	9.9	C	7.5	5.5	7.5	5.5
012	12.0	C	10.0	7.5	10.0	7.5
019	19.0	D	15.0	11.0	15.0	11.0
022[2]	22.0	D	20.0	15.0	15.0	11.0
027[2]	27.0	E	25.0	18.5	20.0	15.0
032[2]	32.0	E	30.0	22.0	25.0	18.5

(1) This rating is only available for PowerFlex 523 drives.

(2) Normal and Heavy Duty ratings are available for this drive.

Notes:

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 520-series drives.

For information on...	See page...
Mounting Considerations	15
AC Supply Source Considerations	19
General Grounding Requirements	20
Fuses and Circuit Breakers	22
Power and Control Module	27
Control Module Cover	30
Power Module Terminal Guard	30
Power Wiring	31
Power Terminal Block	34
Common Bus/Precharge Notes	35
I/O Wiring	35
Control I/O Terminal Block	36
Start and Speed Reference Control	46
CE Conformity	49

Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Mounting Considerations

- Mount the drive upright on a flat, vertical and level surface.

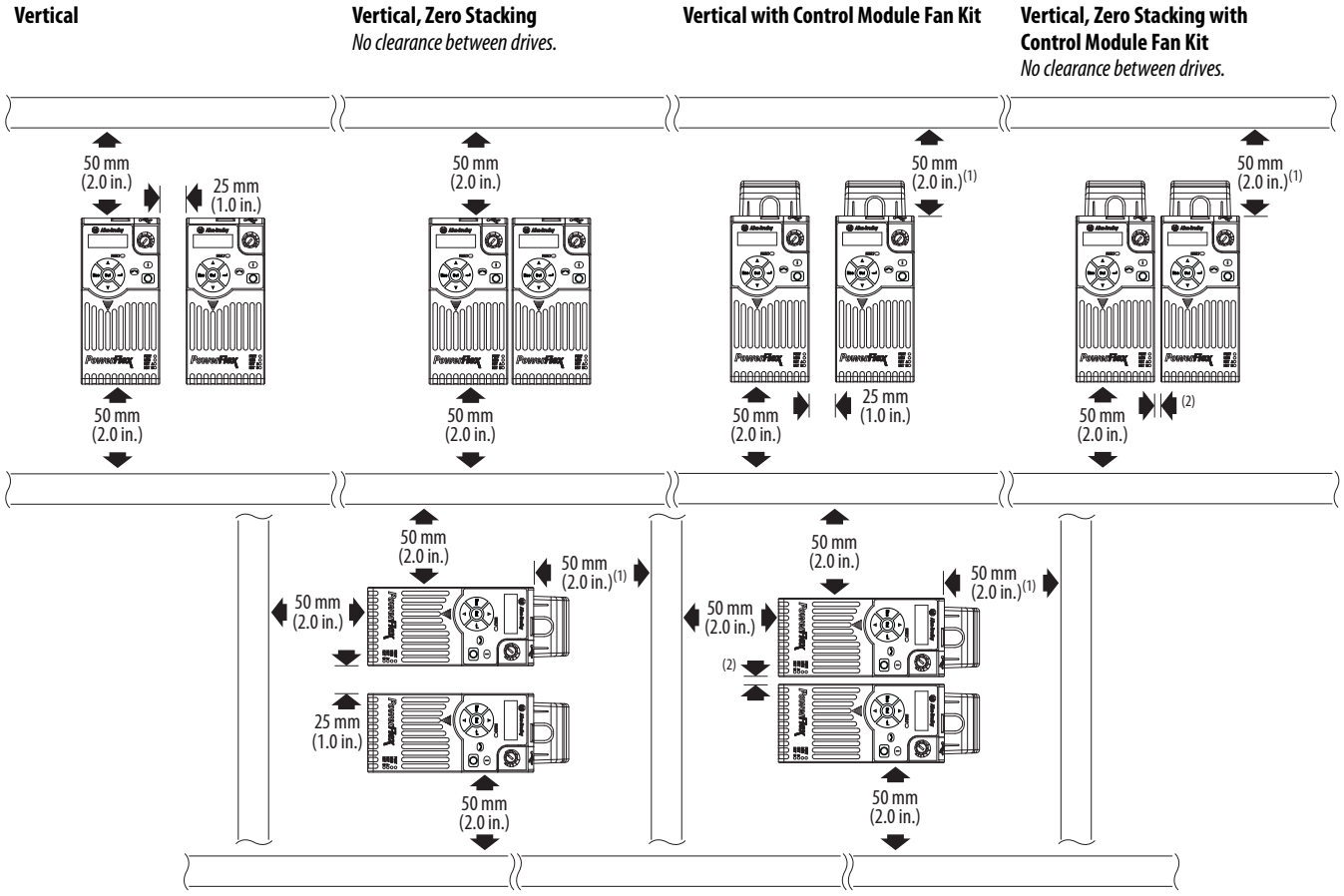
Frame	Screw Size	Screw Torque
A	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
B	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
C	M5 (#10...24)	1.56...1.96 Nm (14...17 lb-in.)
D	M5 (#10...24)	2.45...2.94 Nm (22...26 lb-in.)
E	M8 (5/16 in.)	6.0...7.4 Nm (53...65 lb-in.)

- Protect the cooling fan by avoiding dust or metallic particles.

- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight.

Minimum Mounting Clearances

See Appendix B for mounting dimensions.



(1) For Frame E with Control Module Fan Kit only, clearance of 95 mm (3.7 in.) is required.
(2) For Frame E with Control Module Fan Kit only, clearance of 12 mm (0.5 in.) is required.

Ambient Operating Temperatures

See Appendix B for option kits.

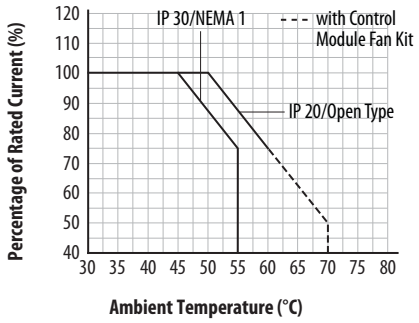
Mounting	Enclosure Rating(1)	Ambient Temperature			
		Minimum	Maximum (No Derate)	Maximum (Derate)(2)	Maximum with Control Module Fan Kit (Derate)(3)(5)
Vertical	IP 20/Open Type	-20 °C (-4 °F)	50 °C (122 °F)	60 °C (140 °F)	70 °C (158 °F)
	IP 30/NEMA 1/UL Type 1		45 °C (113 °F)	55 °C (131 °F)	–
Vertical, Zero Stacking	IP 20/Open Type		45 °C (113 °F)	55 °C (131 °F)	65 °C (149 °F)
	IP 30/NEMA 1/UL Type 1		40 °C (104 °F)	50 °C (122 °F)	–
Horizontal with Control Module Fan Kit(4)(5)	IP 20/Open Type		50 °C (122 °F)	–	70 °C (158 °F)
Horizontal, Zero Stacking with Control Module Fan Kit(4)(5)	IP 20/Open Type		45 °C (113 °F)	–	65 °C (149 °F)

(1) IP 30/NEMA 1/UL Type 1 rating requires installation of the PowerFlex 520-Series IP 30/NEMA 1/UL Type 1 option kit, catalog number 25-JBAx.
(2) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Maximum (Derate) column is reduced by 5 °C (9 °F) for all mounting methods.
(3) For catalogs 25x-D1P4N104 and 25x-E0P9N104, the temperature listed under the Maximum with Control Module Fan Kit (Derate) column is reduced by 10 °C (18 °F) for vertical and vertical with zero stacking mounting methods only.
(4) Catalogs 25x-D1P4N104 and 25x-E0P9N104 cannot be mounted using either of the horizontal mounting methods.
(5) Requires installation of the PowerFlex 520-Series Control Module Fan Kit, catalog number 25-FANx-70C.

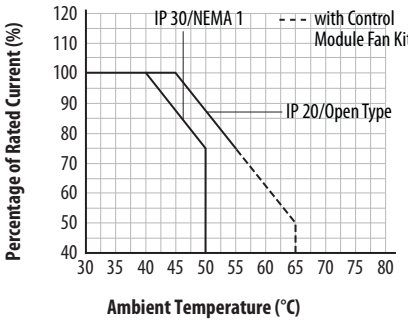
Current Derating Curves

Vertical Mounting

Single Drive

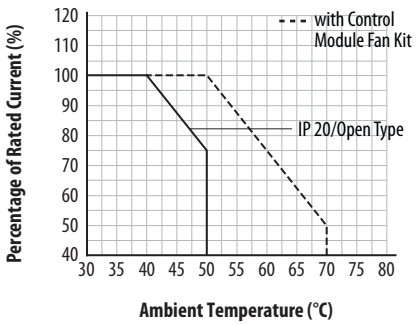


Zero Stacking

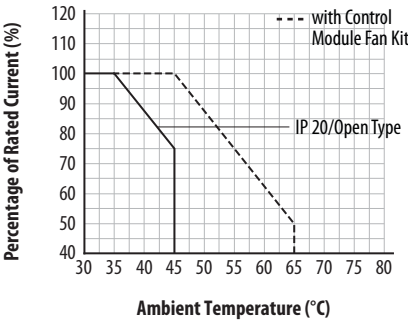


Horizontal/Floor Mounting

Single Drive



Zero Stacking



Derating Guidelines for High Altitude

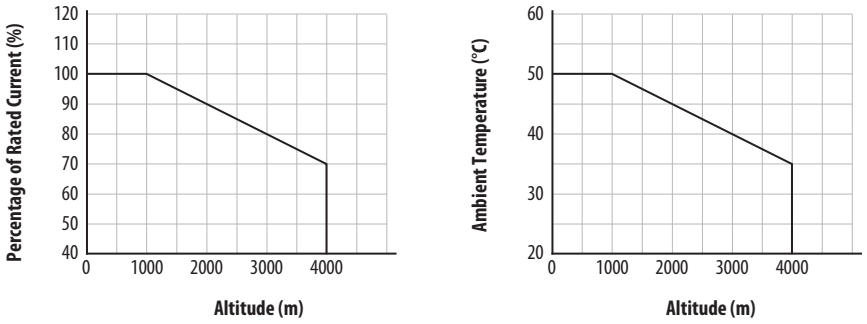
The drive can be used without derating at a maximum altitude of 1000 m (3300 ft). If the drive is used above 1000 m (3300 ft):

- Derate the maximum ambient temperature by 5 °C (9 °F) for every additional 1000 m (3300 ft), subject to limits listed in the Altitude Limit (Based on Voltage) table below.
  Or
- Derate the output current by 10% for every additional 1000 m (3300 ft), up to 3000 m (9900 ft), subject to limits listed in the Altitude Limit (Based on Voltage) table below.

Altitude Limit (Based on Voltage)

Drive Rating	Center Ground (Wye Neutral)	Corner Ground, Impedance Ground, or Ungrounded
100...120V 1-Phase	6000 m	6000 m
200...240V 1-Phase	2000 m	2000 m
200...240V 3-Phase	6000 m	2000 m
380...480V 3-Phase	4000 m	2000 m
525...600V 3-Phase	2000 m	2000 m

High Altitude



Debris Protection

Take precautions to prevent debris from falling through the vents of the drive housing during installation.

Storage

- Store within an ambient temperature range of -40...85°C(1).
- Store within a relative humidity range of 0...95%, noncondensing.
- Do not expose to a corrosive atmosphere.

(1) The maximum ambient temperature for storing a Frame E drive is 70 °C.

AC Supply Source Considerations

Ungrounded Distribution Systems

ATTENTION: PowerFlex 520-series drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

ATTENTION: Removing MOVs in drives with an embedded filter will also disconnect the filter capacitor from earth ground.

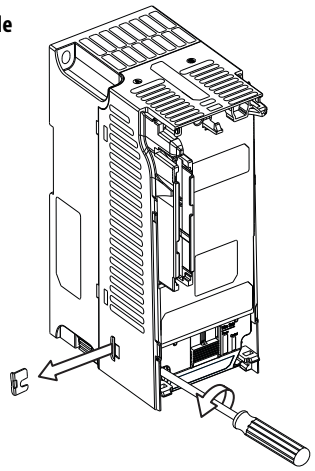
Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system (IT mains) where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the diagrams below.

1. Turn the screw counterclockwise to loosen.
2. Pull the jumper completely out of the drive chassis.
3. Tighten the screw to keep it in place.

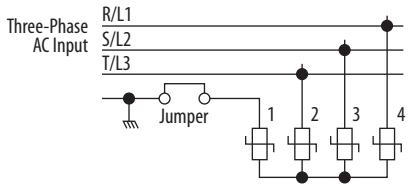
Jumper Location (Typical)

Power Module



IMPORTANT Tighten screw after jumper removal.

Phase to Ground MOV Removal



Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see page 155). Listed in the Input Power Conditions table below are certain input power conditions which may cause component damage or reduction in product life. If any of these conditions exist, install one of the devices listed under the heading Corrective Action on the line side of the drive.

IMPORTANT Only one device per branch circuit is required. It should be mounted closest to the branch and sized to handle the total current of the branch circuit.

Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance)	• Install Line Reactor(2) • or Isolation Transformer
Greater than 120 kVA supply transformer	
Line has power factor correction capacitors	• Install Line Reactor(2) • or Isolation Transformer
Line has frequent power interruptions	
Line has intermittent noise spikes in excess of 6000V (lightning)	
Phase to ground voltage exceeds 125% of normal line to line voltage	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
Ungrounded distribution system	
240V open delta configuration (stinger leg)(1)	• Install Line Reactor(2)

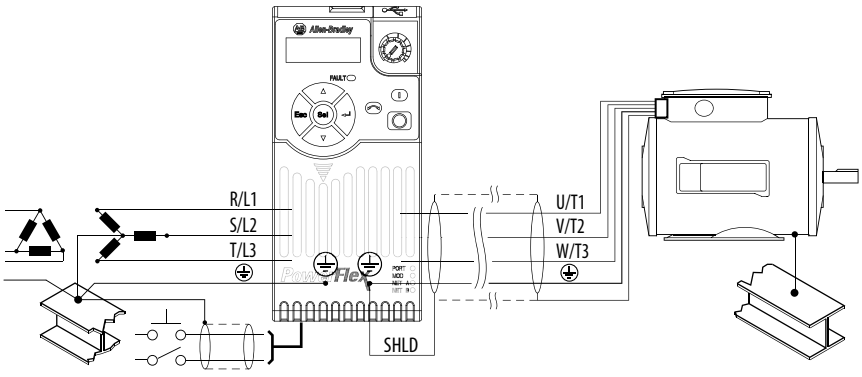
(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the "stinger leg," "high leg," "red leg," etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. See Bulletin 1321-3R Series Line Reactors on page 168 for specific line reactor part numbers.

(2) See Appendix B for accessory ordering information.

General Grounding Requirements

The drive Safety Ground - ⏚ (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

Typical Grounding



Ground Fault Monitoring

If a system ground fault monitor (RCD) is to be used, only Type B (adjustable) devices should be used to avoid nuisance tripping.

Safety Ground - ⏚ (PE)

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

Motor Ground

The motor ground must be connected to one of the ground terminals on the drive.

Shield Termination - SHLD

Either of the safety ground terminals located on the power terminal block provides a grounding point for the motor cable shield. The **motor cable** shield connected to one of these terminals (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal. The earthing plate or conduit box option may be used with a cable clamp for a grounding point for the cable shield.

When shielded cable is used for **control and signal wiring**, the shield should be grounded at the source end only, not at the drive end.

RFI Filter Grounding

Using a drive with filter may result in relatively high ground leakage currents. Therefore, the **filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded** (bonded) to the building power distribution ground. Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections. The integrity of all connections should be periodically checked.

Fuses and Circuit Breakers

The PowerFlex 520-series drive does not provide branch short circuit protection. This product should be installed with either input fuses or an input circuit breaker. National and local industrial safety regulations and/or electrical codes may determine additional requirements for these installations.

The tables found on pages 23...26 provide recommended AC line input fuse and circuit breaker information. See Fusing and Circuit Breakers below for UL and IEC requirements. Sizes listed are the recommended sizes based on 40 °C (104 °F) and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

The recommended fuse types are listed in the tables found on pages 23...26. If available current ratings do not match those listed in the tables provided, choose the next higher fuse rating.

- IEC – BS88 (British Standard) Parts 1 & 2(1), EN60269-1, Parts 1 & 2, type GG or equivalent should be used.
- UL – UL Class CC, T, RK1, or J should be used.

Circuit Breakers

The "non-fuse" listings in the tables found on pages 23...26 include inverse time circuit breakers, instantaneous trip circuit breakers (motor circuit protectors) and 140M self-protected combination motor controllers. If one of these is chosen as the desired protection method, the following requirements apply:

- IEC – Both types of circuit breakers and 140M self-protected combination motor controllers are acceptable for IEC installations.
- UL – Only inverse time circuit breakers and the specified 140M self-protected combination motor controllers are acceptable for UL installations.

Bulletin 140M (Self-Protected Combination Controller)/UL489 Circuit Breakers

When using Bulletin 140M or UL489 rated circuit breakers, the guidelines listed below must be followed in order to meet the NEC requirements for branch circuit protection.

- Bulletin 140M can be used in single motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

(1) Typical designations include, but may not be limited to the following; Parts 1 & 2: AC, AD, BC, BD, CD, DD, ED, EFS, EF, FF, FG, GF, GG, GH.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives

100...120V 1-Phase Input Protection Devices – Frames A...B

Catalog No.		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(1)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.3)
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(2)(3)(4)	
25A-V1P6N104	–	0.25	0.2	0.25	0.2	1.6	0.8	6.4	A	100-C09	10	16	140U-D6D2-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-B80	140M-C2E-B63	–
25A-V2P5N104	25B-V2P5N104	0.5	0.4	0.5	0.4	2.5	1.3	9.6	A	100-C12	16	20	140U-D6D2-C12	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	140U-D6C2-C12	140M-C2E-C10	–
25A-V4P8N104	25B-V4P8N104	1.0	0.75	1.0	0.75	4.8	2.5	19.2	B	100-C23	25	40	140U-D6D2-C25	140M-D8E-C20	CLASS RK5, CC, J, or T / DLS-R-40	140U-D6D2-C25	140M-D8E-C20	–
25A-V6P0N104	25B-V6P0N104	1.5	1.1	1.5	1.1	6.0	3.2	24.0	B	100-C23	32	50	140U-D6D2-C30	140M-F8E-C25	CLASS RK5, CC, J, or T / DLS-R-50	140U-D6D2-C30	140M-F8E-C25	–

200...240V 1-Phase Input Protection Devices – Frames A...B

Catalog No.		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(1)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.3)
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(2)(3)(4)	
25A-A1P6N104	–	0.25	0.2	0.25	0.2	1.6	1.4	5.3	A	100-C09	6	10	140U-D6D2-C10	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-B63	–
25A-A1P6N114	–	0.25	0.2	0.25	0.2	1.6	1.4	5.3	A	100-C09	6	10	140U-D6D2-C10	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-B63	–
25A-A2P5N104	25B-A2P5N104	0.5	0.4	0.5	0.4	2.5	1.7	6.5	A	100-C09	10	16	140U-D6D2-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-C10	–
25A-A2P5N114	25B-A2P5N114	0.5	0.4	0.5	0.4	2.5	1.7	6.5	A	100-C09	10	16	140U-D6D2-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D2-C10	140M-C2E-C10	–
25A-A4P8N104	25B-A4P8N104	1.0	0.75	1.0	0.75	4.8	2.8	10.7	A	100-C12	16	25	140U-D6D2-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	140U-D6D2-C15	140M-C2E-C16	–
25A-A4P8N114	25B-A4P8N114	1.0	0.75	1.0	0.75	4.8	2.8	10.7	A	100-C12	16	25	140U-D6D2-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	140U-D6D2-C15	140M-C2E-C16	–
25A-A8P0N104	25B-A8P0N104	2.0	1.5	2.0	1.5	8.0	4.8	18.0	B	100-C23	25	40	140U-D6D2-C25	140M-F8E-C25	CLASS CC, J, or T / 40	140U-D6D2-C25	140M-F8E-C25	–
25A-A8P0N114	25B-A8P0N114	2.0	1.5	2.0	1.5	8.0	4.8	18.0	B	100-C23	25	40	140U-D6D2-C25	140M-F8E-C25	CLASS CC, J, or T / 40	140U-D6D2-C25	140M-F8E-C25	–
25A-A011N104	25B-A011N104	3.0	2.2	3.0	2.2	11.0	6.0	22.9	B	100-C37	32	50	140G-G6C3-C35	140M-F8E-C25	CLASS CC, J, or T / 50	–	140M-F8E-C25	–
25A-A011N114	25B-A011N114	3.0	2.2	3.0	2.2	11.0	6.0	22.9	B	100-C37	32	50	140G-G6C3-C35	140M-F8E-C25	CLASS CC, J, or T / 50	–	140M-F8E-C25	–

(1) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.
(2) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.
(3) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.
(4) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

200...240V 3-Phase Input Protection Devices – Frames A...E

Catalog No.(1)		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(2)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.3)
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(3)(4)(5)	
25A-B1P6N104	–	0.25	0.2	0.25	0.2	1.6	0.9	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D3-B30	140M-C2E-B25	–
25A-B2P5N104	25B-B2P5N104	0.5	0.4	0.5	0.4	2.5	1.2	2.7	A	100-C09	6	6	140U-D6D3-B40	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-6	140U-D6D3-B40	140M-C2E-B40	–
25A-B5P0N104	25B-B5P0N104	1.0	0.75	1.0	0.75	5.0	2.7	5.8	A	100-C09	10	16	140U-D6D3-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	140U-D6D3-B80	140M-C2E-B63	–
25A-B8P0N104	25B-B8P0N104	2.0	1.5	2.0	1.5	8.0	4.3	9.5	A	100-C12	16	20	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	140U-D6D3-C10	140M-C2E-C10	–
25A-B011N104	25B-B011N104	3.0	2.2	3.0	2.2	11.0	6.3	13.8	A	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	140U-D6D3-C15	140M-C2E-C16	–
25A-B017N104	25B-B017N104	5.0	4.0	5.0	4.0	17.5	9.6	21.1	B	100-C23	32	45	140U-D6D3-C25	140M-F8E-C25	CLASS CC, J, or T / 45	140U-D6D3-C25	140M-F8E-C25	–
25A-B024N104	25B-B024N104	7.5	5.5	7.5	5.5	24.0	12.2	26.6	C	100-C37	35	63	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 60	–	140M-F8E-C32	–
25A-B032N104	25B-B032N104	10.0	7.5	10.0	7.5	32.2	15.9	34.8	D	100-C43	45	70	140G-G6C3-C60	140M-F8E-C45	CLASS RK5, CC, J, or T / DLS-R-70	–	140M-F8E-C45	–
25A-B048N104	25B-B048N104	15.0	11.0	10.0	7.5	48.3	20.1	44.0	E	100-C60	63	90	140G-G6C3-C70	140M-F8E-C45	CLASS CC, J, or T / 90	–	140M-F8E-C45	1416.0(6)
25A-B062N104	25B-B062N104	20.0	15.0	15.0	11.0	62.1	25.6	56.0	E	100-C72	70	125	140G-G6C3-C90	–	CLASS CC, J, or T / 125	–	–	–

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

380...480V 3-Phase Input Protection Devices – Frames A...E

Catalog No.(1)		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(2)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.^{3})
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(3)(4)(5)	
25A-D1P4N104	25B-D1P4N104	0.5	0.4	0.5	0.4	1.4	1.7	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–	140M-C2E-B25	–
25A-D1P4N114	25B-D1P4N114	0.5	0.4	0.5	0.4	1.4	1.7	1.9	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–	140M-C2E-B25	–
25A-D2P3N104	25B-D2P3N104	1.0	0.75	1.0	0.75	2.3	2.9	3.2	A	100-C09	6	10	140U-D6D3-B60	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–	140M-C2E-B40	–
25A-D2P3N114	25B-D2P3N114	1.0	0.75	1.0	0.75	2.3	2.9	3.2	A	100-C09	6	10	140U-D6D3-B60	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–	140M-C2E-B40	–
25A-D4P0N104	25B-D4P0N104	2.0	1.5	2.0	1.5	4.0	5.2	5.7	A	100-C09	10	16	140U-D6D3-B60	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–	140M-C2E-B63	–
25A-D4P0N114	25B-D4P0N114	2.0	1.5	2.0	1.5	4.0	5.2	5.7	A	100-C09	10	16	140U-D6D3-B60	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–	140M-C2E-B63	–
25A-D6P0N104	25B-D6P0N104	3.0	2.2	3.0	2.2	6.0	6.9	7.5	A	100-C09	10	16	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	–	140M-C2E-C10	–
25A-D6P0N114	25B-D6P0N114	3.0	2.2	3.0	2.2	6.0	6.9	7.5	A	100-C09	10	16	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-15	–	140M-C2E-C10	–
25A-D010N104	25B-D010N104	5.0	4.0	5.0	4.0	10.5	12.6	13.8	B	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–	140M-C2E-C16	–
25A-D010N114	25B-D010N114	5.0	4.0	5.0	4.0	10.5	12.6	13.8	B	100-C23	20	32	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–	140M-C2E-C16	–
25A-D013N104	25B-D013N104	7.5	5.5	7.5	5.5	13.0	14.1	15.4	C	100-C23	20	35	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 35	–	140M-D8E-C20	–
25A-D013N114	25B-D013N114	7.5	5.5	7.5	5.5	13.0	14.1	15.4	C	100-C23	20	35	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 35	–	140M-D8E-C20	–
25A-D017N104	25B-D017N104	10.0	7.5	10.0	7.5	17.0	16.8	18.4	C	100-C23	25	40	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 40	–	140M-D8E-C20	–
25A-D017N114	25B-D017N114	10.0	7.5	10.0	7.5	17.0	16.8	18.4	C	100-C23	25	40	140U-D6D3-C25	140M-D8E-C20	CLASS CC, J, or T / 40	–	140M-D8E-C20	–
25A-D024N104	25B-D024N104	15.0	11.0	15.0	11.0	24.0	24.1	26.4	D	100-C37	35	63	140G-G6C3-C40	140M-F8E-C32	CLASS CC, J, or T / 60	–	140M-F8E-C32	656.7(6)
25A-D024N114	25B-D024N114	15.0	11.0	15.0	11.0	24.0	24.1	26.4	D	100-C37	35	63	140G-G6C3-C40	140M-F8E-C32	CLASS CC, J, or T / 60	–	140M-F8E-C32	656.7(6)
25A-D030N104	25B-D030N104	20.0	15.0	15.0	11.0	30.0	30.2	33.0	D	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–	140M-F8E-C45	656.7(6)
25A-D030N114	25B-D030N114	20.0	15.0	15.0	11.0	30.0	30.2	33.0	D	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–	140M-F8E-C45	656.7(6)
25A-D037N114	25B-D037N114	25.0	18.5	20.0	15.0	37.0	30.8	33.7	E	100-C43	45	70	140G-G6C3-C50	140M-F8E-C45	CLASS CC, J, or T / 70	–	140M-F8E-C45	–
25A-D043N114	25B-D043N114	30.0	22.0	25.0	18.5	43.0	35.6	38.9	E	100-C60	50	80	140G-G6C3-C60	140M-F8E-C45	CLASS CC, J, or T / 80	–	140M-F8E-C45	–

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

Fuses and Circuit Breakers for PowerFlex 520-Series Drives *(continued)*

525...600V 3-Phase Input Protection Devices – Frames A...E

Catalog No.(1)		Output Ratings					Input Ratings		Frame Size	Contactor Catalog No.	IEC Applications (Non-UL)				UL Applications			
PF 523	PF 525	ND		HD		Amps	kVA	Max Amps(2)			Fuses (Rating)		Circuit Breakers		Fuses (Max. Rating)	Circuit Breakers		Min. Enclosure Vol. (in.^{3})
		HP	kW	HP	kW						Min.	Max.	140U/140G	140M	Class / Catalog No.	140U/140G	140M(3)(4)(5)	
25A-E0P9N104	25B-E0P9N104	0.5	0.4	0.5	0.4	0.9	1.4	1.2	A	100-C09	3	6	140U-D6D3-B20	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–	140M-C2E-B25	–
25A-E1P7N104	25B-E1P7N104	1.0	0.75	1.0	0.75	1.7	2.6	2.3	A	100-C09	3	6	140U-D6D3-B30	140M-C2E-B25	CLASS RK5, CC, J, or T / DLS-R-6	–	140M-C2E-B25	–
25A-E3P0N104	25B-E3P0N104	2.0	1.5	2.0	1.5	3.0	4.3	3.8	A	100-C09	6	10	140U-D6D3-B50	140M-C2E-B40	CLASS RK5, CC, J, or T / DLS-R-10	–	140M-C2E-B40	–
25A-E4P2N104	25B-E4P2N104	3.0	2.2	3.0	2.2	4.2	6.1	5.3	A	100-C09	10	16	140U-D6D3-B80	140M-C2E-B63	CLASS RK5, CC, J, or T / DLS-R-15	–	140M-D8E-B63	–
25A-E6P6N104	25B-E6P6N104	5.0	4.0	5.0	4.0	6.6	9.1	8.0	B	100-C09	10	20	140U-D6D3-C10	140M-C2E-C10	CLASS RK5, CC, J, or T / DLS-R-20	–	140M-D8E-C10	–
25A-E9P9N104	25B-E9P9N104	7.5	5.5	7.5	5.5	9.9	12.8	11.2	C	100-C16	16	25	140U-D6D3-C15	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-25	–	140M-D8E-C16(6)	–
25A-E012N104	25B-E012N104	10.0	7.5	10.0	7.5	12.0	15.4	13.5	C	100-C23	20	32	140U-D6D3-C20	140M-C2E-C16	CLASS RK5, CC, J, or T / DLS-R-30	–	140M-D8E-C16	–
25A-E019N104	25B-E019N104	15.0	11.0	15.0	11.0	19.0	27.4	24.0	D	100-C30	32	50	140G-G6C3-C30	140M-F8E-C25	CLASS CC, J, or T / 50	–	140M-F8E-C25	656.7(7)
25A-E022N104	25B-E022N104	20.0	15.0	15.0	11.0	22.0	31.2	27.3	D	100-C30	35	63	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 60	–	140M-F8E-C32	656.7(7)
25A-E027N104	25B-E027N104	25.0	18.5	20.0	15.0	27.0	28.2	24.7	E	100-C30	35	50	140G-G6C3-C35	140M-F8E-C32	CLASS CC, J, or T / 50	–	140M-F8E-C32	1416.0(7)
25A-E032N104	25B-E032N104	30.0	22.0	25.0	18.5	32.0	33.4	29.2	E	100-C37	40	63	140G-G6C3-C50	140M-F8E-C32	CLASS CC, J, or T / 60	–	140M-F8E-C32	1416.0(7)

(1) Normal Duty (ND) and Heavy Duty (HD) ratings are available for this drive.

(2) When the drive is controlling motors with lower amp ratings, refer to the drive nameplate for drive input current rating.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.

(5) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 480Y/277 and 600Y/347 AC input. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(6) When used with the 140M circuit breaker, the 25A-E9P9104 must be installed in a ventilated or non-ventilated enclosure with the minimum size of 457.2 x 457.2 x 269.8 mm (18 x 18 x 10.62 in.).

(7) When using a Manual Self-Protected (Type E) Combination Motor Controller with this drive power rating, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

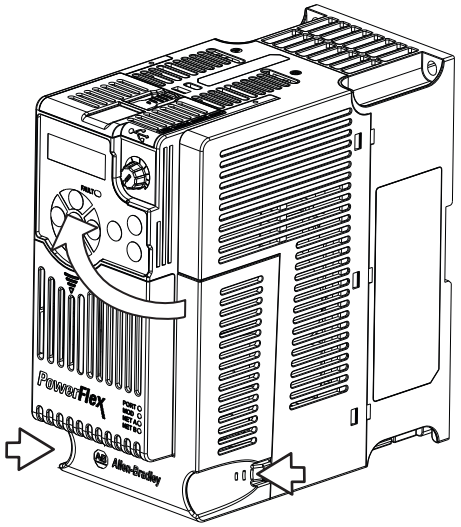
Power and Control Module

PowerFlex 520-series drives consist of a Power Module and Control Module.

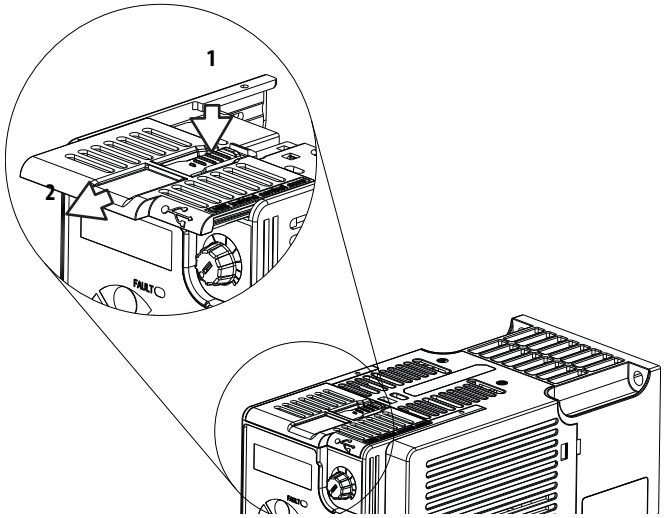
Separating the Power and Control Module

ATTENTION: Perform this action only when drive is NOT powered.

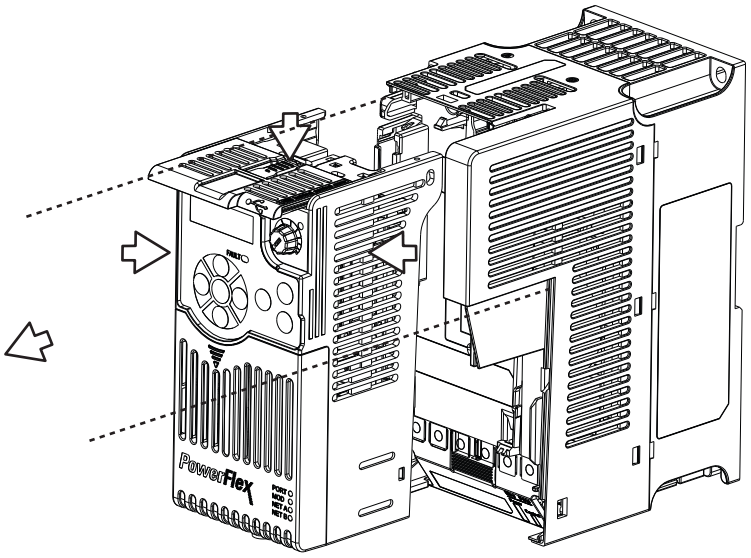
1. Press and hold down the catch on both sides of the frame cover, then pull out and swing upwards to remove (Frames B...E only).



2. Press down and slide out the top cover of the Control Module to unlock it from the Power Module.

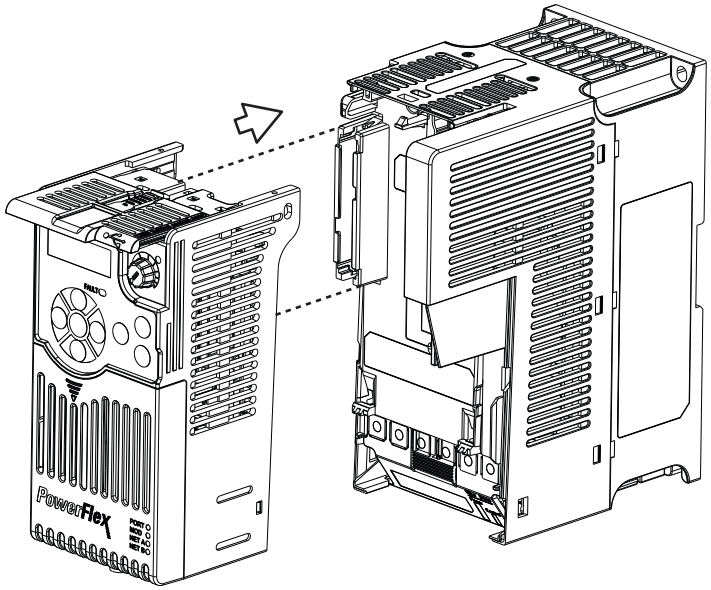


3. Hold the sides and top of the Control Module firmly, then pull out to separate it from the Power Module.

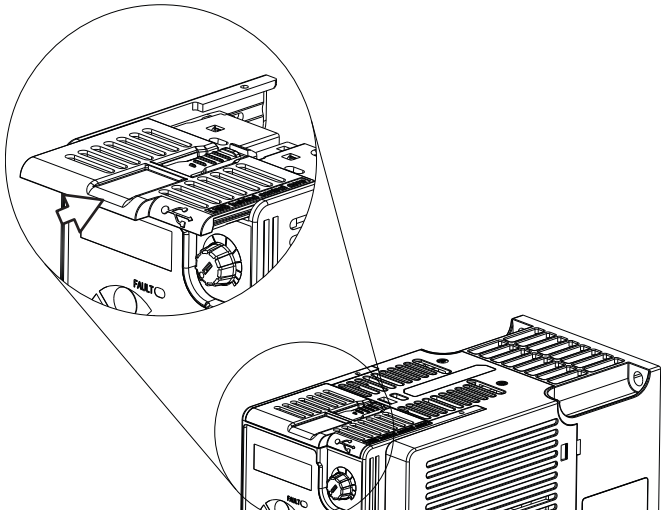


Connecting the Power and Control Module

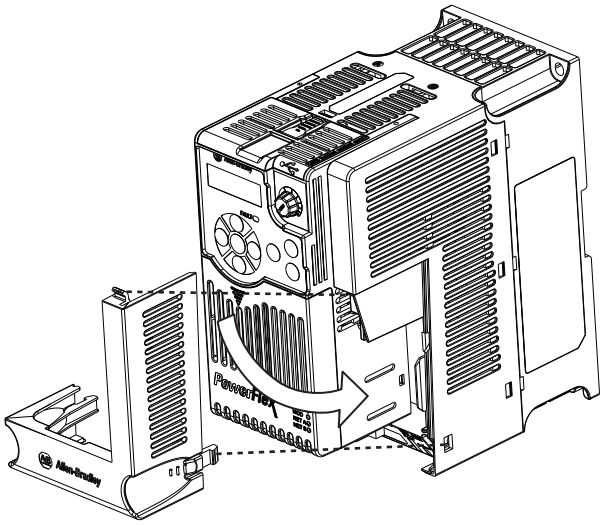
1. Align the connectors on the Power Module and Control Module, then push the Control Module firmly onto the Power Module.



2. Push the top cover of the Control Module towards the Power Module to lock it.



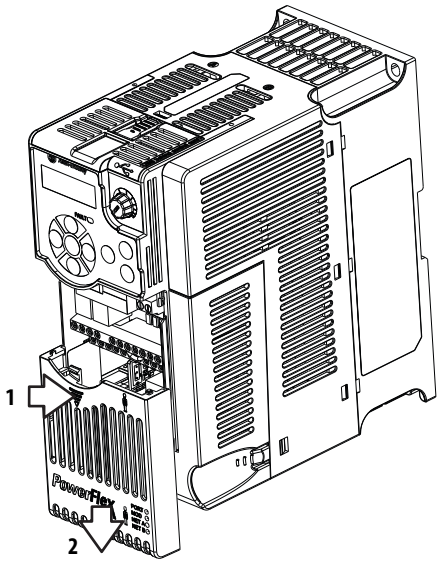
3. Insert the catch at the top of the frame cover into the Power Module, then swing the frame cover to snap the side catches onto the Power Module (Frames B...E only).



Control Module Cover

To access the control terminals, DSI port, and Ethernet port, the front cover must be removed. To remove:

1. Press and hold down the arrow on the front of the cover.
2. Slide the front cover down to remove from the Control Module.

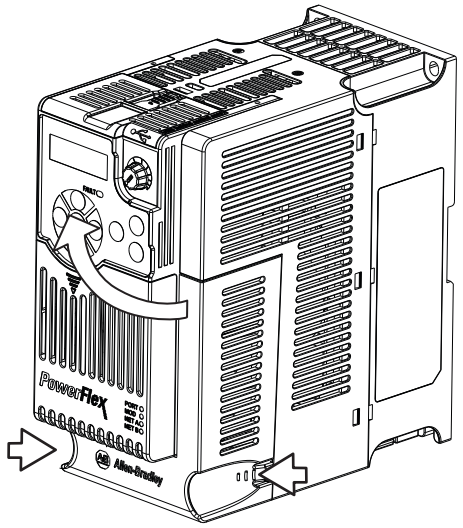


Re-attach the front cover when wiring is complete.

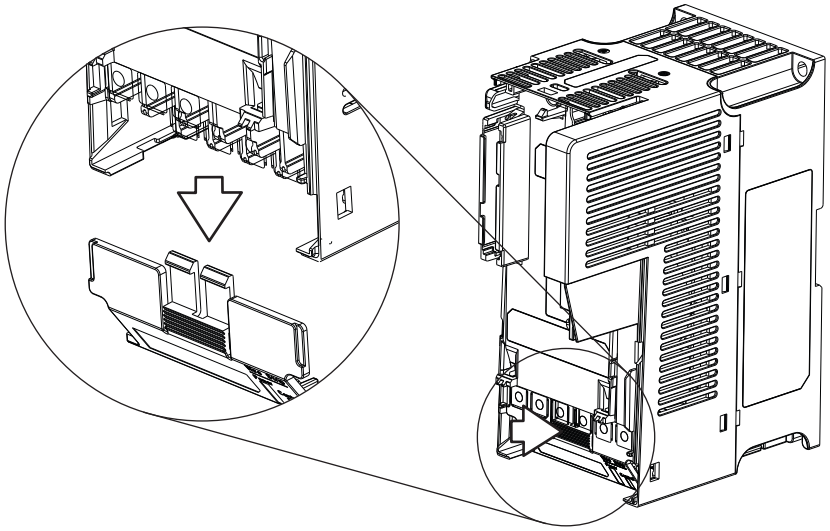
Power Module Terminal Guard

To access the power terminals, the terminal guard must be removed. To remove:

1. Press and hold down the catch on both sides of the frame cover, then pull out and swing upwards to remove (Frames B...E only).



2. Press and hold down the locking tab on the terminal guard.
3. Slide the terminal guard down to remove from the Power Module.



Re-attach the terminal guard when wiring is complete.

To access the power terminals for Frame A, you need to separate the Power and Control Modules. See Separating the Power and Control Module on page 27 for instructions.

Power Wiring

ATTENTION: National Codes and standards (NEC, VDE, BSI, etc.) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

ATTENTION: To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled. This will help minimize the possible shock hazard from "cross coupled" power leads.

Motor Cable Types Acceptable for 100...600 Volt Installations

A variety of cable types are acceptable for drive installations. For many installations, unshielded cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 0.3 m (1 ft) for every 10 m (32.8 ft) of length. In all cases, long parallel runs must be avoided. Do not use cable with an insulation thickness less than 15 mils (0.4 mm/0.015 in.). Do not route more than three sets of motor leads in a single conduit to minimize "cross talk". If more than three drive/motor connections per conduit are required, shielded cable must be used.

UL installations above 50 °C ambient must use 600V, 90 °C wire.
UL installations in 50 °C ambient must use 600V, 75 °C or 90 °C wire.
UL installations in 40 °C ambient should use 600V, 75 °C or 90 °C wire.
Use copper wire only. Wire gauge requirements and recommendations are based on 75 °C. Do not reduce wire gauge when using higher temperature wire.

Unshielded

THHN, THWN or similar wire is acceptable for drive installation in dry environments provided adequate free air space and/or conduit fill rates limits are provided. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.



ATTENTION: Do not use THHN or similarly coated wire in wet areas.

Shielded/Armored Cable

Shielded cable contains all of the general benefits of multi-conductor cable with the added benefit of a copper braided shield that can contain much of the noise generated by a typical AC Drive. Strong consideration for shielded cable should be given in installations with sensitive equipment such as weigh scales, capacitive proximity switches and other devices that may be affected by electrical noise in the distribution system. Applications with large numbers of drives in a similar location, imposed EMC regulations or a high degree of communications / networking are also good candidates for shielded cable.

Shielded cable may also help reduce shaft voltage and induced bearing currents for some applications. In addition, the increased impedance of shielded cable may help extend the distance that the motor can be located from the drive without the addition of motor protective devices such as terminator networks. Refer to Reflected Wave in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

Consideration should be given to all of the general specifications dictated by the environment of the installation, including temperature, flexibility, moisture characteristics and chemical resistance. In addition, a braided shield should be included and be specified by the cable manufacturer as having coverage of at least 75%. An additional foil shield can greatly improve noise containment.

A good example of recommended cable is Belden® 295xx (xx determines gauge). This cable has four (4) XLPE insulated conductors with a 100% coverage foil and an 85% coverage copper braided shield (with drain wire) surrounded by a PVC jacket.

Other types of shielded cable are available, but the selection of these types may limit the allowable cable length. Particularly, some of the newer cables twist 4 conductors of THHN wire and wrap them tightly with a foil shield. This construction can greatly increase the cable charging current required and reduce

the overall drive performance. Unless specified in the individual distance tables as tested with the drive, these cables are not recommended and their performance against the lead length limits supplied is not known.

Recommended Shielded Wire

Location	Rating/Type	Description
Standard (Option 1)	600V, 90 °C (194 °F) XHHW2/RHW-2 Anixter B209500-B209507, Belden 29501-29507, or equivalent	• Four tinned copper conductors with XLPE insulation. • Copper braid/aluminum foil combination shield and tinned copper drain wire. • PVC jacket.
Standard (Option 2)	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter OLF-7xxxxx or equivalent	• Three tinned copper conductors with XLPE insulation. • 5 mil single helical copper tape (25% overlap min.) with three bare copper grounds in contact with shield. • PVC jacket.
Class I & II; Division I & II	Tray rated 600V, 90 °C (194 °F) RHH/RHW-2 Anixter 7V-7xxxx-3G or equivalent	• Three bare copper conductors with XLPE insulation and impervious corrugated continuously welded aluminum armor. • Black sunlight resistant PVC jacket overall. • Three copper grounds on #10 AWG and smaller.

Reflected Wave Protection

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). Refer to Reflected Wave in "Wiring and Grounding Guide, (PWM) AC Drives," publication DRIVES-IN001.

The reflected wave data applies to all carrier frequencies 2...16 kHz.

For 240V ratings and lower, reflected wave effects do not need to be considered.

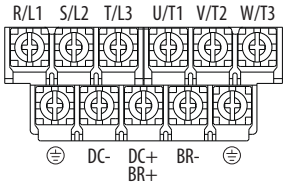
Output Disconnect

The drive is intended to be commanded by control input signals that will start and stop the motor. A device that routinely disconnects then reapplies output power to the motor for the purpose of starting and stopping the motor should not be used. If it is necessary to disconnect power to the motor with the drive outputting power, an auxiliary contact should be used to simultaneously disable drive (Aux Fault or Coast to Stop).

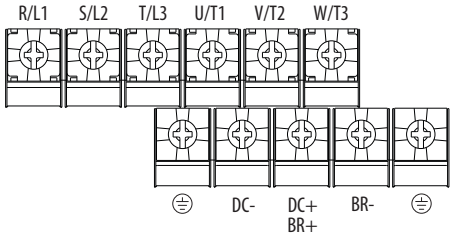
Power Terminal Block

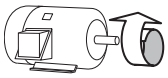
Power Terminal Block

Frame A, B, C & D



Frame E



Terminal	Description
R/L1, S/L2	1-Phase Input Line Voltage Connection
R/L1, S/L2, T/L3	3-Phase Input Line Voltage Connection
U/T1, V/T2, W/T3	Motor Phase Connection =  Switch any two motor leads to change forward direction.
DC+, DC-	DC Bus Connection (except for 110V 1-Phase)
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground - PE

IMPORTANT Terminal screws may become loose during shipment. Ensure that all terminal screws are tightened to the recommended torque before applying power to the drive.

Power Terminal Block Wire Specifications

Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
A	5.3 mm^2 (10 AWG)	0.8 mm^2 (18 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
B	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
C	8.4 mm^2 (8 AWG)	2.1 mm^2 (14 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
D	13.3 mm^2 (6 AWG)	5.3 mm^2 (10 AWG)	1.76...2.16 Nm (15.6...19.1 lb-in.)
E	26.7 mm^2 (3 AWG)	8.4 mm^2 (8 AWG)	3.09...3.77 Nm (27.3...33.4 lb-in.)

(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

Common Bus/Precharge Notes

If drives are used with a disconnect switch to the common DC bus, then an auxiliary contact on the disconnect must be connected to a digital input of the drive. The corresponding input (parameter t062, t063, t065...t068 [DigIn TermBlk xx]) must be set to 30, "Precharge En" This provides the proper precharge interlock, guarding against possible damage to the drive when connected to a common DC bus.

I/O Wiring

Motor Start/Stop Precautions



ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If used, the input device must not exceed one operation per minute or drive damage can occur.

ATTENTION: The drive start/stop control circuitry includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required to remove the AC line to the drive. When the AC line is removed, there will be a loss of any inherent regenerative braking effect that might be present - the motor will coast to a stop. An auxiliary braking method may be required. Alternatively, use the drive's safety input function.

Important points to remember about I/O wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control and signal wires should be separated from power wires by at least 0.3 m (1 ft).

IMPORTANT I/O terminals labeled "Common" are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference.



ATTENTION: Driving the 4-20 mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Signal and Control Wire Types

Recommendations are for 50 °C ambient temperature.
75 °C wire must be used for 60 °C ambient temperature.
90 °C wire must be used for 70 °C ambient temperature.

Recommended Signal Wire

Signal Type/ Where Used	Belden Wire Type(s)[1] *(or equivalent)*	Description	Min. Insulation Rating
Analog I/O & PTC	8760/9460	0.750 mm^2 (18 AWG), twisted pair, 100% shield with drain[2]	300V, 60 °C (140 °F)
Remote Pot	8770	0.750 mm^2 (18 AWG), 3 conductor, shielded	
Encoder/Pulse I/O	9728/9730	0.196 mm^2 (24 AWG), individually shielded pairs	

(1) Stranded or solid wire.

(2) If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

Recommended Control Wire for Digital I/O

Type	Wire Type(s)	Description	Min. Insulation Rating
Unshielded	Per US NEC or applicable national or local code	–	300V, 60 °C (140 °F)
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equivalent)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 m (100 ft). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common may be connected to ground terminal/protective earth. If using the RS485 (DSI) port, I/O Terminal C1 should also be connected to ground terminal/protective earth. Additionally, communication noise immunity can also be improved by connecting I/O Terminal C2 to ground terminal/protective earth.

Control I/O Terminal Block

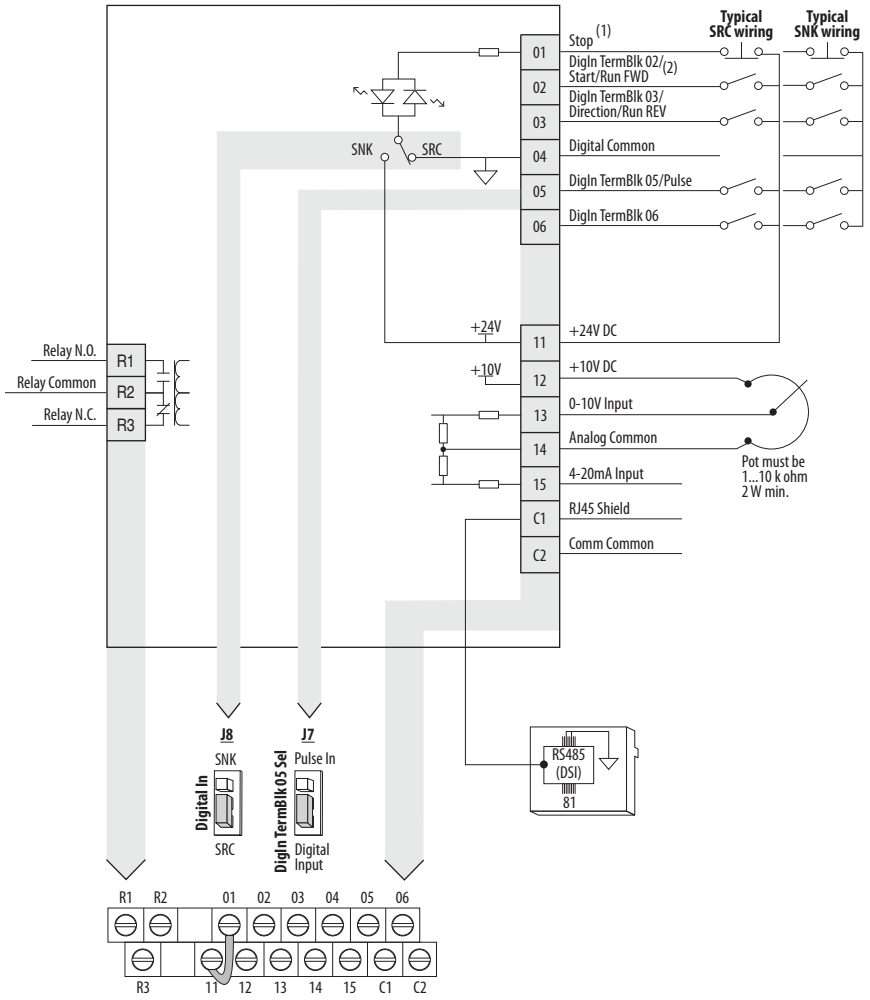
Control I/O Terminal Block Wire Specifications

Frame	Maximum Wire Size[1]	Minimum Wire Size[1]	Torque
A...E	1.3 mm^2 (16 AWG)	0.13 mm^2 (26 AWG)	0.71...0.86 Nm (6.2...7.6 lb-in.)

(1) Maximum/minimum sizes that the terminal block will accept – these are not recommendations.

PowerFlex 523 Control I/O Terminal Block

PowerFlex 523 Control I/O Wiring Block Diagram



Control I/O Wiring Block Diagram Notes

(1) See Digital Input Selection for Start Source on page 47 for more information on configuring the digital inputs.

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. See the tables below for more information.

P046, P048, P050 [Start Source x]	Normal Stop	I/O Terminal 01 Stop
1 "Keypad"	Per P045 [Stop Mode]	Coast
2 "DigIn TrmBlk"		See t062, t063 [DigIn TermBlk xx] below
3 "Serial/DSI"		Coast
4 "Network Opt"		Per P045 [Stop Mode]

t062, t063 [DigIn TermBlk xx]	Normal Stop	I/O Terminal 01 Stop
48 "2-Wire FWD"	Per P045 [Stop Mode]	See t064 [2-Wire Mode] below
49 "3-Wire Start"		Per P045 [Stop Mode]
50 "2-Wire REV"		See t064 [2-Wire Mode] below
51 "3-Wire Dir"		Per P045 [Stop Mode]

t064 [2-Wire Mode]	Normal Stop	I/O Terminal 01 Stop
0 "Edge Trigger"	Per P045 [Stop Mode]	Coast
1 "Level Sense"		Coast
2 "Hi-Spd Edge"		Coast
3 "Momentary"		Per P045 [Stop Mode]

IMPORTANT The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

Control I/O Terminal Designations

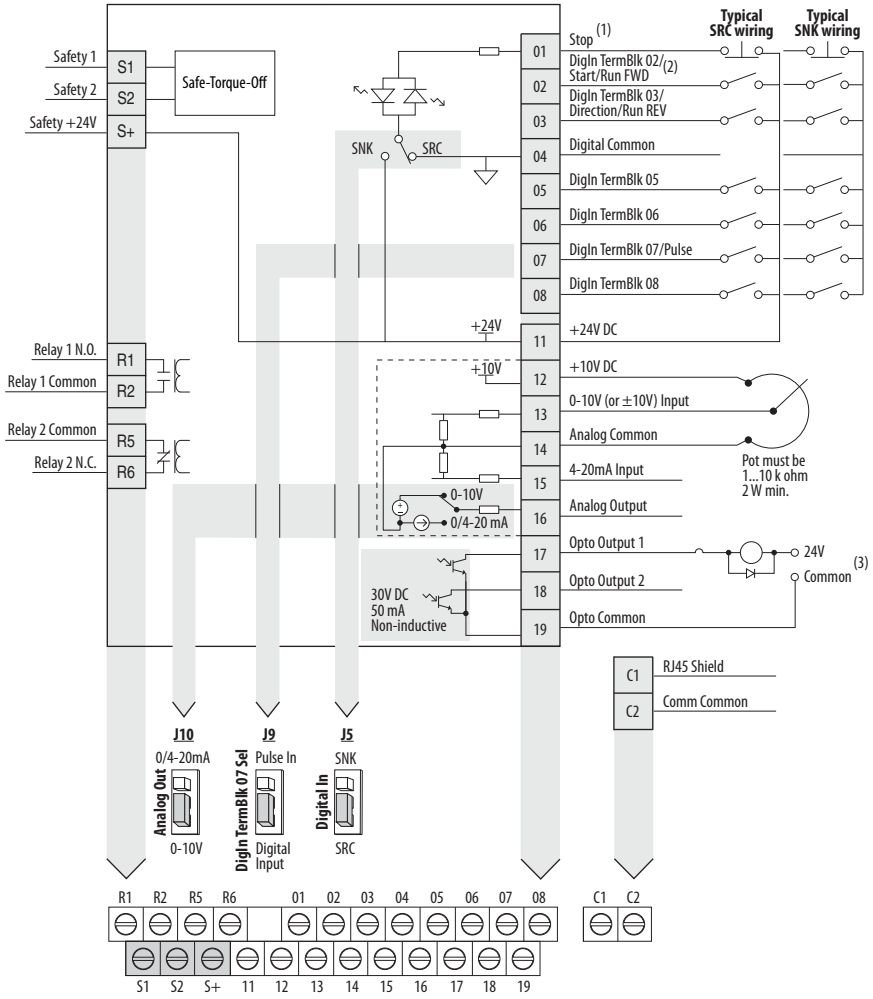
No.	Signal	Default	Description	Parameter
R1	Relay N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay Common	Fault	Common for output relay.	
R3	Relay N.C.	Motor Running	Normally closed contact for output relay.	t081
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045(2)
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t063 [DigIn TermBlk 03] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05/ Pulse In	Preset Freq	Program with t065 [DigIn TermBlk 05]. Also functions as a Pulse Train input for reference or speed feedback. The maximum frequency is 100 kHz. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049
13	0-10V In(1)	Not Active	For external 0-10V (unipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	4-20mA In(1)	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–

(1) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

(2) See Footnote (1) on page 37.

PowerFlex 525 Control I/O Terminal Block

PowerFlex 525 Control I/O Wiring Block Diagram



Control I/O Wiring Block Diagram Notes

(1) See Digital Input Selection for Start Source on page 47 for more information on configuring the digital inputs.

IMPORTANT I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. See the tables below for more information.

P046, P048, P050 [Start Source x]	Normal Stop	I/O Terminal 01 Stop
1 "Keypad"	Per P045 [Stop Mode]	Coast
2 "DigIn TrmBlk"		See t062, t063 [DigIn TermBlk xx] below
3 "Serial/DSI"		Coast
4 "Network Opt"		Per P045 [Stop Mode]
5 "EtherNet/IP"		Per P045 [Stop Mode]

t062, t063 [DigIn TermBlk xx]	Normal Stop	I/O Terminal 01 Stop
48 "2-Wire FWD"	Per P045 [Stop Mode]	See t064 [2-Wire Mode] below
49 "3-Wire Start"		Per P045 [Stop Mode]
50 "2-Wire REV"		See t064 [2-Wire Mode] below
51 "3-Wire Dir"		Per P045 [Stop Mode]

t064 [2-Wire Mode]	Normal Stop	I/O Terminal 01 Stop
0 "Edge Trigger"	Per P045 [Stop Mode]	Coast
1 "Level Sense"		Coast
2 "Hi-Spd Edge"		Coast
3 "Momentary"		Per P045 [Stop Mode]

IMPORTANT The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input  on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) When using an opto output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.

Control I/O Terminal Designations

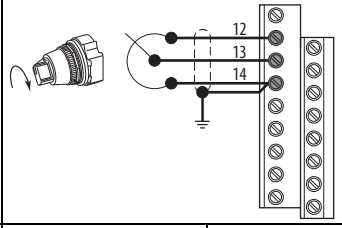
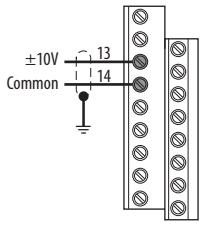
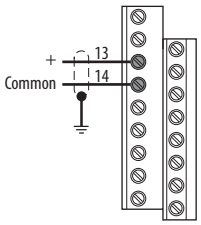
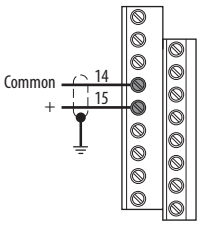
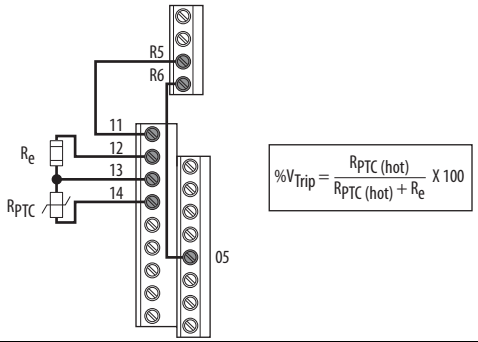
No.	Signal	Default	Description	Parameter
R1	Relay 1 N.O.	Fault	Normally open contact for output relay.	t076
R2	Relay 1 Common	Fault	Common for output relay.	
R5	Relay 2 Common	Motor Running	Common for output relay.	t081
R6	Relay 2 N.C.	Motor Running	Normally closed contact for output relay.	
01	Stop	Coast	Three wire stop. However, it functions as a stop under all input modes and cannot be disabled.	P045(1)
02	DigIn TermBlk 02/ Start/Run FWD	Run FWD	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t062 [DigIn TermBlk 02] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	P045, P046, P048, P050, A544, t062
03	DigIn TermBlk 03/ Dir/Run REV	Run REV	Used to initiate motion and also can be used as a programmable digital input. It can be programmed with t063 [DigIn TermBlk 03] as three wire (Start/Dir with Stop) or two wire (Run FWD/ Run REV) control. Current consumption is 6 mA.	t063
04	Digital Common	–	Return for digital I/O. Electrically isolated (along with the digital I/O) from the rest of the drive.	–
05	DigIn TermBlk 05	Preset Freq	Program with t065 [DigIn TermBlk 05]. Current consumption is 6 mA.	t065
06	DigIn TermBlk 06	Preset Freq	Program with t066 [DigIn TermBlk 06]. Current consumption is 6 mA.	t066
07	DigIn TermBlk 07/ Pulse In	Start Source 2 + Speed Reference2	Program with t067 [DigIn TermBlk 07]. Also functions as a Pulse Train input for reference or speed feedback. The maximum frequency is 100 kHz. Current consumption is 6 mA.	t067
08	DigIn TermBlk 08	Jog Forward	Program with t068 [DigIn TermBlk 08]. Current consumption is 6 mA.	t068
C1	C1	–	This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.	–
C2	C2	–	This is the signal common for the communication signals.	–
S1	Safety 1	–	Safety input 1. Current consumption is 6 mA.	–
S2	Safety 2	–	Safety input 2. Current consumption is 6 mA.	–
S+	Safety +24V	–	+24V supply for safety circuit. Internally tied to the +24V DC source (Pin 11).	–

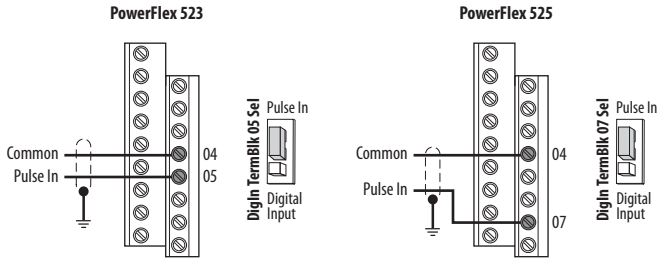
Control I/O Terminal Designations

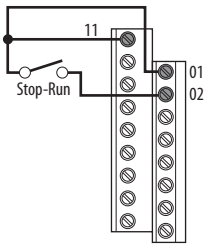
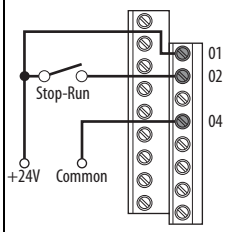
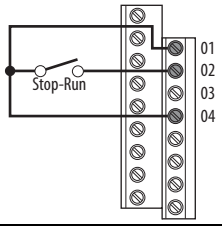
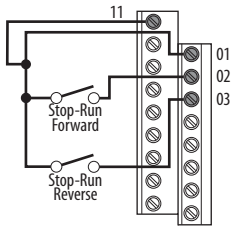
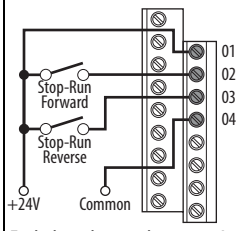
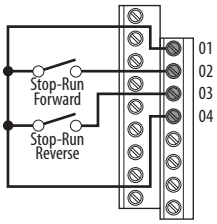
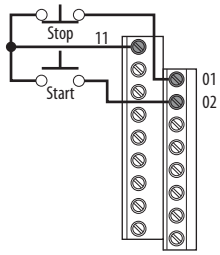
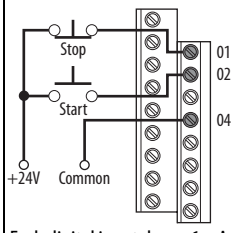
No.	Signal	Default	Description	Parameter
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100 mA.	–
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0...10V external potentiometer. Maximum output current is 15 mA.	P047, P049
13	±10V In	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply or potentiometer wiper. Input impedance: Voltage source = 100 kΩ Allowable potentiometer resistance range = 1...10 kΩ	P047, P049, t062, t063, t065, t066, t093, A459, A471
14	Analog Common	–	Return for the analog I/O. Electrically isolated (along with the analog I/O) from the rest of the drive.	–
15	4-20mA In	Not Active	For external 4-20 mA input supply. Input impedance = 250 Ω	P047, P049, t062, t063, t065, t066, A459, A471
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To convert a current value, change the Analog Output jumper to 0-20 mA. Program with t088 [Analog Out Sel]. Maximum analog value can be scaled with t089 [Analog Out High]. Maximum Load: 4-20 mA = 525 Ω (10.5V) 0-10V = 1 kΩ (10 mA)	t088, t089
17	Opto Output 1	Motor Running	Program with t069 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t069, t070, t075
18	Opto Output 2	At Frequency	Program with t072 [Opto Out1 Sel]. Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	t072, t073, t075
19	Opto Common	–	The emitters of the Optocoupler Outputs (1 and 2) are tied together at Optocoupler Common. Electrically isolated from the rest of the drive.	–

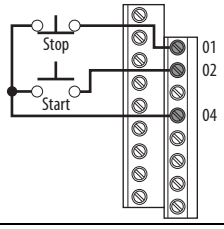
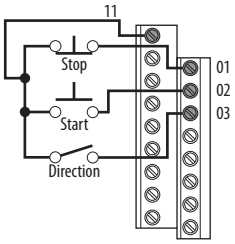
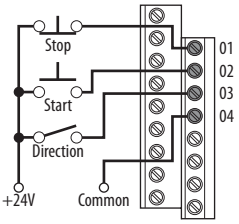
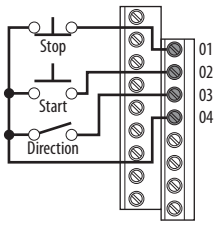
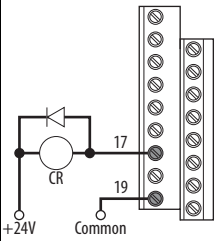
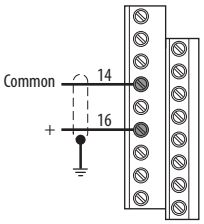
(1) See Footnote (1) on page 37.

I/O Wiring Examples

<table>
<tr><th>I/O</th><th colspan="3">Connection Example</th></tr>
<tr><td rowspan="2">Potentiometer
1...10k Ω Pot. Recommended (2 W minimum)</td><td colspan="3">P047 [Speed Reference1] = 5 “0-10V Input”</td></tr>
<tr><td colspan="3"> 
</td></tr>
<tr><td rowspan="2">Analog Input
0-10V, 100k Ω impedance
4-20 mA, 250 Ω impedance</td><td>Bipolar
P047 [Speed Reference1] = 5 “0-10V Input” and t093 [10V Bipolar Enbl] = 1 “Bi-Polar In”</td><td>Unipolar (Voltage)
P047 [Speed Reference1] = 5 “0-10V Input”</td><td>Unipolar (Current)
P047 [Speed Reference1] = 6 “4-20mA Input”</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>Analog Input, PTC
For Drive Fault</td><td colspan="3">Wire the PTC and External Resistor (typically matched to the PTC Hot Resistance) to I/O Terminals 12, 13, 14.
Wire R2/R3 Relay Output (SRC) to I/O Terminals 5 & 11.
t065 [DigIn TermBlk 05] = 12 “Aux Fault”
t081 [Relay Out 2 Sel] = 10 “Above Anlg V”
t082 [Relay Out 2 Level] = % Voltage Trip</td></tr>
<tr><td></td><td colspan="3"> 
</td></tr>
<tr><td>Pulse Train Input
PowerFlex 523
t065 [DigIn TermBlk 05] = 52
PowerFlex 525
t067 [DigIn TermBlk 07] = 52

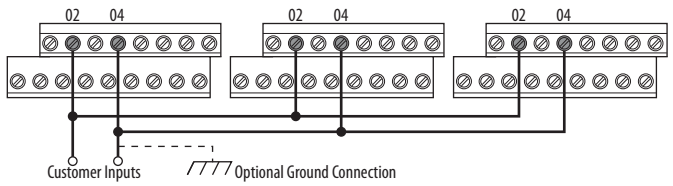
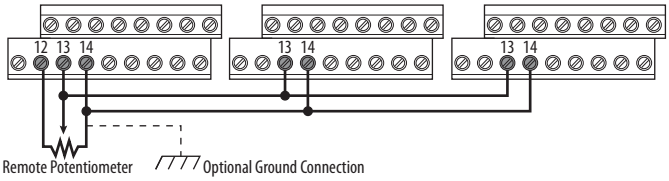
Use P047, P049 and P051 [Speed Referencex] to select pulse input.
Jumper for DigIn TermBlk 05 or 07 Sel must be moved to Pulse In.</td><td colspan="3"> 
</td></tr>
</table>

I/O	Connection Example	
2 Wire SRC Control - Non-Reversing P046 [Start Source 1] = 2 and t062 [DigIn TermBlk 02] = 48 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P045 [Stop Mode]. If desired, a User Supplied 24V DC power source can be used. Refer to the "External Supply (SRC)" example.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
2 Wire SNK Control - Non-Reversing	Internal Supply (SNK) 	
2 Wire SRC Control - Run FWD/Run REV P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 48 and t063 [DigIn TermBlk 03] = 50 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P045 [Stop Mode]. If both Run Forward and Run Reverse inputs are closed at the same time, an undetermined state could occur.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
2 Wire SNK Control - Run FWD/Run REV	Internal Supply (SNK) 	
3 Wire SRC Control - Non-Reversing P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 49 and t063 [DigIn TermBlk 03] = 51 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P045 [Stop Mode].	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.

I/O	Connection Example	
3 Wire SNK Control - Non-Reversing	Internal Supply (SNK) 	
3 Wire SRC Control - Reversing P046 [Start Source 1] = 2, t062 [DigIn TermBlk 02] = 49 and t063 [DigIn TermBlk 03] = 51 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P045 [Stop Mode]. I/O Terminal 03 determines direction.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
3 Wire SNK Control - Reversing	Internal Supply (SNK) 	
Opto Output (1 & 2)[1] t069 [Opto Out1 Sel] determines Opto-Output 1 (I/O Terminal 17) operation. t072 [Opto Out2 Sel] determines Opto-Output 2 (I/O Terminal 18) operation. When using Opto-Output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.	Opto-Output 1  Each Opto-Output is rated 30V DC 50 mA (Non-inductive).	
Analog Output[1] t088 [Analog Out Sel] determines analog output type and drive conditions. 0-10V, 1k Ω minimum 0-20 mA/4-20 mA, 525 Ω maximum	t088 [Analog Out Sel] = 0 through 23 The Analog Output Select jumper must be set to match the analog output signal mode set in t088 [Analog Out Sel]. 	

(1) Feature is specific to PowerFlex 525 drives only.

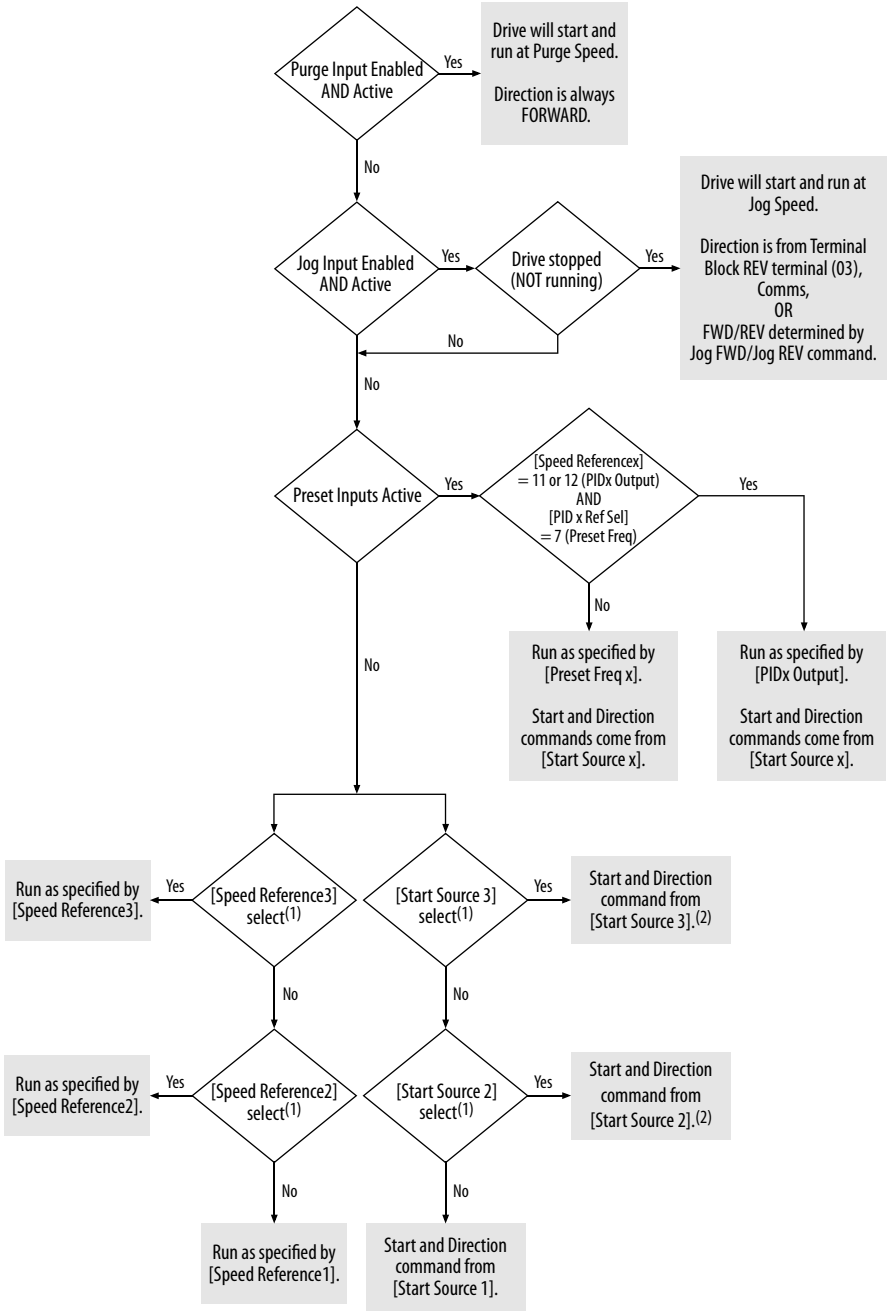
Typical Multiple Drive Connection Examples

Input/Output	Connection Example
Multiple Digital Input Connections Customer Inputs can be wired per External Supply (SRC).	 When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect I/O Terminal 04 common together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of I/O Terminal 04 should be connected. **ATTENTION:** I/O Common terminals should **not** be tied together when using SNK (Internal Supply) mode. In SNK mode, if power is removed from one drive, inadvertent operation of other drives that share the same I/O Common connection may occur.
Multiple Analog Connections	 When connecting a single potentiometer to multiple drives it is important to connect I/O Terminal 14 common together for all drives. I/O Terminal 14 common and I/O Terminal 13 (potentiometer wiper) should be daisy-chained to each drive. All drives must be powered up for the analog signal to be read correctly.

Start and Speed Reference Control

Start Source and Speed Reference Selection

The start and drive speed command can be obtained from a number of different sources. By default, start source is determined by P046 [Start Source 1] and drive speed source is determined by P047 [Speed Reference1]. However, various inputs can override this selection, See below for the override priority.

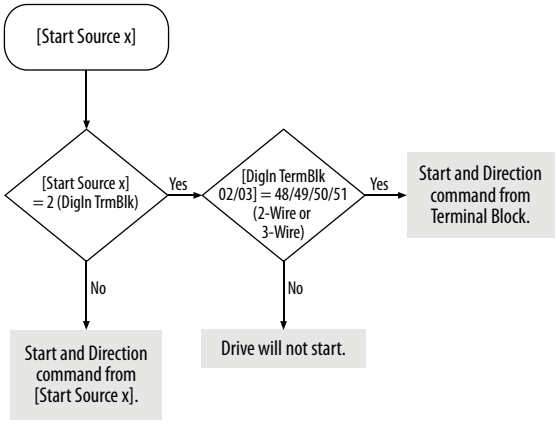


(1) [Start Source 2/3] and [Speed Reference2/3] can be selected by the control terminal block or communication commands.

(2) See Digital Input Selection for Start Source on page 47 for information on selecting the correct digital input.

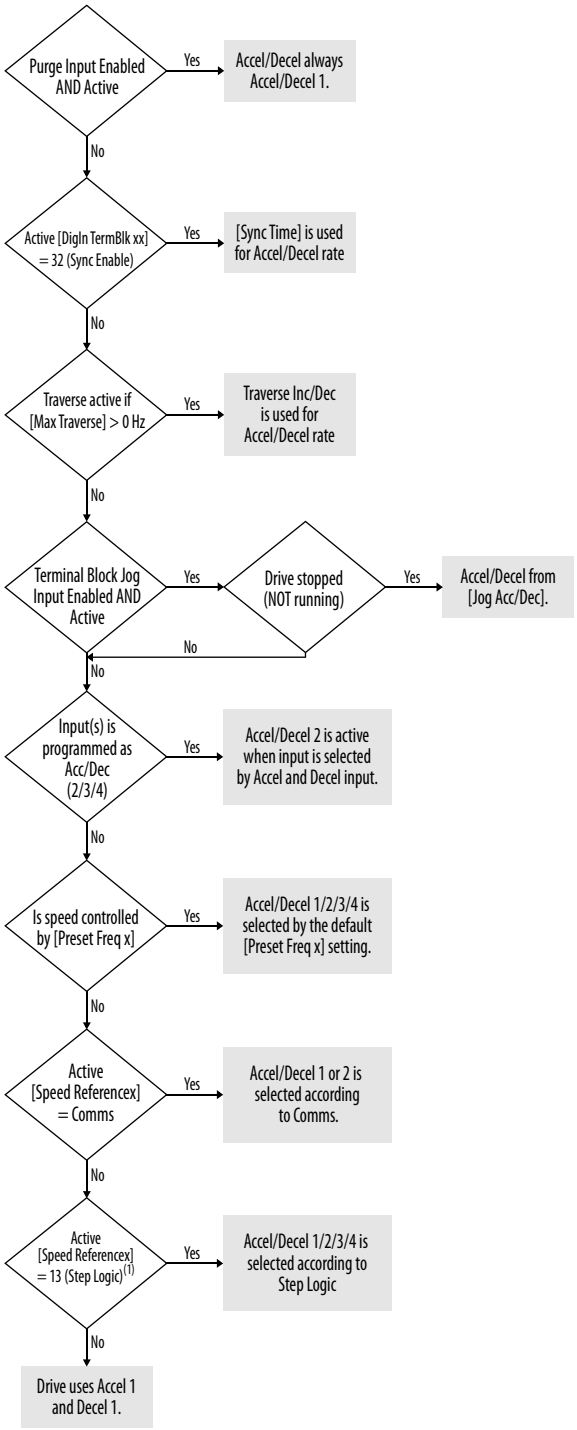
Digital Input Selection for Start Source

If P046, P048 or P050 [Start Source x] has been set to 2, "DigIn TermBlk", then t062 and t063 [DigIn TermBlk xx] must be configured for 2-Wire or 3-Wire control for the drive to function properly.



Accel/Decel Selection

The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P041 [Accel Time 1] and P042 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, communications and/or parameters. See below for the override priority.



(1) Setting is specific to PowerFlex 525 drives only.

CE Conformity

Compliance with the Low Voltage Directive and Electromagnetic Compatibility Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex 520-series drives comply with the EN standards listed below when installed according to the installation instructions in this manual.

CE Declarations of Conformity are available online at: http://www.rockwellautomation.com/products/certification/.

Low Voltage Directive (2006/95/EC)

- EN 61800-5-1 Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy.

Pollution Degree Ratings According to EN 61800-5-1

Pollution Degree	Description
1	No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
2	Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the drive is out of operation.

EMC Directive (2004/108/EC)

- EN 61800-3:2004 +A1:2012 – Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

Machinery Directive (2006/42/EC)

- EN ISO 13849-1:2008 – Safety of machinery – Safety related parts of control systems -Part 1: General principles for design
- EN 62061:2005 – Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
- EN 60204-1:2006 – Safety of machinery – Electrical equipment of machines - Part 1: General requirements
- EN 61800-5-2:2007 – Adjustable speed electrical power drive systems - Part 5-2: Safety requirement – Functional

Refer to Appendix G for installation consideration related to Machinery Directive.

General Considerations

- For CE compliance, drives must satisfy installation requirements related to both EN 61800-5-1 and EN 61800-3 provided in this document.
- PowerFlex 520-series drives must be installed in a pollution degree 1 or 2 environment to be compliant with the CE LV Directive. See Pollution Degree Ratings According to EN 61800-5-1 on page 49 for descriptions of each pollution degree rating.

- PowerFlex 520-series drives comply with the EMC requirements of EN 61800-3 when installed according to good EMC practices and the instructions provided in this document. However, many factors can influence the EMC compliance of an entire machine or installation, and compliance of the drive itself does not ensure compliance of all applications.
- PowerFlex 520-series drives are not intended to be used on public low-voltage networks which supply domestic premises. Without additional mitigation, radio frequency interference is expected if used on such a network. The installer is responsible for taking measures such as a supplementary line filter and enclosure (see Connections and Grounding on page 52) to prevent interference, in addition to the installation requirements of this document.



ATTENTION: NEMA/UL Open Type drives must either be installed in a supplementary enclosure or equipped with a "NEMA Type 1 Kit" to be CE compliant with respect to protection against electrical shock.

- PowerFlex 520-series drives generate harmonic current emissions on the AC supply system. When operated on a public low-voltage network it is the responsibility of the installer or user to ensure that applicable requirements of the distribution network operator have been met. Consultation with the network operator and Rockwell Automation may be necessary.
- If the optional NEMA 1 kit is not installed, the drive must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The motor cable should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents.
- Use of line filters in ungrounded systems is not recommended.
- In CE installations, input power must be a Balanced Wye with Center Ground configuration for EMC compliance.

Installation Requirements Related to EN 61800-5-1 and the Low Voltage Directive

- 600V PowerFlex 520-series drives can only be used on a "center grounded" supply system for altitudes up to and including 2000 m (6562 ft).
- When used at altitudes above 2000 m (6562 ft) up to a maximum of 4800 m (15,748 ft), PowerFlex 520-series drives of voltage classes up to 480V may not be powered from a "corner-earthed" supply system in order to maintain compliance with the CE LV Directive. See Derating Guidelines for High Altitude on page 18.

- PowerFlex 520-series drives produce leakage current in the protective earthing conductor which exceeds 3.5 mA AC and/or 10 mA DC. The minimum size of the protective earthing (grounding) conductor used in the application must comply with local safety regulations for high protective earthing conductor current equipment.



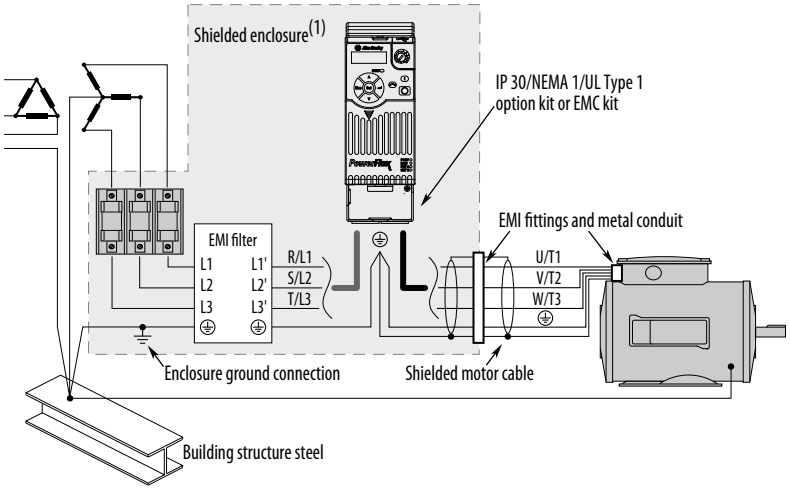
ATTENTION: PowerFlex 520-series drives produce DC current in the protective earthing conductor which may reduce the ability of RCD's (residual current-operated protective devices) or RCM's (residual current-operated monitoring devices) of type A or AC to provide protection for other equipment in the installation. Where an RCD or RCM is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.

Installation Requirements Related to EN 61800-3 and the EMC Directive

- The drive must be earthed (grounded) as described in Connections and Grounding on page 52. See General Grounding Requirements on page 20 for additional grounding recommendations.
- Output power wiring to the motor must employ cables with a braided shield providing 75% or greater coverage, or the cables must be housed in metal conduit, or equivalent shield must be provided. Continuous shielding must be provided from the drive enclosure to the motor enclosure. Both ends of the motor cable shield (or conduit) must terminate with a low-impedance connection to earth.
  Drive Frames A...E: At the drive end of the motor, either
  a. The cable shield must be clamped to a properly installed "EMC Plate" for the drive. Kit number 25-EMC1-Fx.
     or
  b. The cable shield or conduit must terminate in a shielded connector installed in an EMC plate, conduit box, or similar.
- At the motor end, the motor cable shield or conduit must terminate in a shielded connector which must be properly installed in an earthed motor wiring box attached to the motor. The motor wiring box cover must be installed and earthed.
- All control (I/O) and signal wiring to the drive must use cable with a braided shield providing 75% or greater coverage, or the cables must be housed in metal conduit, or equivalent shielding must be provided. When shielded cable is used, the cable shield should be terminated with a low impedance connection to earth at only one end of the cable, preferably the end where the receiver is located. When the cable shield is terminated at the drive end, it may be terminated either by using a shielded connector in conjunction with a conduit plate or conduit box, or the shield may be clamped to an "EMC plate."
- Motor cabling must be separated from control and signal wiring wherever possible.

- Maximum motor cable length must not exceed the maximum length indicated in PowerFlex 520-Series RF Emission Compliance and Installation Requirements on page 52 for compliance with radio frequency emission limits for the specific standard and installation environment.

Connections and Grounding



(1) Some installations require a shielded enclosure. Keep wire length as short as possible between the enclosure entry point and the EMI filter.

PowerFlex 520-Series RF Emission Compliance and Installation Requirements

Filter Type	Standard/Limits		
	EN61800-3 Category C1 EN61000-6-3 CISPR11 Group 1 Class B	**EN61800-3 Category C2 EN61000-6-4 CISPR11 Group 1 Class A (Input power ≤ 20 kVA)**	**EN61800-3 Category C3 (I ≤ 100 A) CISPR11 Group 1 Class A (Input power > 20 kVA)**
Internal	–	10 m (33 ft)	20 m (66 ft)
External(1)	30 m (16 ft)	100 m (328 ft)	100 m (328 ft)

(1) See Appendix B for more information on optional external filters.

Additional Installation Requirements

This section provides information on additional requirements for Class C1 and C2 installation, such as enclosures and EMC cores.

IMPORTANT EMC cores are included with:

- drives that have an internal EMC filter (25x-xxxxN114)
- external EMC filter accessory kit (25-RFxxx)

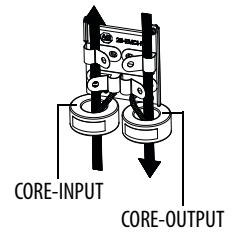
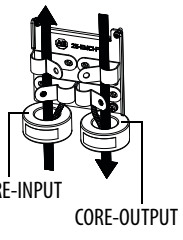
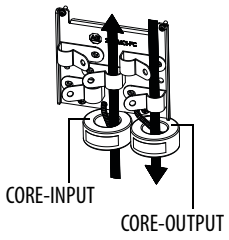
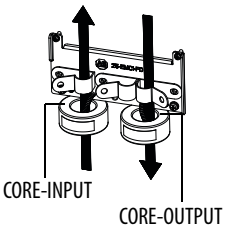
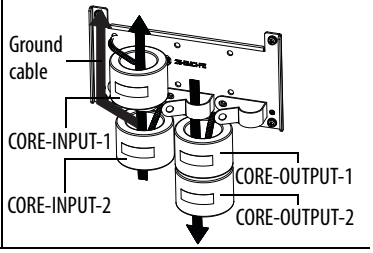
Additional Installation Requirements

Frame Size	Class C1		Class C2	
	Enclosure and Conduit Cable (Input and Output)	**EMC Cores Required (Included with product)**	**Enclosure**	**EMC Cores Required (Included with product)**
200...240V AC (-15%, +10%) – 1-Phase Input with External EMC Filter, 0...230V 3-Phase Output				
A	Shielded	None	None	INPUT (CORE-RF-A-1) / OUTPUT (CORE-RF-A-2)
B	Shielded	OUTPUT (CORE-RF-B-2)	None	INPUT (CORE-RF-B-1) / OUTPUT (CORE-RF-B-2)

Additional Installation Requirements

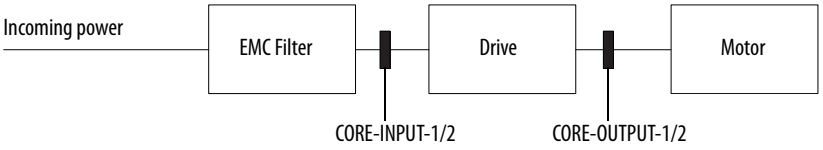
Frame Size	Class C1		Class C2	
	Enclosure and Conduit Cable (Input and Output)	EMC Cores Required (Included with product)	Enclosure	EMC Cores Required (Included with product)
200...240V AC (-15%, +10%) – 1-Phase Input with Internal EMC Filter, 0...230V 3-Phase Output				
A	–	–	Shielded	None
B	–	–	Shielded	None
200...240V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...230V 3-Phase Output				
A	Shielded	OUTPUT (CORE-RF-A-2)	None	INPUT (CORE-RF-A-1) / OUTPUT (CORE-RF-A-2)
B	Shielded	OUTPUT (CORE-RF-B-2)	None	INPUT (CORE-RF-B-1) / OUTPUT (CORE-RF-B-2)
C	Shielded	OUTPUT (CORE-RF-C-2)	None	INPUT (CORE-RF-C-1) / OUTPUT (CORE-RF-C-2)
D	Shielded	None	None	INPUT (CORE-RF-D-1)
E	Shielded	OUTPUT (CORE-RF-E-1)	None	INPUT (CORE-RF-E-1)
380...480V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...460V 3-Phase Output				
A	Shielded	None	None	INPUT (CORE-RF-A-1) / OUTPUT (CORE-RF-A-2)
B	Shielded	None	None	INPUT (CORE-RF-B-1) / OUTPUT (CORE-RF-B-2)
C	Shielded	None	None	INPUT (CORE-RF-C-1)
D	Shielded	OUTPUT (CORE-RF-D-2)	None	INPUT (CORE-RF-D-1) / OUTPUT (CORE-RF-D-2)
E	Shielded	None	Shielded	INPUT -1 (CORE-E-1) and INPUT-2 (CORE-E-2) / OUTPUT-1 (CORE-E-3) and OUTPUT-2 (CORE-E-4)
380...480V AC (-15%, +10%) – 3-Phase Input with Internal EMC Filter, 0...460V 3-Phase Output				
A	–	–	None	INPUT (CORE-A-1) / OUTPUT (CORE-A-2)
B	–	–	None	INPUT (CORE-B-1) / OUTPUT (CORE-B-2)
C	–	–	None	INPUT (CORE-C-1) / OUTPUT (CORE-C-2)
D	–	–	None	INPUT (CORE-D-1) / OUTPUT (CORE-D-2)
E	–	–	None	INPUT -1 (CORE-E-1) and INPUT-2 (CORE-E-2) / OUTPUT-1 (CORE-E-3) and OUTPUT-2 (CORE-E-4)
525...600V AC (-15%, +10%) – 3-Phase Input with External EMC Filter, 0...575V 3-Phase Output				
A	Metal Enclosure	None	None	INPUT (CORE-RF-B-1) / OUTPUT (CORE-RF-B-2)
B	Metal Enclosure	None	None	INPUT (CORE-RF-B-1) / OUTPUT (CORE-RF-B-2)
C	Metal Enclosure	None	None	INPUT (CORE-RF-C-1) / OUTPUT (CORE-RF-C-2)
D	Metal Enclosure	None	None	INPUT (CORE-RF-D-1) / OUTPUT (CORE-RF-D-2)
E	Metal Enclosure	None	Metal Enclosure	None

Recommended Placement of EMC Cores with Optional EMC Plate

Frame A	Frame B	Frame C	Frame D	Frame E
Input cable to drive (Shielded or Unshielded)				
				
Output cable from drive (Shielded)				
 Shows contact to shielded layer		 Shows cable/zip tie for securing EMC Core		

Recommended Placement of EMC Cores Relative to External Filter

All Frame sizes



IMPORTANT The ground cable/shield for both input and output must pass through the EMC core(s), except for the following:

- Frame E drives with internal filters where the grounded input cable must not pass through EMC CORE-E-1.
- 600V drives with external filters where the grounded output cable must not pass through the EMC core(s).

Start Up

This chapter describes how to start up the PowerFlex 520-series drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

For information on...	See page...
Prepare for Drive Start-Up	55
Display and Control Keys	58
Viewing and Editing Parameters	59
Drive Programming Tools	60
Smart Start-Up with Basic Program Group Parameters	61
LCD Display with QuickView	63
Using the USB Port	63

IMPORTANT Read the *General Precautions* section before proceeding.

ATTENTION: Power must be applied to the drive to perform the following start-up procedures. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove All Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the drive. Correct the malfunction before continuing.

Prepare for Drive Start-Up

Drive Startup Task List

1. Disconnect and lock out power to the machine.
2. Verify that AC line power at the disconnect device is within the rated value of the drive.
3. If replacing a drive, verify the current drive's catalog number. Verify all options installed on the drive.
4. Verify that any digital control power is 24 volts.
5. Inspect grounding, wiring, connections, and environmental compatibility.

6. Verify that the Sink (SNK)/Source (SRC) jumper is set to match your control wiring scheme. See the PowerFlex 523 Control I/O Wiring Block Diagram on page 37 and PowerFlex 525 Control I/O Wiring Block Diagram on page 39 for location.

IMPORTANT The default control scheme is Source (SRC). The Stop terminal is jumpered to allow starting from the keypad or comms. If the control scheme is changed to Sink (SNK), the jumper must be removed from I/O Terminals 01 and 11 and installed between I/O Terminals 01 and 04.

7. Wire I/O as required for the application.
8. Wire the power input and output terminals.
9. Confirm that all inputs are connected to the correct terminals and are secure.
10. Collect and record motor nameplate and encoder or feedback device information. Verify motor connections.
    - Is the motor uncoupled?
    - What direction will the motor need to turn for the application?
11. Verify the input voltage to the drive. Verify if the drive is on a grounded system. Ensure the MOV jumpers are in the correct position. See AC Supply Source Considerations on page 19 for more information.
12. Apply power and reset the drive and communication adapters to factory default settings. To reset the drive, see parameter P053 [Reset to Defalts]. To reset the communication adapters, see the user manual of the adapter for more information.
13. Configure the basic program parameters related to the motor. See Smart Start-Up with Basic Program Group Parameters on page 61.
14. Complete the autotune procedure for the drive. See parameter P040 [Autotune] for more information.
15. If you are replacing a drive and have a backup of the parameter settings obtained using the USB utility application, use the USB utility application to apply the backup to the new drive. See Using the USB Port on page 63 for more information.

    Otherwise, set the necessary parameters for your application using the LCD keypad interface, Connected Components Workbench, or RSLogix or Logix Designer if using an Add-on Profile through EtherNet/IP.
    - Configure the communication parameters needed for the application (node number, IP address, Datalinks in and out, communication rate, speed reference, start source, and so on). Record these settings for your reference.
    - Configure the other drive parameters needed for the drive analog and digital I/O to work correctly. Verify the operation. Record these settings for your reference.

16. Verify the drive and motor perform as specified.
    - Verify that the Stop input is present or the drive will not start.

    IMPORTANT If I/O Terminal 01 is used as a stop input, the jumper between I/O Terminals 01 and 11 must be removed.

    - Verify the drive is receiving the speed reference from the correct place and that the reference is scaled correctly.
    - Verify the drive is receiving start and stop commands correctly.
    - Verify input currents are balanced.
    - Verify motor currents are balanced.
17. Save a backup of the drive settings using the USB utility application. See Using the USB Port on page 63 for more information.

Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the keypad. No programming is required to start, stop, change direction and control speed directly from the keypad.

IMPORTANT To disable reverse operation, see A544 [Reverse Disable].

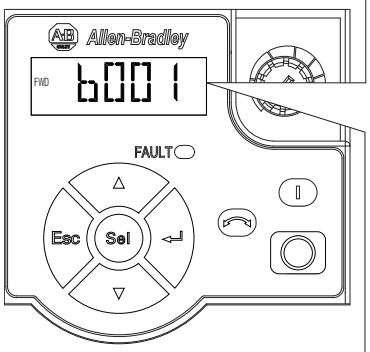
If a fault appears on power up, see Fault Descriptions on page 145 for an explanation of the fault code.

Variable Torque Fan/Pump Applications

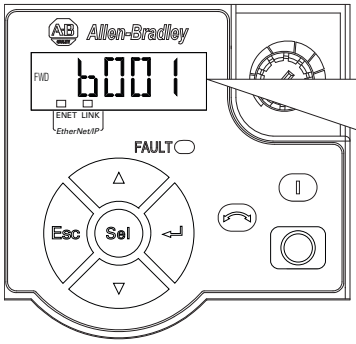
For improved motor tuning performance when using a premium efficient motor on a variable torque loading SVC mode, set A530 [Boost Select] to 2 “35.0, VT”.

Display and Control Keys

PowerFlex 523



PowerFlex 525



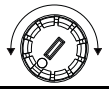
Menu	Parameter Group and Description
b	**Basic Display** Commonly viewed drive operating conditions.
P	**Basic Program** Commonly used programmable functions.
t	**Terminal Blocks** Programmable terminal functions.
C	**Communications** Programmable communication functions.
L	**Logic (PowerFlex 525 only)** Programmable logic functions.
d	**Advanced Display** Advanced drive operating conditions.
A	**Advanced Program** Remaining programmable functions.
N	**Network** Network functions that are shown only when a comm card is used.
M	**Modified** Functions from the other groups with values changed from default.
F	**Fault and Diagnostic** Consists of list of codes for specific fault conditions.
G	**AppView and CustomView** Functions from the other groups organized for specific applications.

Control and Navigation Keys

Display	Display State	Description
ENET (PowerFlex 525 only)	Off	Adapter is not connected to the network.
	Steady	Adapter is connected to the network and drive is controlled through Ethernet.
	Flashing	Adapter is connected to the network but drive is not controlled through Ethernet.
LINK (PowerFlex 525 only)	Off	Adapter is not connected to the network.
	Steady	Adapter is connected to the network but not transmitting data.
	Flashing	Adapter is connected to the network and transmitting data.

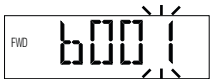
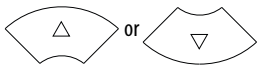
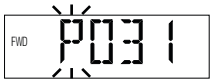
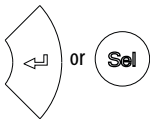
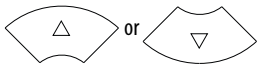
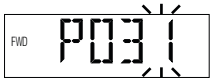
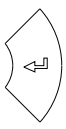
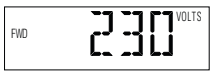
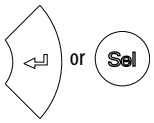
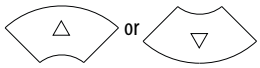
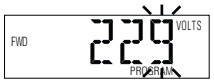
LED	LED State	Description
FAULT	Flashing Red	Indicates drive is faulted.

Key	Name	Description
	Up Arrow Down Arrow	Scroll through user-selectable display parameters or groups. Increment values.
	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	Enter	Advance one step in programming menu. Save a change to a parameter value.

Key	Name	Description
	Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P046, P048 and P050 [Start Source x] and A544 [Reverse Disable].
	Start	Used to start the drive. Default is active. Controlled by parameters P046, P048 and P050 [Start Source x].
	Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P045 [Stop Mode].
	Potentiometer	Used to control speed of drive. Default is active. Controlled by parameters P047, P049 and P051 [Speed Referencex].

Viewing and Editing Parameters

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program a parameter.

Step	Key(s)	Example Display
1. When power is applied, the last user-selected Basic Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of b001 [Output Freq] with the drive stopped.)		
2. Press Esc to display the Basic Display Group parameter number shown on power-up. The parameter number will flash.		
3. Press Esc to enter the parameter group list. The parameter group letter will flash.		
4. Press the Up Arrow or Down Arrow to scroll through the group list (b, P, t, C, L, d, A, f and Gx).		
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.		
6. Press the Up Arrow or Down Arrow to scroll through the parameter list.		
7. Press Enter to view the value of the parameter. Or Press Esc to return to the parameter list.		
8. Press Enter or Sel to enter Program Mode and edit the value. The right digit will flash and the word Program on the LCD display will light up.		
9. Press the Up Arrow or Down Arrow to change the parameter value.		

Step	Key(s)	Example Display
10. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	Sel	FWD 229 VOLTS PROGRAM
11. Press Esc to cancel a change and exit Program Mode. Or Press Enter to save a change and exit Program Mode. The digit will stop flashing and the word Program on the LCD display will turn off.	Esc or ⏎	FWD 230 VOLTS or FWD 229 VOLTS
12. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu. If pressing Esc does not change the display, then b001 [Output Freq] is displayed. Press Enter or Sel to enter the group list again.	Esc	FWD P031

Drive Programming Tools

Some features in the PowerFlex 520-series drive are not supported by older configuration software tools. It is strongly recommended that customers using such tools migrate to RSLogix 5000 (version 17.0 or greater) or Logix Designer (version 21.0 or greater) with Add-On-Profile (AOP), or Connected Components Workbench (version 5.0 or greater) to enjoy a richer, full-featured configuration experience.

Description	Catalog Number/Release Version
Connected Components Workbench(1)	Version 5.0 or greater
Logix Designer	Version 21.0 or greater
RSLogix 5000	Version 17.0 or greater
Built-in USB software tool	–
Serial Converter Module(2)	22-SCM-232
USB Converter Module(2)	1203-USB
Remote Panel Mount, LCD Display(2)	22-HIM-C2S
Remote Handheld, LCD Display(2)	22-HIM-A3

(1) Available as a free download at http://ab.rockwellautomation.com/programmable-controllers/connected-components-workbench-software.

(2) Does not support the new dynamic parameter groups (AppView, CustomView), and CopyCat functionality is limited to the linear parameter list.

Language Support

Language	Keypad/LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
English	Y	Y	Y
French	Y	Y	Y
Spanish	Y	Y	Y
Italian	Y	Y	Y
German	Y	Y	Y
Japanese	–	Y	–
Portuguese	Y	Y	–
Chinese Simplified	–	Y	Y
Korean	–	Y	–

Language	Keypad/LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
Polish(1)	Y	–	–
Turkish(1)	Y	–	–
Czech(1)	Y	–	–

(1) Due to a limitation of the LCD Display, some of the characters for Polish, Turkish, and Czech will be modified.

Smart Start-Up with Basic Program Group Parameters

The PowerFlex 520-series drive is designed so that start up is simple and efficient. The Basic Program Group contains the most commonly used parameters. See Programming and Parameters on page 65 for detailed descriptions of the parameters listed here, as well as the full list of available parameters.

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P030	[Language]	1/15	1 = English 2 = Français 3 = Español 4 = Italiano 5 = Deutsch 6 = Reserved 7 = Português 8 = Reserved 9 = Reserved 10 = Reserved 11 = Reserved 12 = Polish 13 = Reserved 14 = Turkish 15 = Czech	1
	Selects the language displayed. **Important:** The setting takes effect after the drive is power cycled.			
P031	[Motor NP Volts]	10V (for 200V Drives), 20V (for 400V Drives), 25V (for 600V Drives)/Drive Rated Volts	1V	Based on Drive Rating
	Sets the motor nameplate rated volts.			
P032	[Motor NP Hertz]	15/500 Hz	1 Hz	60 Hz
	Sets the motor nameplate rated frequency.			
P033	[Motor OL Current]	0.0/(Drive Rated Amps x 2)	0.1 A	Based on Drive Rating
	Sets the motor nameplate overload current.			
P034	[Motor NP FLA]	0.0/(Drive Rated Amps x 2)	0.1 A	Drive Rated Amps
	Sets the motor nameplate FLA.			
P035	[Motor NP Poles]	2/40	1	4
	Sets the number of poles in the motor.			
P036	[Motor NP RPM]	0/24000 rpm	1 rpm	1750 rpm
	Sets the rated nameplate rpm of motor.			
P037 PF 525	[Motor NP Power]	0.00/Drive Rated Power	0.01 kW	Drive Rated Power
	Sets the motor nameplate power. Used in PM regulator.			
P038	[Voltage Class]	2/3	2 = “480V” 3 = “600V”	3
	Sets the voltage class of 600V drives. Only applicable to 600V drives.			
P039	[Torque Perf Mode]	0/3	0 = “V/Hz” 1 = “SVC” 2 = “Economize” 3 = “Vector”(1)	1
	Selects the motor control mode. (1) Setting is specific to PowerFlex 525 drives only.			

= Stop drive before changing this parameter.
PF 525 = Parameter is specific to PowerFlex 525 drives only.

No.	Parameter	Min/Max	Display/Options	Default
P040	[Autotune]	0/2	0 = "Ready/Idle" 1 = "Static Tune" 2 = "Rotate Tune"	0
	Enables a static (not spinning) or dynamic (motor spinning) autotune.			
P041	[Accel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to accel from 0 Hz to [Maximum Freq].			
P042	[Decel Time 1]	0.00/600.00 s	0.01 s	10.00 s
	Sets the time for the drive to decel from [Maximum Freq] to 0 Hz.			
P043	[Minimum Freq]	0.00/500.00 Hz	0.01 Hz	0.00 Hz
	Sets the lowest frequency the drive outputs.			
P044	[Maximum Freq]	0.00/500.00 Hz	0.01 Hz	60.00 Hz
	Sets the highest frequency the drive outputs.			
P045	[Stop Mode]	0/11	0 = "Ramp, CF"(1) 1 = "Coast, CF"(1) 2 = "DC Brake, CF"(1) 3 = "DCBrkAuto,CF"(1) 4 = "Ramp" 5 = "Coast" 6 = "DC Brake" 7 = "DC BrakeAuto" 8 = "Ramp+EM B,CF"(1) 9 = "Ramp+EM Brk" 10 = "PointStp,CF"(1) 11 = "PointStop"	0
	Stop command for normal stop. **Important:** I/O Terminal 01 is always a stop input. The stopping mode is determined by the drive setting. **Important:** The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input. (1) Stop input also clears active fault.			
P046, P048, P050	[Start Source 1]	1/5	1 = "Keypad"(1) 2 = "DigIn TrmBlk"(2) 3 = "Serial/DSI" 4 = "Network Opt" 5 = "Ethernet/IP"(3)	P046 = 1 P048 = 2 P050 = 3 (PowerFlex 523) 5 (PowerFlex 525)
	Sets the default control scheme used to start the drive unless overriden by P048 [Start Source 2] or P050 [Start Source 3]. (1) When active, the Reverse key is also active unless disabled by A544 [Reverse Disable]. (2) If "DigIn TrmBlk" is selected, ensure that the digital inputs are properly configured. (3) Setting is specific to PowerFlex 525 drives only.			
P047, P049, P051	[Speed Reference1]	1/16	1 = "Drive Pot" 2 = "Keypad Freq" 3 = "Serial/DSI" 4 = "Network Opt" 5 = "0-10V Input" 6 = "4-20mA Input" 7 = "Preset Freq" 8 = "Anlg In Mult"(1) 9 = "MOP" 10 = "Pulse Input" 11 = "PID1 Output" 12 = "PID2 Output"(1) 13 = "Step Logic"(1) 14 = "Encoder"(1) 15 = "Ethernet/IP"(1) 16 = "Positioning"(1)	P047 = 1 P049 = 5 P051 = 3 (PowerFlex 523) 15 (PowerFlex 525)
	Sets the default speed command of the drive unless overridden by P049 [Speed Reference2] or P051 [Speed Reference3]. (1) Setting is specific to PowerFlex 525 drives only.			
P052	[Average kWh Cost]	0.00/655.35	0.01	0.00
	Sets the average cost per kWh.			
P053	[Reset To Defalts]	0/3	0 = "Ready/Idle" 1 = "Param Reset" 2 = "Factory Rset" 3 = "Power Reset"	0
	Resets parameters to their factory defaults values. After a Reset command, the value of this parameter returns to zero.			

LCD Display with QuickView

QuickView™ enables text to scroll across the LCD display of the PowerFlex 520-series drive. This allows you to easily configure parameters, troubleshoot faults and view diagnostic items without using a separate device.

Use parameter A556 [Text Scroll] to set the speed at which the text scrolls across the display. Select 0 "Off" to turn off text scrolling. See Language Support on page 60 for the languages supported by the PowerFlex 520-series drive.

Using the USB Port

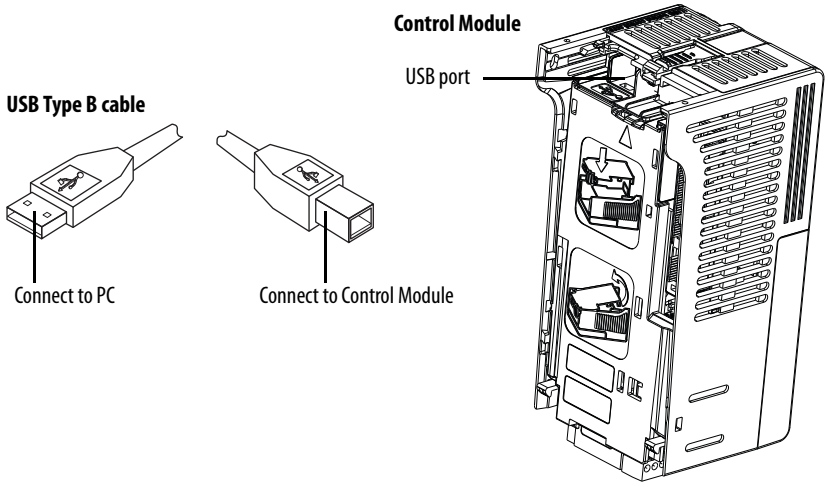
The PowerFlex 520-series drive has a USB port that connects to a PC for the purpose of upgrading drive firmware or uploading/downloading a parameter configuration.

IMPORTANT To use the USB feature of the PowerFlex 520-series drive, Microsoft .Net Framework 2.0 and Windows XP or later is required.

MainsFree Programming

The MainsFree™ programming feature allows you to quickly configure your PowerFlex 520-series drive without having to power up the control module or install additional software. Simply connect the control module to your PC with a USB Type B cable and you can download a parameter configuration to your drive. You can also easily upgrade your drive with the latest firmware.

Connecting a PowerFlex 520-series drive to a PC

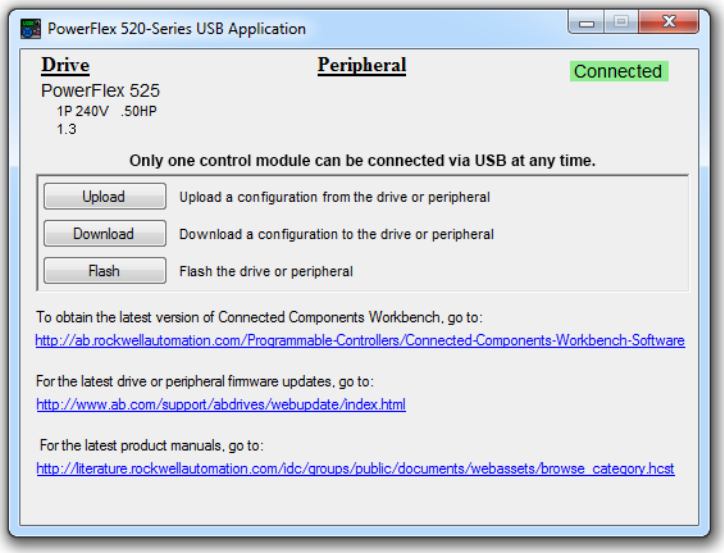


When connected, the drive appears on the PC and contains two files:

- GUIDE.PDF
  This file contains links to relevant product documentation and software downloads.
- PF52XUSB.EXE
  This file is an application to flash upgrade firmware or upload/download a parameter configuration.

  It is not possible to delete these files or add more to the drive.

Double-click on the PF52XUSB.EXE file to launch the USB utility application. The main menu is displayed. Follow the program instructions to upgrade the firmware or upload/download configuration data.



IMPORTANT Make sure your PC is powered by an AC power outlet or has a fully charged battery before starting any operation. This prevents the operation from terminating before completion due to insufficient power.

Limitation in Downloading .pf5 Configuration Files with the USB Utility Application

Before downloading a .pf5 configuration file using the USB utility application, parameter C169 [MultiDrv Sel] in the destination drive must match the incoming configuration file. If it does not, set the parameter manually to match and then cycle drive power.

This means you cannot apply a multi-drive configuration using the USB utility application to a drive in single mode (parameter C169 [MultiDrv Sel] set to 0 “Disabled”), or apply a single mode configuration to a drive in multi-drive mode.

Programming and Parameters

This chapter provides a complete listing and description of the PowerFlex 520-series drive parameters. Parameters are programmed (viewed/edited) using either the drive's built-in keypad, RSLogix 5000 version 17.0 or greater, Logix Designer version 21.0 or greater, or Connected Components Workbench version 5.0 or greater software. The Connected Components Workbench software can be used offline (through USB) to upload parameter configurations to the drive or online (through Ethernet connection).

Limited functionality is also available when using the Connected Components Workbench software online (through DSI and serial converter module), a legacy external HIM, or legacy software online (DriveTools SP™). When using these methods, the parameter list can only be displayed linearly, and there is no access to communications option card programming.

For information on...	See page...
About Parameters	65
Parameter Groups	66
Basic Display Group	71
Basic Program Group	76
Terminal Block Group	82
Communications Group	94
Logic Group	100
Advanced Display Group	103
Advanced Program Group	107
Network Parameter Group	129
Modified Parameter Group	129
Fault and Diagnostic Group	130
AppView Parameter Groups	137
CustomView Parameter Group	138
Parameter Cross Reference by Name	139

About Parameters

To configure a drive to operate in a specific way, drive parameters may have to be set. Three types of parameters exist:

- **ENUM**
  ENUM parameters allow a selection from 2 or more items. Each item is represented by a number.
- **Numeric Parameters**
  These parameters have a single numerical value (0.1V).

- **Bit Parameters**
  Bit parameters have five individual digits associated with features or conditions. If the digit is 0, the feature is off or the condition is false. If the digit is 1, the feature is on or the condition is true.

Some parameters are marked as follows.

= Stop drive before changing this parameter.

= 32 bit parameter. Parameters marked 32 bit will have two parameter numbers ([Step Units x] and [Step Units F x]) when using RS485 communications and programming software. The second parameter number is shown only in the Parameter Groups and Parameter Cross Reference by Name tables for reference.

PF 525 = Parameter is specific to PowerFlex 525 drives only.

Parameter Groups

For an alphabetical listing of parameters, see Parameter Cross Reference by Name on page 139.

Basic Display		Output Voltage	b004	Control Source	b012	Elapsed Run Time	b019	Accum CO2 Sav	b026
		DC Bus Voltage	b005	Contrl In Status	b013	Average Power	b020	Drive Temp	b027
		Drive Status	b006	Dig In Status	b014	Elapsed kWh	b021	Control Temp	b028
		Fault 1 Code	b007	Output RPM	b015	Elapsed MWh	b022	Control SW Ver	b029
Output Freq	b001	Fault 2 Code	b008	Output Speed	b016	Energy Saved	b023		
Commanded Freq	b002	Fault 3 Code	b009	Output Power	b017	Accum kWh Sav	b024		
Output Current	b003	Process Display	b010	Power Saved	b018	Accum Cost Sav	b025		
Basic Program		Motor NP Hertz	P032	Voltage Class	P038	Maximum Freq	P044	Start Source 3	P050
		Motor OL Current	P033	Torque Perf Mode	P039	Stop Mode	P045	Speed Reference3	P051
		Motor NP FLA	P034	Autotune	P040	Start Source 1	P046	Average kWh Cost	P052
		Motor NP Poles	P035	Accel Time 1	P041	Speed Reference1	P047	Reset To Defalts	P053
Language	P030	Motor NP RPM	P036	Decel Time 1	P042	Start Source 2	P048		
Motor NP Volts	P031	Motor NP Power	P037	Minimum Freq	P043	Speed Reference2	P049		
Terminal Blocks		DigIn TermBlk 07[1]	t067	Relay 1 On Time	t079	Analog Out High[1]	t089	Anlg Loss Delay	t098
		DigIn TermBlk 08[1]	t068	Relay 1 Off Time	t080	Anlg Out Setpt[1]	t090	Analog In Filter	t099
		Opto Out1 Sel[1]	t069	Relay Out2 Sel[1]	t081	Anlg In 0-10V Lo	t091	Sleep-Wake Sel	t100
		Opto Out1 Level[1]	t070	Relay Out2 Level[1]	t082	Anlg In 0-10V Hi	t092	Sleep Level	t101
DigIn TermBlk 02	t062	Opto Out2 Sel[1]	t072	Relay 2 On Time[1]	t084	10V Bipolar Enbl[1]	t093	Sleep Time	t102
DigIn TermBlk 03	t063	Opto Out2 Level[1]	t073	Relay 2 Off Time[1]	t085	Anlg In V Loss	t094	Wake Level	t103
2-Wire Mode	t064	Opto Out Logic[1]	t075	EM Brk Off Delay	t086	Anlg In4-20mA Lo	t095	Wake Time	t104
DigIn TermBlk 05	t065	Relay Out1 Sel	t076	EM Brk On Delay	t087	Anlg In4-20mA Hi	t096	Safety Open En[1]	t105
DigIn TermBlk 06	t066	Relay Out1 Level	t077	Analog Out Sel[1]	t088	Anlg In mA Loss	t097		
Communications		EN Addr Sel[1]	C128	EN Gateway Cfg 3[1]	C139	EN Data In 1[1]	C153	Opt Data In 4	C164
		EN IP Addr Cfg 1[1]	C129	EN Gateway Cfg 4[1]	C140	EN Data In 2[1]	C154	Opt Data Out 1	C165
		EN IP Addr Cfg 2[1]	C130	EN Rate Cfg[1]	C141	EN Data In 3[1]	C155	Opt Data Out 2	C166
		EN IP Addr Cfg 3[1]	C131	EN Comm Flt Actn[1]	C143	EN Data In 4[1]	C156	Opt Data Out 3	C167
Comm Write Mode	C121	EN IP Addr Cfg 4[1]	C132	EN Idle Flt Actn[1]	C144	EN Data Out 1[1]	C157	Opt Data Out 4	C168
Cmd Stat Select[1]	C122	EN Subnet Cfg 1[1]	C133	EN Flt Cfg Logic[1]	C145	EN Data Out 2[1]	C158	MultiDrv Sel	C169
RS485 Data Rate	C123	EN Subnet Cfg 2[1]	C134	EN Flt Cfg Ref[1]	C146	EN Data Out 3[1]	C159	Drv 1 Addr	C171
RS485 Node Addr	C124	EN Subnet Cfg 3[1]	C135	EN Flt Cfg DL 1[1]	C147	EN Data Out 4[1]	C160	Drv 2 Addr	C172
Comm Loss Action	C125	EN Subnet Cfg 4[1]	C136	EN Flt Cfg DL 2[1]	C148	Opt Data In 1	C161	Drv 3 Addr	C173
Comm Loss Time	C126	EN Gateway Cfg 1[1]	C137	EN Flt Cfg DL 3[1]	C149	Opt Data In 2	C162	Drv 4 Addr	C174
RS485 Format	C127	EN Gateway Cfg 2[1]	C138	EN Flt Cfg DL 4[1]	C150	Opt Data In 3	C163	DSI I/O Cfg	C175

(1) Parameter is specific to PowerFlex 525 drives only.

Logic[1]		Stp Logic 2	L182	Stp Logic Time 0	L190	Stp Logic Time 6	L196	Step Units 4	L208
		Stp Logic 3	L183	Stp Logic Time 1	L191	Stp Logic Time 7	L197	Step Units 5	L210
		Stp Logic 4	L184	Stp Logic Time 2	L192	Step Units 0	L200	Step Units 6	L212
		Stp Logic 5	L185	Stp Logic Time 3	L193	Step Units 1	L202	Step Units 7	L214
Stp Logic 0	L180	Stp Logic 6	L186	Stp Logic Time 4	L194	Step Units 2	L204		
Stp Logic 1	L181	Stp Logic 7	L187	Stp Logic Time 5	L195	Step Units 3	L206		
Advanced Display		Elapsed Time-hr	d362	Motor OL Level	d369	Torque Current	d382	Units Traveled H[1]	d388
		Elapsed Time-min	d363	Slip Hz Meter	d375	PID1 Fdbk Displ	d383	Units Traveled L[1]	d389
		Counter Status	d364	Speed Feedback	d376	PID1 Setpnt Disp	d384	Fiber Status	d390
		Timer Status	d365	Encoder Speed[1]	d378	PID2 Fdbk Displ	d385	Stp Logic Status[1]	d391
Analog In 0-10V	d360	Drive Type	d367	DC Bus Ripple	d380	PID2 Setpnt Disp	d386		
Analog In 4-20mA	d361	Testpoint Data	d368	Output Powr Fctr	d381	Position Status	d387		
Advanced Program		DB Resistor Sel	A437	PID 2 Trim Hi[1]	A468	Motor Lx[1]	A500	Compensation	A547
		DB Threshold	A438	PID 2 Trim Lo[1]	A469	Speed Reg Sel	A509	Power Loss Mode	A548
		S Curve %	A439	PID 2 Trim Sel[1]	A470	Freq 1	A510	Half Bus Enable	A549
		PWM Frequency	A440	PID 2 Ref Sel[1]	A471	Freq 1 BW	A511	Bus Reg Enable	A550
Preset Freq 0	A410	Droop Hertz@ FLA[1]	A441	PID 2 Fdback Sel[1]	A472	Freq 2	A512	Fault Clear	A551
Preset Freq 1	A411	Accel Time 2	A442	PID 2 Prop Gain[1]	A473	Freq 2 BW	A513	Program Lock	A552
Preset Freq 2	A412	Decel Time 2	A443	PID 2 Integ Time[1]	A474	Freq 3	A514	Program Lock Mod	A553
Preset Freq 3	A413	Accel Time 3	A444	PID 2 Diff Rate[1]	A475	Freq 3 BW	A515	Drv Ambient Sel	A554
Preset Freq 4	A414	Decel Time 3	A445	PID 2 Setpoint[1]	A476	Freq 1 Kp	A521	Reset Meters	A555
Preset Freq 5	A415	Accel Time 4	A446	PID 2 Deadband[1]	A477	Freq 1 Ki	A522	Text Scroll	A556
Preset Freq 6	A416	Decel Time 4	A447	PID 2 Preload[1]	A478	Freq 2 Kp	A523	Out Phas Loss En	A557
Preset Freq 7	A417	Skip Frequency 1	A448	PID 2 Invert Err[1]	A479	Freq 2 Ki	A524	Positioning Mode[1]	A558
Preset Freq 8[1]	A418	Skip Freq Band 1	A449	Process Disp Lo	A481	Freq 3 Kp	A525	Counts Per Unit[1]	A559
Preset Freq 9[1]	A419	Skip Frequency 2	A450	Process Disp Hi	A482	Freq 3 Ki	A526	Enh Control Word[1]	A560
Preset Freq 10[1]	A420	Skip Freq Band 2	A451	Testpoint Sel	A483	Boost Select	A530	Home Save[1]	A561
Preset Freq 11[1]	A421	Skip Frequency 3[1]	A452	Current Limit 1	A484	Start Boost	A531	Find Home Freq[1]	A562
Preset Freq 12[1]	A422	Skip Freq Band 3[1]	A453	Current Limit 2[1]	A485	Break Voltage	A532	Find Home Dir[1]	A563
Preset Freq 13[1]	A423	Skip Frequency 4[1]	A454	Shear Pin1 Level	A486	Break Frequency	A533	Encoder Pos Tol[1]	A564
Preset Freq 14[1]	A424	Skip Freq Band 4[1]	A455	Shear Pin 1 Time	A487	Maximum Voltage	A534	Pos Reg Filter[1]	A565
Preset Freq 15[1]	A425	PID 1 Trim Hi	A456	Shear Pin2 Level[1]	A488	Motor Fdbk Type[1]	A535	Pos Reg Gain[1]	A566
Keypad Freq	A426	PID 1 Trim Lo	A457	Shear Pin 2 Time[1]	A489	Encoder PPR[1]	A536	Max Traverse	A567
MOP Freq	A427	PID 1 Trim Sel	A458	Load Loss Level[1]	A490	Pulse In Scale	A537	Traverse Inc	A568
MOP Reset Sel	A428	PID 1 Ref Sel	A459	Load Loss Time[1]	A491	Ki Speed Loop[1]	A538	Traverse Dec	A569
MOP Preload	A429	PID 1 Fdback Sel	A460	Stall Fault Time	A492	Kp Speed Loop[1]	A539	P Jump	A570
MOP Time	A430	PID 1 Prop Gain	A461	Motor OL Select	A493	Var PWM Disable	A540	Sync Time	A571
Jog Frequency	A431	PID 1 Integ Time	A462	Motor OL Ret	A494	Auto Rstrt Tries	A541	Speed Ratio	A572
Jog Accel/Decel	A432	PID 1 Diff Rate	A463	Drive OL Mode	A495	Auto Rstrt Delay	A542	Mtr Options Cfg	A573
Purge Frequency	A433	PID 1 Setpoint	A464	IR Voltage Drop	A496	Start At PowerUp	A543		
DC Brake Time	A434	PID 1 Deadband	A465	Flux Current Ref	A497	Reverse Disable	A544		
DC Brake Level	A435	PID 1 Preload	A466	Motor Rr[1]	A498	Flying Start En	A545		
DC Brk Time@Strt	A436	PID 1 Invert Err	A467	Motor Lm[1]	A499	FlyStrt CurLimit	A546		

Network



This group contains parameters for the network option card that is installed.
See the network option card's user manual for more information on the available parameters.

Modified



This group contains parameters that have their values changed from the factory default.
When a parameter has its default value changed, it is automatically added to this group. When a parameter has its value changed back to the factory default, it is automatically removed from this group.

(1) Parameter is specific to PowerFlex 525 drives only.

Fault and Diagnostic		Fault 5 Time-min	F625	Fault10 Current[1]	F650	EN Rate Act[1]	F685	Drv 1 Reference	F710
		Fault 6 Time-min[1]	F626	Fault 1 BusVolts	F651	DSI I/O Act	F686	Drv 1 Logic Sts	F711
		Fault 7 Time-min[1]	F627	Fault 2 BusVolts	F652	HW Addr 1[1]	F687	Drv 1 Feedback	F712
		Fault 8 Time-min[1]	F628	Fault 3 BusVolts	F653	HW Addr 2[1]	F688	Drv 2 Logic Cmd	F713
Fault 4 Code	F604	Fault 9 Time-min[1]	F629	Fault 4 BusVolts	F654	HW Addr 3[1]	F689	Drv 2 Reference	F714
Fault 5 Code	F605	Fault10 Time-min[1]	F630	Fault 5 BusVolts	F655	HW Addr 4[1]	F690	Drv 2 Logic Sts	F715
Fault 6 Code	F606	Fault 1 Freq	F631	Fault 6 BusVolts[1]	F656	HW Addr 5[1]	F691	Drv 2 Feedback	F716
Fault 7 Code	F607	Fault 2 Freq	F632	Fault 7 BusVolts[1]	F657	HW Addr 6[1]	F692	Drv 3 Logic Cmd	F717
Fault 8 Code	F608	Fault 3 Freq	F633	Fault 8 BusVolts[1]	F658	EN IP Addr Act 1[1]	F693	Drv 3 Reference	F718
Fault 9 Code	F609	Fault 4 Freq	F634	Fault 9 BusVolts[1]	F659	EN IP Addr Act 2[1]	F694	Drv 3 Logic Sts	F719
Fault10 Code	F610	Fault 5 Freq	F635	Fault10 BusVolts[1]	F660	EN IP Addr Act 3[1]	F695	Drv 3 Feedback	F720
Fault 1 Time-hr	F611	Fault 6 Freq[1]	F636	Status @ Fault 1	F661	EN IP Addr Act 4[1]	F696	Drv 4 Logic Cmd	F721
Fault 2 Time-hr	F612	Fault 7 Freq[1]	F637	Status @ Fault 2	F662	EN Subnet Act 1[1]	F697	Drv 4 Reference	F722
Fault 3 Time-hr	F613	Fault 8 Freq[1]	F638	Status @ Fault 3	F663	EN Subnet Act 2[1]	F698	Drv 4 Logic Sts	F723
Fault 4 Time-hr	F614	Fault 9 Freq[1]	F639	Status @ Fault 4	F664	EN Subnet Act 3[1]	F699	Drv 4 Feedback	F724
Fault 5 Time-hr	F615	Fault10 Freq[1]	F640	Status @ Fault 5	F665	EN Subnet Act 4[1]	F700	EN Rx Overruns[1]	F725
Fault 6 Time-hr[1]	F616	Fault 1 Current	F641	Status @ Fault 6[1]	F666	EN Gateway Act 1[1]	F701	EN Rx Packets[1]	F726
Fault 7 Time-hr[1]	F617	Fault 2 Current	F642	Status @ Fault 7[1]	F667	EN Gateway Act 2[1]	F702	EN Rx Errors[1]	F727
Fault 8 Time-hr[1]	F618	Fault 3 Current	F643	Status @ Fault 8[1]	F668	EN Gateway Act 3[1]	F703	EN Tx Packets[1]	F728
Fault 9 Time-hr[1]	F619	Fault 4 Current	F644	Status @ Fault 9[1]	F669	EN Gateway Act 4[1]	F704	EN Tx Errors[1]	F729
Fault10 Time-hr[1]	F620	Fault 5 Current	F645	Status @ Fault10[1]	F670	Drv 0 Logic Cmd	F705	EN Missed IO Pkt[1]	F730
Fault 1 Time-min	F621	Fault 6 Current[1]	F646	Comm Sts - DSI	F681	Drv 0 Reference	F706	DSI Errors	F731
Fault 2 Time-min	F622	Fault 7 Current[1]	F647	Comm Sts - Opt	F682	Drv 0 Logic Sts	F707		
Fault 3 Time-min	F623	Fault 8 Current[1]	F648	Com Sts-Emb Enet[1]	F683	Drv 0 Feedback	F708		
Fault 4 Time-min	F624	Fault 9 Current[1]	F649	EN Addr Src[1]	F684	Drv 1 Logic Cmd	F709		

(1) Parameter is specific to PowerFlex 525 drives only.

AppView Parameter Groups

PowerFlex 520-series drives include various AppView™ parameter groups that groups certain parameters together for quick and easy access based on different types of applications. See AppView Parameter Groups on page 137 for more information.

Conveyor		Motor NP Volts	P031	Decel Time 1	P042	DigIn TermBlk 03	t063	Anlg In mA Loss	t097
		Motor NP Hertz	P032	Minimum Freq	P043	Opto Out1 Sel	t069	Slip Hz Meter	d375
		Motor OL Current	P033	Maximum Freq	P044	Relay Out1 Sel	t076	Preset Freq 0	A410
		Motor NP FLA	P034	Stop Mode	P045	Anlg In 0-10V Lo	t091	Jog Frequency	A431
Language	P030	Motor NP Poles	P035	Start Source 1	P046	Anlg In 0-10V Hi	t092	Jog Accel/Decel	A432
Output Freq	b001	Autotune	P040	Speed Reference1	P047	Anlg In4-20mA Lo	t095	S Curve %	A439
Commanded Freq	b002	Accel Time 1	P041	DigIn TermBlk 02	t062	Anlg In4-20mA Hi	t096	Reverse Disable	A544
Mixer		Commanded Freq	b002	Motor NP Poles	P035	Stop Mode	P045	Anlg In4-20mA Lo	t095
		Output Current	b003	Autotune	P040	Start Source 1	P046	Anlg In4-20mA Hi	t096
		Motor NP Volts	P031	Accel Time 1	P041	Speed Reference1	P047	Anlg In mA Loss	t097
		Motor NP Hertz	P032	Decel Time 1	P042	Relay Out1 Sel	t076	Preset Freq 0	A410
Language	P030	Motor OL Current	P033	Minimum Freq	P043	Anlg In 0-10V Lo	t091	Stall Fault Time	A492
Output Freq	b001	Motor NP FLA	P034	Maximum Freq	P044	Anlg In 0-10V Hi	t092		
Compressor		Motor NP Hertz	P032	Maximum Freq	P044	Anlg In 0-10V Lo	t091	Start At PowerUp	A543
		Motor OL Current	P033	Stop Mode	P045	Anlg In 0-10V Hi	t092	Reverse Disable	A544
		Motor NP FLA	P034	Start Source 1	P046	Anlg In4-20mA Lo	t095	Power Loss Mode	A548
		Motor NP Poles	P035	Speed Reference1	P047	Anlg In4-20mA Hi	t096	Half Bus Enable	A549
Language	P030	Autotune	P040	Relay Out1 Sel	t076	Anlg In mA Loss	t097		
Output Freq	b001	Accel Time 1	P041	Analog Out Sel	t088	Preset Freq 0	A410		
Commanded Freq	b002	Decel Time 1	P042	Analog Out High	t089	Auto Rstrt Tries	A541		
Motor NP Volts	P031	Minimum Freq	P043	Anlg Out Setpt	t090	Auto Rstrt Delay	A542		

Centrifugal Pump		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	PID 1 Diff Rate	A463
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	PID 1 Setpoint	A464
		Motor NP Poles	P035	Relay Out1 Sel	t076	Preset Freq 0	A410	PID 1 Deadband	A465
		Autotune	P040	Analog Out Sel	t088	PID 1 Trim Hi	A456	PID 1 Preload	A466
Language	P030	Accel Time 1	P041	Analog Out High	t089	PID 1 Trim Lo	A457	Auto Rstrt Tries	A541
Output Freq	b001	Decel Time 1	P042	Anlg Out Setpt	t090	PID 1 Ref Sel	A459	Auto Rstrt Delay	A542
Commanded Freq	b002	Minimum Freq	P043	Anlg In 0-10V Lo	t091	PID 1 Fdback Sel	A460	Start At PowerUp	A543
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	PID 1 Prop Gain	A461	Reverse Disable	A544
Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	PID 1 Integ Time	A462		
Blower/Fan		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	PID 1 Diff Rate	A463
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	PID 1 Setpoint	A464
		Motor NP Poles	P035	Relay Out1 Sel	t076	Preset Freq 0	A410	PID 1 Deadband	A465
		Autotune	P040	Analog Out Sel	t088	PID 1 Trim Hi	A456	PID 1 Preload	A466
Language	P030	Accel Time 1	P041	Analog Out High	t089	PID 1 Trim Lo	A457	Auto Rstrt Tries	A541
Output Freq	b001	Decel Time 1	P042	Anlg Out Setpt	t090	PID 1 Ref Sel	A459	Auto Rstrt Delay	A542
Commanded Freq	b002	Minimum Freq	P043	Anlg In 0-10V Lo	t091	PID 1 Fdback Sel	A460	Start At PowerUp	A543
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	PID 1 Prop Gain	A461	Reverse Disable	A544
Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	PID 1 Integ Time	A462	Flying Start En	A545
Extruder		Motor NP Hertz	P032	Stop Mode	P045	Anlg In4-20mA Lo	t095	Encoder PPR	A536
		Motor OL Current	P033	Start Source 1	P046	Anlg In4-20mA Hi	t096	Pulse In Scale	A537
		Motor NP FLA	P034	Speed Reference1	P047	Anlg In mA Loss	t097	Ki Speed Loop	A538
		Motor NP Poles	P035	Relay Out1 Sel	t076	Slip Hz Meter	d375	Kp Speed Loop	A539
Language	P030	Autotune	P040	Analog Out Sel	t088	Speed Feedback	d376	Power Loss Mode	A548
Output Freq	b001	Accel Time 1	P041	Analog Out High	t089	Encoder Speed	d378	Half Bus Enable	A549
Commanded Freq	b002	Decel Time 1	P042	Anlg Out Setpt	t090	Preset Freq 0	A410		
Output Current	b003	Minimum Freq	P043	Anlg In 0-10V Lo	t091	Stall Fault Time	A492		
Motor NP Volts	P031	Maximum Freq	P044	Anlg In 0-10V Hi	t092	Motor Fdbk Type	A535		
Positioning[1]		Stop Mode	P045	Stp Logic 5	L185	Step Units 6	L212	Jog Accel/Decel	A432
		Start Source 1	P046	Stp Logic 6	L186	Step Units 7	L214	DB Threshold	A438
		Speed Reference1	P047	Stp Logic 7	L187	Slip Hz Meter	d375	S Curve %	A439
		DigIn TermBlk 02	t062	Stp Logic Time 0	L190	Speed Feedback	d376	Motor Fdbk Type	A535
Language	P030	DigIn TermBlk 03	t063	Stp Logic Time 1	L191	Encoder Speed	d378	Encoder PPR	A536
Output Freq	b001	DigIn TermBlk 05	t065	Stp Logic Time 2	L192	Units Traveled H	d388	Pulse In Scale	A537
Commanded Freq	b002	DigIn TermBlk 06	t066	Stp Logic Time 3	L193	Units Traveled L	d389	Ki Speed Loop	A538
Motor NP Volts	P031	Opto Out1 Sel	t069	Stp Logic Time 4	L194	Preset Freq 0	A410	Kp Speed Loop	A539
Motor NP Hertz	P032	Opto Out2 Sel	t072	Stp Logic Time 5	L195	Preset Freq 1	A411	Bus Reg Enable	A550
Motor OL Current	P033	Relay Out1 Sel	t076	Stp Logic Time 6	L196	Preset Freq 2	A412	Positioning Mode	A558
Motor NP FLA	P034	EM Brk Off Delay	t086	Stp Logic Time 7	L197	Preset Freq 3	A413	Counts Per Unit	A559
Motor NP Poles	P035	EM Brk On Delay	t087	Step Units 0	L200	Preset Freq 4	A414	Enh Control Word	A560
Autotune	P040	Stp Logic 0	L180	Step Units 1	L202	Preset Freq 5	A415	Find Home Freq	A562
Accel Time 1	P041	Stp Logic 1	L181	Step Units 2	L204	Preset Freq 6	A416	Find Home Dir	A563
Decel Time 1	P042	Stp Logic 2	L182	Step Units 3	L206	Preset Freq 7	A417	Encoder Pos Tol	A564
Minimum Freq	P043	Stp Logic 3	L183	Step Units 4	L208	Preset Freq 8	A418	Pos Reg Filter	A565
Maximum Freq	P044	Stp Logic 4	L184	Step Units 5	L210	Jog Frequency	A431	Pos Reg Gain	A566
Textile/Fiber		Motor NP FLA	P034	DigIn TermBlk 02	t062	Slip Hz Meter	d375	Max Traverse	A567
		Motor NP Poles	P035	DigIn TermBlk 03	t063	Fiber Status	d390	Traverse Inc	A568
		Autotune	P040	Opto Out1 Sel	t069	Preset Freq 0	A410	Traverse Dec	A569
		Accel Time 1	P041	Opto Out2 Sel	t072	Jog Frequency	A431	P Jump	A570
Language	P030	Decel Time 1	P042	Relay Out1 Sel	t076	Jog Accel/Decel	A432	Sync Time	A571
Output Freq	b001	Minimum Freq	P043	Anlg In 0-10V Lo	t091	S Curve %	A439	Speed Ratio	A572
Commanded Freq	b002	Maximum Freq	P044	Anlg In 0-10V Hi	t092	Reverse Disable	A544		
Motor NP Volts	P031	Stop Mode	P045	Anlg In4-20mA Lo	t095	Power Loss Mode	A548		
Motor NP Hertz	P032	Start Source 1	P046	Anlg In4-20mA Hi	t096	Half Bus Enable	A549		
Motor OL Current	P033	Speed Reference1	P047	Anlg In mA Loss	t097	Bus Reg Enable	A550		

(1) This AppView parameter group is specific to PowerFlex 525 drives only.

CustomView Parameter Group

PowerFlex 520-series drives include a CustomView™ parameter group for you to store frequently used parameters for your application. See CustomView Parameter Group on page 138 for more information.

Custom Group	
	This group can store up to 100 parameters.

Basic Display Group

b001 [Output Freq] Related Parameter(s): b002, b010, P043, P044, P048, P050, P052

Output frequency present at T1, T2 & T3 (U, V & W). Does not include slip frequency.

Values	Default:	Read Only
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

b002 [Commanded Freq] Related Parameter(s): b001, b013, P043, P044, P048, P050, P052

Value of the active frequency command even if the drive is not running.

IMPORTANT The frequency command can come from a number of sources. See Start and Speed Reference Control on page 46 for more information.

Values	Default:	Read Only
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

b003 [Output Current]

Output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

b004 [Output Voltage] Related Parameter(s): P031, A530, A534

Output voltage present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/Drive Rated Volts
	Display:	0.1V

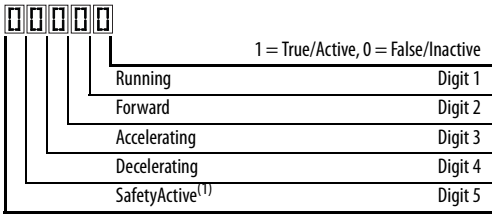
b005 [DC Bus Voltage]

Filtered DC bus voltage level of the drive.

Values	Default:	Read Only
	Min/Max:	0/1200VDC
	Display:	1VDC

b006 [Drive Status] Related Parameter(s): A544

Present operating condition of the drive.



(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	00000/11111
	Display:	00000

Basic Display Group *(continued)*

b007 [Fault 1 Code]
b008 [Fault 2 Code]
b009 [Fault 3 Code]

Related Parameter(s): F604-F610

A code that represents a drive fault. Codes appear in these parameters in the order they occur (b007 [Fault 1 Code] = the most recent fault). Repetitive faults are only recorded once. See Fault and Diagnostic Group for more information.

Values	Default:	Read Only
	Min/Max:	F0/F127
	Display:	F0

b010 [Process Display]

Related Parameter(s): b001, A481, A482

32 32 bit parameter.

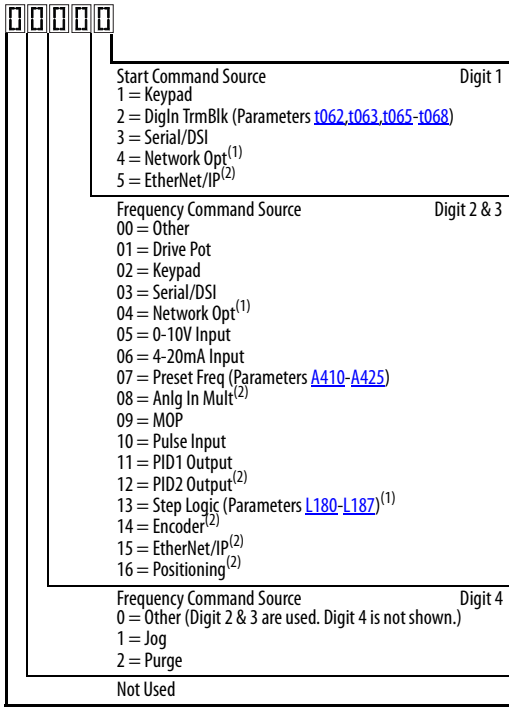
Output frequency scaled by [Process Disp Hi] and [Process Disp Lo].

Values	Default:	Read Only
	Min/Max:	0/9999
	Display:	1

b012 [Control Source]

Related Parameter(s): P046, P047, P048, P049, P050, P051, t062, t063, t065-t068, L180-L187, A410-A425

Active source of the Start Command and Frequency Command. Normally defined by the settings of P046, P048, P050 [Start Source x] and P047, P049, P051 [Speed Referencex]. See Start and Speed Reference Control on page 46 for more information.



Example

Display reads...	Description
2004	Start source comes from Network Opt and Frequency source is Purge.
113	Start source comes from Serial/DSI and Frequency source comes from PID1 Output.
155	Start source and Frequency source comes from EtherNet/IP.
052	Start source comes from DigIn TrmBlk and Frequency source from 0-10V Input.
011	Start source comes from Keypad and Frequency source comes from Drive Pot.

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the Start source and/or Frequency source.
(2) Setting is specific to PowerFlex 525 drives only.

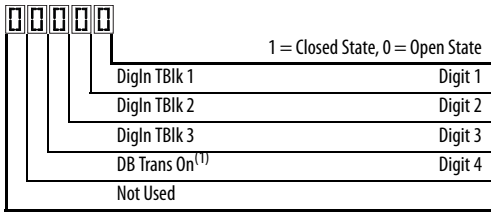
Values	Default:	Read Only
	Min/Max:	0000/2165
	Display:	0000

Basic Display Group *(continued)*

b013 [Contrl In Status] Related Parameter(s): b002, P044, P045

State of the digital terminal blocks 1...3 and DB transistor.

IMPORTANT Actual control commands may come from a source other than the control terminal block.

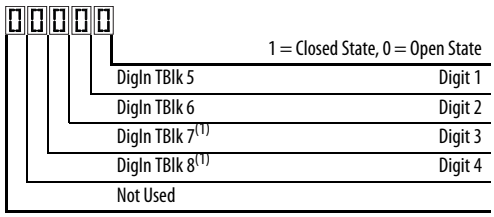


(1) The DB Transistor "on" indication must have a 0.5 s hysteresis. It will turn on and stay on for at least 0.5 s every time the DB transistor is turned on.

Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

b014 [Dig In Status] Related Parameter(s): t065-t068

State of the programmable digital inputs.



(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

b015 [Output RPM] Related Parameter(s): P035

Current output frequency in rpm. Scale is based on P035 [Motor NP Poles].

Values	Default:	Read Only
	Min/Max:	0/24000 rpm
	Display:	1 rpm

b016 [Output Speed] Related Parameter(s): P044

Current output frequency in %. Scale is 0% at 0.00 Hz to 100% at P044 [Maximum Freq].

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

b017 [Output Power] Related Parameter(s): b018

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power x 2)
	Display:	0.01 kW

Basic Display Group *(continued)*

b018 [Power Saved] Related Parameter(s): b017

Instantaneous power savings of using this drive compared to an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.00/655.35 kW
	Display:	0.01 kW

b019 [Elapsed Run time] Related Parameter(s): A555

Accumulated time drive is outputting power. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/65535 x 10 hr
	Display:	1 = 10 hr

b020 [Average Power] Related Parameter(s): A555

Average power used by the motor since the last reset of the meters.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power x 2)
	Display:	0.01 kW

b021 [Elapsed kWh] Related Parameter(s): b022

Accumulated output energy of the drive. When the maximum value of this parameter is reached, it resets to zero and b022 [Elapsed MWh] is incremented.

Values	Default:	Read Only
	Min/Max:	0.0/100.0 kWh
	Display:	0.1 kWh

b022 [Elapsed MWh] Related Parameter(s): b021

Accumulated output energy of the drive.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 MWh
	Display:	0.1 MWh

b023 [Energy Saved] Related Parameter(s): A555

Total energy savings of using this drive compared to an across the line starter since the last reset of the meters.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kWh
	Display:	0.1 kWh

b024 [Accum kWh Sav] Related Parameter(s): b025

Total approximate accumulated energy savings of the drive compared to using an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kWh
	Display:	0.1 = 10 kWh

Basic Display Group *(continued)*

b025 [Accum Cost Sav] Related Parameter(s): b024, P052, A555

Total approximate accumulated cost savings of the drive compared to using an across the line starter.
[Accum Cost Sav] = [Average kWh cost] x [Accum kWh Sav]

Values	Default:	Read Only
	Min/Max:	0.0/6553.5
	Display:	0.1

b026 [Accum CO2 Sav] Related Parameter(s): A555

Total approximate accumulated CO2 savings of the drive compared to using an across the line starter.

Values	Default:	Read Only
	Min/Max:	0.0/6553.5 kg
	Display:	0.1 kg

b027 [Drive Temp]

Present operating temperature of the drive heatsink (inside module).

Values	Default:	Read Only
	Min/Max:	0/120 °C
	Display:	1 °C

b028 [Control Temp]

Present operating temperature of the drive control.

Values	Default:	Read Only
	Min/Max:	0/120 °C
	Display:	1 °C

b029 [Control SW Ver]

Current drive firmware version.

Values	Default:	Read Only
	Min/Max:	0.000/65.535
	Display:	0.001

Basic Program Group

P030 [Language]

Selects the language displayed. A reset or power cycle is required after selection is made.

			Language Support		
			Keypad/ LCD Display	RSLogix 5000/ Logix Designer	Connected Components Workbench
Options	1 English (Default)		Y	Y	Y
	2 Français		Y	Y	Y
	3 Español		Y	Y	Y
	4 Italiano		Y	Y	Y
	5 Deutsch		Y	Y	Y
	6 Japanese		–	Y	–
	7 Português		Y	Y	–
	8 Chinese	Chinese Simplified	–	Y	Y
	9 Reserved				
	10 Reserved				
	11 Korean		–	Y	–
	12 Polish(1)		Y	–	–
	13 Reserved				
	14 Turkish(1)		Y	–	–
	15 Czech(1)		Y	–	–

(1) Due to a limitation of the LCD Display, some of the characters for Polish, Turkish, and Czech will be modified.

P031 [Motor NP Volts] Related Parameter(s): b004, A530, A531, A532, A533

Stop drive before changing this parameter.

Sets the motor nameplate rated volts.

Values	Default:	Drive Rated Volts
	Min/Max:	10V (for 230V Drives), 20V (for 460V Drives), 25V (for 600V Drives)/Drive Rated Volts
	Display:	1V

P032 [Motor NP Hertz] Related Parameter(s): A493, A530, A531, A532, A533

Stop drive before changing this parameter.

Sets the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/500 Hz
	Display:	1 Hz

P033 [Motor OL Current] Related Parameter(s): t069, t072, t076, t081, A484, A485, A493

Sets the motor nameplate overload current. Used to determine motor overload conditions and can be set from 0.1 A to 200% of drive rated current.

IMPORTANT The drive will fault on an F007 "Motor Overload" if the value of this parameter is exceeded by 150% for 60 s.

Values	Default:	Drive Rated Amps
	Min/Max:	0.0/(Drive Rated Amps x 2)
	Display:	0.1 A

Basic Program Group *(continued)*

P034 [Motor NP FLA] Related Parameter(s): P040

Sets the motor nameplate FLA. Used to assist the Autotune routine and motor control.

Values	Default:	Based on Drive Rating
	Min/Max:	0.1/(Drive Rated Amps x 2)
	Display:	0.1 A

P035 [Motor NP Poles] Related Parameter(s): b015

Sets the number of poles in the motor.

Values	Default:	4
	Min/Max:	2/40
	Display:	1

P036 [Motor NP RPM]

Stop drive before changing this parameter.

Sets the rated nameplate rpm of the motor. Used to calculate the rated slip of the motor. To reduce the slip frequency, set this parameter closer to the motor synchronous speed.

Values	Default:	1750 rpm
	Min/Max:	0/24000 rpm
	Display:	1 rpm

P037 [Motor NP Power]

PF 525 PowerFlex 525 only.

Sets the motor nameplate power. Used in PM regulator.

Values	Default:	Drive Rated Power
	Min/Max:	0.00/Drive Rated Power
	Display:	0.01 kW

P038 [Voltage Class]

Stop drive before changing this parameter.

Sets the voltage class of 600V drives. Only applicable to 600V drives.

Options	2	"480V"
	3	"600V" (Default)

P039 [Torque Perf Mode] Related Parameter(s): P040, A530, A531, A532, A533

Stop drive before changing this parameter.

Selects the motor control mode.

Options	0	"V/Hz"
	1	"SVC" (Default)
	2	"Economize"
	3	"Vector"(1)

(1) Setting is specific to PowerFlex 525 drives only.

Basic Program Group *(continued)*

P040 [Autotune] Related Parameter(s): P034, P039, A496, A497

Stop drive before changing this parameter.

Enables a static (not spinning) or dynamic (motor spinning) autotune to automatically set the motor parameters. Start must be pressed to begin the routine. After the routine is complete the parameter resets to a zero. A failure (such as if a motor is not connected) results in an Autotune Fault.

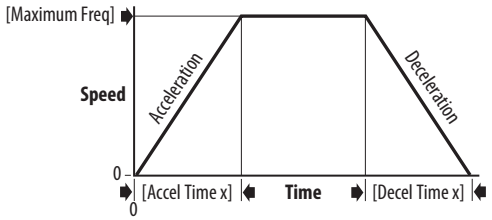
IMPORTANT All motor parameters in the Basic Program group must be set before running the routine. If a start command is not given (or a stop command is given) within 30 s, the parameter automatically returns to a zero and an Autotune Fault occurs.

ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, it is recommended that the motor be disconnected from the load before proceeding.

Options	0 "Ready/Idle" (Default)	
	1 "Static Tune"	Static Autotune runs at next start command.
	2 "Rotate Tune"	Static + Dynamic Autotune runs at next start command. Use Rotate Tune for best performance.

P041 [Accel Time 1] Related Parameter(s): P044, A439

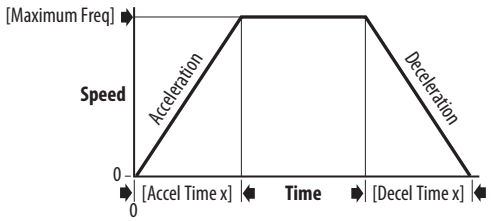
Sets the time for the drive to accelerate from 0 Hz to P044 [Maximum Freq].
Accel Rate = [Maximum Freq] / [Accel Time x]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

P042 [Decel Time 1] Related Parameter(s): P044, A439

Sets the time for the drive to decelerate from P044 [Maximum Freq] to 0 Hz.
Decel Rate = [Maximum Freq] / Decel Time x]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

P043 [Minimum Freq] Related Parameter(s): b001, b002, b013, P044, A530, A531

Stop drive before changing this parameter.

Sets the lowest frequency the drive outputs.

Values	Default:	0.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

Basic Program Group *(continued)*

P044 [Maximum Freq] Related Parameter(s): b001, b002, b013, b016, P043, A530, A531

Stop drive before changing this parameter.

Sets the highest frequency the drive outputs.

IMPORTANT This value must be greater than the value set in P043 [Minimum Freq].

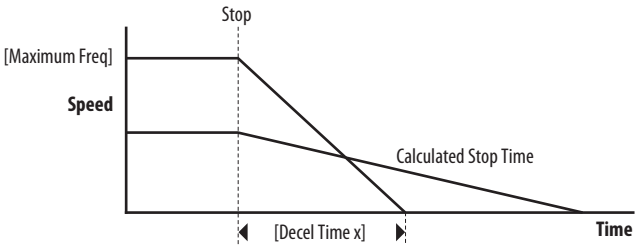
Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

P045 [Stop Mode] Related Parameter(s): t086, t087, A434, A435

Determines the stopping mode used by the drive when a stop is initiated.

Options	0	"Ramp, CF" (Default)	Ramp to Stop. Stop command clears active fault.
	1	"Coast, CF"	Coast to Stop. Stop command clears active fault.
	2	"DC Brake, CF"	DC Injection Braking Stop. Stop command clears active fault.
	3	"DC BrkAuto,CF"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A434 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped. Stop command clears active fault.
	4	"Ramp"	Ramp to Stop.
	5	"Coast"	Coast to Stop.
	6	"DC Brake"	DC Injection Braking Stop.
	7	"DC BrakeAuto"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A434 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped.
	8	"Ramp+EM B,CF"	Ramp to Stop with EM Brake Control. Stop command clears active fault.
	9	"Ramp+EM Brk"	Ramp to Stop with EM Brake Control.
	10	"PointStp,CF"	PointStop. Stop command clears active fault.
	11	"PointStop"	PointStop.

Provides a method to stop at a constant distance instead of a fixed rate.



P046 [Start Source 1]
P048 [Start Source 2]
P050 [Start Source 3]

Related Parameter(s): b012, C125

Stop drive before changing this parameter.

Configures the start source of the drive. Changes to these inputs take effect as soon as they are entered. P046 [Start Source 1] is the factory default start source unless overridden. See Start and Speed Reference Control on page 46 for more information.

Options	1	"Keypad"	[Start Source 1] default
	2	"DigIn TrmBlk"	[Start Source 2] default
	3	"Serial/DSI"	[Start Source 3] default for PowerFlex 523
	4	"Network Opt"(1)	
	5	"EtherNet/IP"(2)	[Start Source 3] default for PowerFlex 525

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the start source.
(2) Setting is specific to PowerFlex 525 drives only.

Basic Program Group *(continued)*

P047 [Speed Reference1]
P049 [Speed Reference2]
P051 [Speed Reference3]

Related Parameter(s): C125

Selects the source of speed command for the drive. Changes to these inputs take effect as soon as they are entered. P047 [Speed Reference1] is the factory default speed reference unless overridden.

See Start and Speed Reference Control on page 46 for more information.

Options	1	"Drive Pot"	[Speed Reference1] default
	2	"Keypad Freq"	
	3	"Serial/DSI"	[Speed Reference3] default for PowerFlex 523
	4	"Network Opt"(1)	
	5	"0-10V Input"	[Speed Reference2] default
	6	"4-20mA Input"	
	7	"Preset Freq"	
	8	"Anlg In Mult"(2)	
	9	"MOP"	
	10	"Pulse Input"	
	11	"PID1 Output"	
	12	"PID2 Output"(2)	
	13	"Step Logic"(2)	
	14	"Encoder"(2)	
	15	"EtherNet/IP"(2)	[Speed Reference3] default for PowerFlex 525
	16	"Positioning"(2)	Referencing from A558 [Positioning Mode]

(1) Select this setting if using the optional PowerFlex 25-COMM-E2P, 25-COMM-D, or 25-COMM-P adapters as the speed reference.
(2) Setting is specific to PowerFlex 525 drives only.

P052 [Average kWh Cost]

Related Parameter(s): b025

Sets the average cost per kWh.

Values	Default:	0.00
	Min/Max:	0.00/655.35
	Display:	0.01

Basic Program Group *(continued)*

P053 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameters to their factory default values. After a Reset command, the value of this parameter returns to zero.

Parameters that are NOT Reset when P053 = 1

Parameter	Parameter	Parameter
P030 [Language]	C138 [EN Gateway Cfg 2]	C159 [EN Data Out 3]
C121 [Comm Write Mode]	C139 [EN Gateway Cfg 3]	C160 [EN Data Out 4]
C122 [Cmd Stat Select]	C140 [EN Gateway Cfg 4]	C161 [Opt Data In 1]
C1238 [RS485 Data Rate]	C141 [EN Rate Cfg]	C162 [Opt Data In 2]
C124 [RS485 Node Addr]	C143 [EN Comm Flt Actn]	C163 [Opt Data In 3]
C124 [Comm Loss Action]	C144 [EN Idle Flt Actn]	C164 [Opt Data In 4]
C126 [Comm Loss Time]	C145 [EN Flt Cfg Logic]	C165 [Opt Data Out 1]
C127 [RS485 Format]	C146 [EN Flt Cfg Ref]	C166 [Opt Data Out 2]
C128 [EN Addr Sel]	C147 [EN Flt Cfg DL 1]	C167 [Opt Data Out 3]
C129 [EN IP Addr Cfg 1]	C148 [EN Flt Cfg DL 2]	C168 [Opt Data Out 4]
C130 [EN IP Addr Cfg 2]	C149 [EN Flt Cfg DL 3]	C169 [MultiDrv Sel]
C131 [EN IP Addr Cfg 3]	C150 [EN Flt Cfg DL 4]	C171 [Drv 1 Addr]
C132 [EN IP Addr Cfg 4]	C153 [EN Data In 1]	C172 [Drv 2 Addr]
C133 [EN Subnet Cfg 1]	C154 [EN Data In 2]	C173 [Drv 3 Addr]
C134 [EN Subnet Cfg 2]	C155 [EN Data In 3]	C174 [Drv 4 Addr]
C135 [EN Subnet Cfg 3]	C156 [EN Data In 4]	C175 [DSI I/O Cfg]
C136 [EN Subnet Cfg 4]	C157 [EN Data Out 1]	GC [Parameters in Custom Group]
C137 [EN Gateway Cfg 1]	C158 [EN Data Out 2]	

Parameters that are Reset when P053 = 3

Parameter Name
P031 [Motor NP Volts]
P033 [Motor OL] Current
P034 [Motor NP FLA]
P035 [Motor NP Poles]
P038 [Voltage Class]
A435 [DC Brake Level]
A484 [Current Limit 1]
A485 [Current Limit 2]
A486 [Shear Pin1 Level]
A488 [Shear Pin2 Level]
A490 [Load Loss Level]
A496 [IR Voltage Drop]
A497 [Flux Current Ref]
A530 [Boost Select]
A531 [Start Boost]
A532 [Break Voltage]
A533 [Break Frequency]
A534 [Maximum] Voltage

Options		
0	"Ready/Idle" (Default)	
1	"Param Reset"	Does not reset custom groups, parameter P030 [Language], and communication parameters.
2	"Factory Rset"	Restore drive to factory condition.
3	"Power Reset"	Resets only power parameters. Can be used when swapping power modules.

Terminal Block Group

t062	**[DigIn TermBlk 02]**	**t063**	**[DigIn TermBlk 03]**
t065	**[DigIn TermBlk 05]**	**t066**	**[DigIn TermBlk 06]**
t067	**[DigIn TermBlk 07]**	**t068**	**[DigIn TermBlk 08]**

PF 525 PowerFlex 525 only.

Related Parameter(s): b012, b013, b014, P045, P046, P048, P049, P050, P051, t064, t086, A410-A425, A427, A431, A432, A433, A434, A435, A442, A443, A488, A535, A560, A562, A563, A567, A571

Stop drive before changing this parameter.

Programmable digital input. Changes to these inputs takes effect as soon as they are entered. If a digital input is set for a selection that is only usable on one input, no other input can be set for the same selection.

Options	0	"Not Used"	Terminal has no function but can be read over network communications with b013 [Contrl In Status] and b014 [Dig In Status].
	1	"Speed Ref 2"	Selects P049 [Speed Reference2] as drive's speed command.
	2	"Speed Ref 3"	Selects P051 [Speed Reference3] as drive's speed command.
	3	"Start Src 2"	Selects P048 [Start Source 2] as control source to start the drive.
	4	"Start Src 3"	Selects P050 [Start Source 3] as control source to start the drive.
	5	"Spd + Strt 2"	[DigIn TermBlk 07] default. Selects combination of P049 [Speed Reference2] and P048 [Start Source 2] as speed command with control source to start the drive.
	6	"Spd + Strt 3"	Selects combination of P051 [Speed Reference3] and P050 [Start Source 3] as speed command with control source to start the drive.
	7	"Preset Freq" (PF523: only for DigIn TermBlk 03, 05, and 06) (PF525: only for DigIn TermBlk 05...08)	[DigIn TermBlk 05] and [DigIn TermBlk 06] default. • Selects a preset frequency in Velocity mode (P047, P049, P051 [Speed Referencex] = 1...15). See A410...A425 [Preset Freq x]. • Selects a preset frequency and position in Positioning mode (P047, P049, P051 [Speed Referencex] = 16). See L200...L214 [Step Units x] (only for PowerFlex 525 drives). **IMPORTANT** Digital Inputs have priority for frequency control when programmed as Preset Speed and are active. See Start Source and Speed Reference Selection on page 46 for more information.
	8	"Jog"	• When input is present, drive accelerates according to the value set in A432 [Jog Accel/Decel] and ramps to the value set in A431 [Jog Frequency]. • When input is removed, drive ramps to a stop according to the value set in A432 [Jog Accel/Decel]. • A valid Start command will override this input.
	9	"Jog Forward"	[DigIn TermBlk 08] default. Drive accelerates to A431 [Jog Frequency] according to A432 [Jog Accel/Decel] and ramps to a stop when input becomes inactive. A valid Start command will override this input.
	10	"Jog Reverse"	Drive accelerates to A431 [Jog Frequency] according to A432 [Jog Accel/Decel] and ramps to a stop when input becomes inactive. A valid Start command will override this input.
	11	"Acc/Dec Sel2"(1)	If active, determines which Accel/Decel time will be used for all ramp rates except jog. Can be used with option 29 "Acc/Dec Sel3" for additional Accel/Decel times. See A442 [Accel Time 2] for more information.
	12	"Aux Fault"	When enabled, an F002 "Auxiliary Input" fault will occur when the input is removed.
	13	"Clear Fault"	When active, clears an active fault.
	14	"RampStop,CF"	Causes drive to immediately ramp to a stop regardless of how P045 [Stop Mode] is set.
	15	"CoastStop,CF"	Causes drive to immediately coast to a stop regardless of how P045 [Stop Mode] is set.
	16	"DCInjStop,CF"	Causes drive to immediately begin a DC Injection stop regardless of how P045 [Stop Mode] is set.
	17	"MOP Up"	Increases the value of A427 [MOP Freq] at the rate set in A430 [MOP Time].
	18	"MOP Down"	Decreases the value of A427 [MOP Freq] at the rate set in A430 [MOP Time].
	19	"Timer Start"(1)	Clears and starts the timer function. May be used to control the relay or opto outputs.
	20	"Counter In"(1)	Starts the counter function. May be used to control the relay or opto outputs.
	21	"Reset Timer"	Clears the active timer.
	22	"Reset Countr"	Clears the active counter.
	23	"Rset Tim&Cnt"	Clear the active timer and counter.
	24	"Logic In 1"(1)(2)	Logic function input number 1. May be used to control the relay or opto outputs (t076, t081 [Relay Outx Sel] and t069, t072 [Opto Outx Sel], options 11...14). May be used in conjunction with StepLogic parameters L180...L187 [Stp Logic x].
	25	"Logic In 2"(1)(2)	Logic function input number 2. May be used to control the relay or opto outputs (t076, t081 [Relay Outx Sel] and t069, t072 [Opto Outx Sel], options 11...14). May be used in conjunction with StepLogic parameters L180...L187 [Stp Logic x].

Options

26	"Current Lmt2"[2]	When active, A485 [Current Limit 2] determines the drive current limit level.
27	"Anlg Invert"	Inverts the scaling of the analog input levels set in t091 [Anlg In 0-10V Lo] and t092 [Anlg In 0-10V Hi] or t095 [Anlg In4-20mA Lo] and t096 [Anlg In4-20mA Hi].
28	"EM Brk Rlse"	If EM brake function is enabled, this input releases the brake. See t086 [EM Brk Off Delay] for more information.  **ATTENTION:** If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.
29	"Acc/Dec Sel3"[1]	If active, determines which Accel/Decel time is used for all ramp rates except jog. Used with option 11 "Acc/Dec Sel2" for the Accel/Decel times listed in this table.
30	"Precharge En"	Forces drive into precharge state. Typically controlled by auxiliary contact on the disconnect at the DC input to the drive. If this input is assigned, it must be energized for the pre-charge relay to close and for the drive to run. If it is de-energized, the pre-charge relay opens and the drive coasts to a stop.
31	"Inertia Dcel"	Forces drive into Inertia Ride-Through state. The drive attempts to regulate the DC bus at the current level.
32	"Sync Enable"	Must be used in order to hold the existing frequency when Sync Time is set to enable speed synchronization. When this input is released the drive accelerates to the commanded frequency in A571 [Sync Time].
33	"Traverse Dis"	When an input is programmed the traverse function is disabled while this input is active. See A567 [Max Traverse].
34	"Home Limit"[2]	In Positioning mode, indicates the drive is at the home position. See Appendix E for more information on Positioning.
35	"Find Home"[2]	In Positioning mode, causes the drive to return to the Home position when a Start command is issued. Uses A562 [Find Home Freq] and A563 [Find Home Dir] until the "Home Limit" input is activated. If it passes this point, it then runs in the reverse direction at 1/10th the frequency of [Find Home Freq] until the "Home Limit" is activated again. As long as this input is active, any start command causes the drive to enter the homing routine. Only functions if in Positioning mode. Once the Find Home routine has finished, the drive stops. See Appendix E for more information on Positioning.
36	"Hold Step"[2]	In Positioning mode, overrides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released. While in "Hold", the drive ignores any input command which would normally result in a move to a new step. Timers continue to run. Therefore, when the Hold is removed, the drive must see any required digital inputs transition (even if they already transitioned during the hold), but it does not reset any timer. See Appendix E for more information on Positioning.
37	"Pos Redefine"[2]	In Positioning mode, resets the home position to the current position of the machine. See Appendix E for more information on Positioning.
38	"Force DC"	If the drive is not running, causes the drive to apply a DC Holding current (A435 [DC Brake Level], ignoring A434 [DC Brake Time]) while the input is applied.
39	"Damper Input"	When active, drive is allowed to run normally. When inactive, drive is forced into sleep mode and is prevented from accelerating to command speed.
40	"Purge"[1]	Starts the drive at A433 [Purge Frequency] regardless of the selected control source. Supersedes the keypad Control function as well as any other control command to take control of the drive. Purge can occur, and is operational, at any time whether the drive is running or stopped regardless of the selected logic source selection. If a valid stop (other than from comms or SW enable) is present, the drive will not start on the purge input transition.  **ATTENTION:** If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.
41	"Freeze-Fire"	When inactive, will cause an immediate F094 "Function Loss" fault. Use to safely bypass the drive with an external switching device.
42	"SW Enable"	Works like an interlock that has to be active for the drive to run.
43	"SherPin1 Dis"	Disables shear pin 1 but leaves shear pin 2 active. If A488 [Shear Pin 2 Level] is greater than 0.0 A, shear pin 2 is enabled.
44	Reserved	
45	Reserved	
46	Reserved	
47	Reserved	

Option 29	Option 11	Description
0	0	Acc/Dec 1
0	1	Acc/Dec 2
1	0	Acc/Dec 3
1	1	Acc/Dec 4

Options	48 "2-Wire FWD" (only for DigIn TermBlk 02)	[DigIn TermBlk 02] default. Select 2-Wire FWD for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 2-wire run forward mode. Also see t064 [2-Wire Mode] for level trigger settings.
	49 "3-Wire Start" (only for DigIn TermBlk 02)	Select 3-Wire Start for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 3-wire start mode.
	50 "2-Wire REV" (only for DigIn TermBlk 03)	[DigIn TermBlk 03] default. Select 2-Wire REV for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to configure [Start Source x] to a 2-wire run reverse mode. Also see t064 [2-Wire Mode] for level trigger settings. For PowerFlex 523 drives, this setting will be disabled If [DigIn TermBlk 03] is set to 7 "Preset Freq".
	51 "3-Wire Dir" (only for DigIn TermBlk 03)	Select 3-Wire Dir for this input. Select this option and set P046, P048 or P050 [Start Source x] to 2 "DigIn TrmBlk" to change the direction of [Start Source x]. For PowerFlex 523 drives, this setting will be disabled If [DigIn TermBlk 03] is set to 7 "Preset Freq".
	52 "Pulse Train" (PF523: only for DigIn TermBlk 05) (PF525: only for DigIn TermBlk 07)	Select pulse train for this input. Use P047, P049 and P051 [Speed Referencex] to select pulse input. Jumper for DigIn TermBlk 05 or 07 Sel must be moved to Pulse In.

(1) This function may be tied to one input only.
(2) Setting is specific to PowerFlex 525 drives only.

t064 [2-Wire Mode]

Related Parameter(s): P045, P046, P048, P050, t062, t063

Stop drive before changing this parameter.

Programs the mode of trigger only for t062 [DigIn TermBlk 02] and t063 [DigIn TermBlk 03] when 2-wire option is being selected as P046, P048 or P050 [Start Source x].

Options	0 "Edge Trigger" (Default)	Standard 2-Wire operation.
	1 "Level Sense"	• I/O Terminal 01 "Stop" = Coast to stop. Drive will restart after a Stop command when: – Stop is removed and – Start is held active • I/O Terminal 03 "Run REV" **ATTENTION:** Hazard of injury exists due to unintended operation. When t064 [2-Wire Mode] is set to option 1, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).
	2 "Hi-Spd Edge"	**IMPORTANT** There is greater potential voltage on the output terminals when using this option. • Outputs are kept in a ready-to-run state. The drive will respond to a Start command within 10 ms. • I/O Terminal 01 "Stop" = Coast to stop. • I/O Terminal 03 "Run REV"
	3 "Momentary"	• Drive will start after a momentary input from either the Run FWD input (I/O Terminal 02) or the Run REV input (I/O Terminal 03). • I/O Terminal 01 "Stop" = Stop according to the value set in P045 [Stop Mode].

Terminal Block Group *(continued)*

t069 [Opto Out1 Sel]
t072 [Opto Out2 Sel]

Related Parameter(s): P046, P048, P050, t070, t073, t077, t082, t086, t087, t093, t094, t097, A541, A564

PF 525 PowerFlex 525 only.

Determines the operation of the programmable digital outputs.

Options	Setting Output Changes State When...	Hysteresis
0 "Ready/Fault"	Opto outputs are active when power is applied. Indicates that the drive is ready for operation. Opto outputs are inactive when power is removed or a fault occurs.	None
1 "At Frequency"	Drive reaches commanded frequency.	0.5 Hz above; 1.0 Hz below
2 "MotorRunning"	Motor is receiving power from the drive.	None
3 "Reverse"	Drive is commanded to run in reverse direction.	None
4 "Motor OverId"	Motor overload condition exists.	100 ms time delay on or off
5 "Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.	100 ms time delay on or off
6 "Above Freq"	Drive exceeds the frequency (Hz) value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
7 "Above Cur"	Drive exceeds the current (% Amps) value set in t070 or t073 [Opto Outx Level]. **IMPORTANT** Value for t070 or t073 [Opto Outx Level] must be entered in percent of drive rated output current.	100 ms time delay on or off
8 "Above DCVolt"	Drive exceeds the DC bus voltage value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
9 "Retries Exst"	Value set in A541 [Auto Rstrt Tries] is exceeded.	None
10 "Above Anlg V"	Analog input voltage (0-10V input) exceeds the value set in t070 or t073 [Opto Outx Level]. **IMPORTANT** Do not use if t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In".	100 ms time delay on or off
11 "Above PF Ang"	Power Factor angle exceeds the value set in t070 or t073 [Opto Outx Level].	100 ms time delay on or off
12 "Anlg In Loss"	Analog input loss has occurred. Program t094 [Anlg In V Loss] or t097 [Anlg In mA Loss] for desired action when input loss occurs.	On, 2 mA / ±1V Off, 3 mA / ±1.5V
13 "ParamControl"	Output is directly controlled by the state of the t070 or t073 [Opto Outx Level]. A value of 0 causes the output to turn off. A value of 1 or greater in this parameter causes the output to turn on.	None
14 "NonRec Fault"	• Value set in A541 [Auto Rstrt Tries] is exceeded or • A541 [Auto Rstrt Tries] is not enabled or • A non-resettable fault has occurred.	None
15 "EM Brk Cntrl"	EM Brake is energized. Program t087 [EM Brk On Delay] and t086 [EM Brk Off Delay] for desired action.	None
16 "Thermal OL"	Relay energizes when thermal Motor overload counter is above the value set in t077 or t082 [Relay Outx Level]. It also energizes if the drive is within 5 °C of the drive overheat trip point.	None
17 "Amb OverTemp"	Relay energizes when control module over temperature occurs.	None
18 "Local Active"	Active when drive P046, P048 or P050 [Start Source x] is in local keypad control.	None
19 "Comm Loss"	Active when communication is lost from any comm source with reference or control.	None
20 "Logic In 1"	An input is programmed as "Logic Input 1" and is active.	None
21 "Logic In 2"	An input is programmed as "Logic Input 2" and is active.	None
22 "Logic 1 & 2"	Both Logic inputs are programmed and active.	None
23 "Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.	None
24 "StpLogic Out"	Drive enters StepLogic step with Command Word set to enable Logic output.	None
25 "Timer Out"	Timer has reached the value set in t070 or t073 [Opto Outx Level] or not timing.	None
26 "Counter Out"	Counter has reached the value set in t070 or t073 [Opto Outx Level] or not counting.	None
27 "At Position"	Drive is in Positioning mode and has reached the commanded position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
28 "At Home"	Drive is in Positioning mode and has reached the home position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
29 "Safe-Off"	Both safe-off inputs are active.	–

Values		
	Default: Opto Out1 Sel: Opto Out2 Sel:	 2 1
	Min/Max:	0/29
	Display:	1

Terminal Block Group *(continued)*

t070 [Opto Out1 Level]
t073 [Opto Out2 Level]

Related Parameter(s): t069, t072

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Determines the on/off point for the digital outputs when t069 or t072 [Opto Outx Sel] is set to the values shown below.

Min/Max Value Range Based On [Opto Outx Sel] Setting							
6:	0...500 Hz	10:	0...100%	16:	0.1...9999 s	20:	0/1
7:	0...180%	11	0/1	17:	1...9999 counts	26:	0...150%
8:	0...815V	13	0...800	18:	0...180°	–	

Values	Default:	0
	Min/Max:	0/9999
	Display:	1

t075 [Opto Out Logic]

PF 525 PowerFlex 525 only.

Determines the logic (Normally Open/NO or Normally Closed/NC) of the digital outputs only.

Setting	Digital Out 1 Logic	Digital Out 2 Logic
0	NO	NO
1	NC	NO
2	NO	NC
3	NC	NC

Values	Default:	0
	Min/Max:	0/3
	Display:	1

Terminal Block Group *(continued)*

t076 [Relay Out1 Sel]

t081 [Relay Out2 Sel]

PF 525 PowerFlex 525 only.

Related Parameter(s): P046, P048, P050, t070, t073, t077, t082, t086, t087, t093, t094, t097, A541, A564

Determines the operation of the programmable output relay.

Options	Output Relay Changes State When...	Hysteresis
0 "Ready/Fault"	Relay changes state when power is applied. Indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.	None
1 "At Frequency"	Drive reaches commanded frequency.	0.5 Hz above; 1.0 Hz below
2 "MotorRunning"	Motor is receiving power from the drive.	None
3 "Reverse"	Drive is commanded to run in reverse direction.	None
4 "Motor Overld"	Motor overload condition exists.	100 ms time delay on or off
5 "Ramp Reg"	Ramp regulator is modifying the programmed accel/ decel times to avoid an overcurrent or overvoltage fault from occurring.	100 ms time delay on or off
6 "Above Freq"	Drive exceeds the frequency (Hz) value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
7 "Above Cur"	Drive exceeds the current (% Amps) value set in t077 or t082 [Relay Outx Level]. **IMPORTANT** Value for t077 or t082 [Relay Outx Level] must be entered in percent of drive rated output current.	100 ms time delay on or off
8 "Above DCVolt"	Drive exceeds the DC bus voltage value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
9 "Retries Exst"	Value set in A541 [Auto Rstrt Tries] is exceeded.	None
10 "Above Anlg V"	Analog input voltage (0-10V input) exceeds the value set in t077 or t082 [Relay Outx Level]. **IMPORTANT** Do not use if t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In".	100 ms time delay on or off
11 "Above PF Ang"	Power Factor angle exceeds the value set in t077 or t082 [Relay Outx Level].	100 ms time delay on or off
12 "Anlg In Loss"	Analog input loss has occurred. Program t094 [Anlg In V Loss] or t097 [Anlg In mA Loss] for desired action when input loss occurs.	On, 2 mA / ±1V Off, 3 mA / ±1.5V
13 "ParamControl"	Output will be directly controlled by the state of the t077 or t082 [Relay Outx Level]. A value of 0 causes the output to turn off. A value of 1 or greater in this parameter causes the output to turn on.	None
14 "NonRec Fault"	• Value set in A541 [Auto Rstrt Tries] is exceeded or • A541 [Auto Rstrt Tries] is not enabled or • A non-resettable fault has occurred.	None
15 "EM Brk Cntrl"	EM Brake is energized. Program t087 [EM Brk On Delay] and t086 [EM Brk Off Delay] for desired action.	None
16 "Thermal OL"	Relay energizes when thermal Motor overload counter is above the value set in t077 or t082 [Relay Outx Level]. It also energizes if the drive is within 5°C of the drive overheat trip point.	None
17 "Amb OverTemp"	Relay energizes when control module over temperature occurs.	None
18 "Local Active	Active when drive P046, P048 or P050 [Start Source x] is in local keypad control.	None
19 "Comm Loss"	Active when communication is lost from any comm source with reference or control.	None
20 "Logic In 1"(1)	An input is programmed as "Logic Input 1" and is active.	None
21 "Logic In 2"(1)	An input is programmed as "Logic Input 2" and is active.	None
22 "Logic 1 & 2"(1)	Both Logic inputs are programmed and active.	None
23 "Logic 1 or 2"(1)	One or both Logic inputs are programmed and one or both is active.	None
24 "StpLogic Out"(1)	Drive enters StepLogic step with Command Word set to enable Logic output.	None
25 "Timer Out"	Timer has reached the value set in t077 or t082 [Relay Outx Level] or not timing.	None
26 "Counter Out"	Counter has reached the value set in t077 or t082 [Relay Outx Level] or not counting.	None
27 "At Position"(1)	Drive is in Positioning mode and has reached the commanded position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
28 "At Home"(1)	Drive is in Positioning mode and has reached the home position. Tolerance is adjusted with A564 [Encoder Pos Tol].	–
29 "Safe-Off"(1)	Both safe-off inputs are active.	–

Values		
	Default: Relay Out1 Sel: Relay Out2 Sel:	 0 2
	Min/Max:	0/29
	Display:	1

(1) Setting is specific to PowerFlex 525 drives only.

Terminal Block Group *(continued)*

t077 [Relay Out1 Level]

Related Parameter(s): t076, t081

t082 [Relay Out2 Level]

PF 525 PowerFlex 525 only.

32 bit parameter.

Determines the on/off point for the output relay when t076 or t081 [Relay Outx Sel] is set to the values shown below.

Min/Max Value Range Based On [Relay Outx Sel] Setting							
6:	0...500 Hz	10:	0...100%	16:	0.1...9999 s	20:	0/1
7:	0...180%	11:	0/1	17:	1...9999 counts	26:	0...150%
8:	0...815V	13:	0...800	18:	0...180°	–	

Values	Default:	0
	Min/Max:	0/9999
	Display:	1

t079 [Relay 1 On Time]

t084 [Relay 2 On Time]

PF 525 PowerFlex 525 only.

Sets the delay time before Relay energizes after required condition is met.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t080 [Relay 1 Off Time]

t085 [Relay 2 Off Time]

PF 525 PowerFlex 525 only.

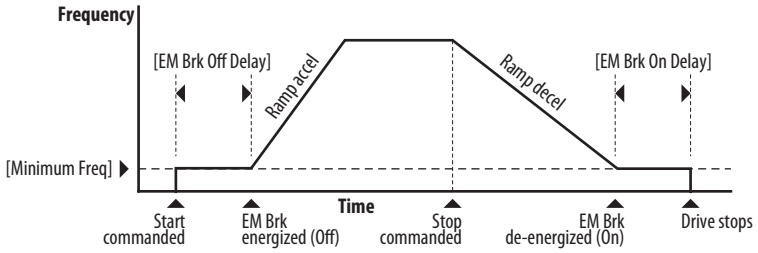
Sets the delay time before Relay de-energizes after required condition ceases.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t086 [EM Brk Off Delay]

Related Parameter(s): P045

Sets the time the drive remains at minimum frequency before ramping up to the commanded frequency (and engaging the brake coil relay) if Electromechanical (EM) Brake Control Mode is enabled with P045 [Stop Mode].

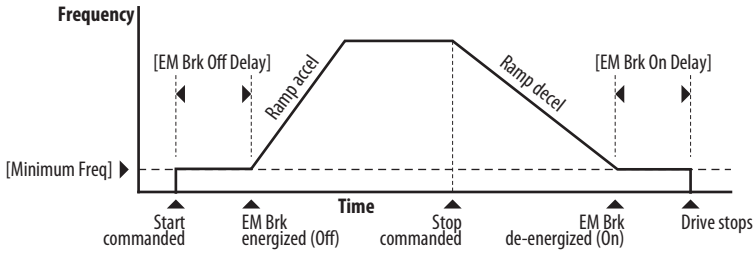


Values	Default:	2.00 s
	Min/Max:	0.00/10.00 s
	Display:	0.01 s

Terminal Block Group *(continued)*

t087 [EM Brk On Delay] Related Parameter(s): P045

Sets the time the drive remains at minimum frequency (after releasing the brake coil relay) before stopping if EM Brake Control Mode is enabled with P045 [Stop Mode].



Values	Default:	2.00 s
	Min/Max:	0.00/10.00 s
	Display:	0.01 s

t088 [Analog Out Sel] Related Parameter(s): t090

PF 525 PowerFlex 525 only.

The 0-10V, 0-20 mA or 4-2 0 mA analog output can be used to provide a signal proportional to several drive conditions. This parameter also selects which analog calibration parameters to use.

Options	Output Range	Minimum Output Value	Maximum Output Value = t089 [Analog Out High]	Filter(1)	Related Parameter
0 "OutFreq 0-10"	0-10V	0V = 0 Hz	[Maximum Freq]	None	b001
1 "OutCurr 0-10"	0-10V	0V = 0 A	200% Drive Rated FLA	Filter A	b003
2 "OutVolt 0-10"	0-10V	0V = 0 V	120% Drive Rated Output Volts	None	b004
3 "OutPowr 0-10"	0-10V	0V = 0 kW	200% Drive Rated Power	Filter A	b017
4 "OutTorq 0-10"	0-10V	0V = 0 A	200% Drive Rated FLA	Filter A	d382
5 "TstData 0-10"	0-10V	0V = 0000	65535 (Hex FFFF)	None	–
6 "Setpnt 0-10"	0-10V	0V = 0%	100.0% Setpoint setting	None	t090
7 "DCVolt 0-10"	0-10V	0V = 0V	100.0% of trip value	None	b005
8 "OutFreq 0-20"	0-20 mA	0 mA = 0 Hz	[Maximum Freq]	None	b001
9 "OutCurr 0-20"	0-20 mA	0 mA = 0 A	200% Drive Rated FLA	Filter A	b003
10 "OutVolt 0-20"	0-20 mA	0 mA = 0 V	120% Drive Rated Output Volts	None	b004
11 "OutPowr 0-20"	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	Filter A	b017
12 "OutTorq 0-20"	0-20 mA	0 mA = 0 A	200% Drive Rated FLA	Filter A	d382
13 "TstData 0-20"	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	None	–
14 "Setpnt 0-20"	0-20 mA	0 mA = 0%	100.0% Setpoint setting	None	t090
15 "DCVolt 0-20"	0-20 mA	0 mA = 0V	100.0% of trip value	None	b005
16 "OutFreq 4-20"	4-20 mA	4 mA = 0 Hz	[Maximum Freq]	None	b001
17 "OutCurr 4-20"	4-20 mA	4 mA = 0 A	200% Drive Rated FLA	Filter A	b003
18 "OutVolt 4-20"	4-20 mA	4 mA = 0 V	120% Drive Rated Output Volts	None	b004
19 "OutPowr 4-20"	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	Filter A	b017
20 "OutTorq 4-20"	4-20 mA	4 mA = 0 A	200% Drive Rated FLA	Filter A	d382
21 "TstData 4-20"	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	None	–
22 "Setpnt 4-20"	4-20 mA	4 mA = 0%	100.0% Setpoint setting	None	t090
23 "DCVolt 4-20"	4-20 mA	4 mA = 0V	100.0% of trip value	None	b005

(1) Filter A is a single pole digital filter with a 162 ms time constant. Given a 0...100% step input from a steady state, the output of Filter A takes 500 ms to get to 95% of maximum, 810 ms to get to 99%, and 910 ms to get to 100%.

Values	Default:	0
	Min/Max:	0/23
	Display:	1

Terminal Block Group *(continued)*

t089 [Analog Out High]

PF 525 PowerFlex 525 only.

Scales the maximum output value (V or mA) when the source setting is at maximum.

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

t090 [Anlg Out Setpt]

Related Parameter(s): t088

PF 525 PowerFlex 525 only.

Sets the percentage of output desired when t088 [Analog Out Sel] is set to 6, 14 or 22 "Analog Setpoint".

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

t091 [Anlg In 0-10V Lo]

Related Parameter(s): P043, t092, t093

Stop drive before changing this parameter.

Sets the percentage (based on 10V) of input voltage applied to the 0-10V analog input used to represent P043 [Minimum Freq].
Analog inversion can be accomplished by setting this value larger than t092 [Anlg In 0-10V Hi].
If t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In", this parameter is ignored.

Values	Default:	0.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t092 [Anlg In 0-10V Hi]

Related Parameter(s): P044, t091, t093

Stop drive before changing this parameter.

Sets the percentage (based on 10V) of input voltage applied to the 0-10V analog input used to represent P044 [Maximum Freq].
Analog inversion can be accomplished by setting this value smaller than t091 [Anlg In 0-10V Lo].
If t093 [10V Bipolar Enbl] is set to 1 "Bi-Polar In", the same value applies to positive and negative voltage.

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t093 [10V Bipolar Enbl]

Related Parameter(s): t091, t092

PF 525 PowerFlex 525 only.

Enables/disables bi-polar control. In bi-polar mode direction is commanded by the polarity of the voltage.
If bi-polar control is enabled, P043 [Minimum Freq] and t091 [Anlg In 0-10V Lo] are ignored.

Options	0	"Uni-Polar In" (Default)	0-10V only
	1	"Bi-Polar In"	±10V

Terminal Block Group *(continued)*

t094 [Anlg In V Loss] Related Parameter(s): P043, P044, A426, A427

Sets the response to a loss of input. When the 0-10V input (or –10 to +10V) is used for any reference, any input less than 1V is reported as a signal loss. Input must exceed 1.5V for the signal loss condition to end.

If enabled, this function affects any input that is being used as a speed reference, PID reference or PID setpoint in the drive.

Options	0	"Disabled" (Default)
	1	"Fault (F29)"
	2	"Stop"
	3	"Zero Ref"
	4	"Min Freq Ref"
	5	"Max Freq Ref"
	6	"Key Freq Ref"
	7	"MOP Freq Ref"
	8	"Continu Last"

t095 [Anlg In4-20mA Lo] Related Parameter(s): P043, t096

Stop drive before changing this parameter.

Sets the percentage (based on 4-20 mA) of input current applied to the 4-20 mA analog input used to represent P043 [Minimum Freq].

Analog inversion can be accomplished by setting this value larger than t096 [Anlg In4-20mA Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

t096 [Anlg In4-20mA Hi] Related Parameter(s): P044, t095

Stop drive before changing this parameter.

Sets the percentage (based on 4-20 mA) of input current applied to the 4-20 mA analog input used to represent P044 [Maximum Freq].

Analog inversion can be accomplished by setting this value smaller than t095 [Anlg In4-20mA Lo].

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

t097 [Anlg In mA Loss] Related Parameter(s): P043, P044, A426, A427

Sets the response to a loss of input. When the 4-20mA input is used for any reference, any input less than 2 mA is reported as a signal loss. Input must exceed 3 mA for the signal loss condition to end.

If enabled, this function affects any input that is being used as a speed reference or PID reference or PID setpoint in the drive.

Options	0	"Disabled" (Default)
	1	"Fault (F29)"
	2	"Stop"
	3	"Zero Ref"
	4	"Min Freq Ref"
	5	"Max Freq Ref"
	6	"Key Freq Ref"
	7	"MOP Freq Ref"
	8	"Continu Last"

Terminal Block Group *(continued)*

t098 [Anlg Loss Delay] Related Parameter(s): t094, t097

Sets the length of time after power-up during which the drive detects no analog signal loss.
Response to an analog signal loss is set in t094 or t097 [Analog In x Loss].

Values	Default:	0.0 s
	Min/Max:	0.0 /20.0 s
	Display:	0.1 s

t099 [Analog In Filter]

Sets the level of additional filtering of the analog input signals. A higher number increases filtering and decreases bandwidth. Each setting doubles the applied filtering (1 = 2x filter, 2 = 4x filter, and so on).

Values	Default:	0
	Min/Max:	0/14
	Display:	1

t100 [Sleep-Wake Sel] Related Parameter(s): t101, t102, t103

Drive "sleeps" if the appropriate analog input drops below the set t101 [Sleep Level] for the time set in t102 [Sleep Time] and the drive is running. When entering sleep mode the drive ramps to zero and the run indicator on the keypad display flashes to indicate the drive is in "sleep" mode.
When the appropriate analog input rises above the set [Sleep Level], the drive "wakes" and ramps to the commanded frequency.
Inversion can be accomplished by setting [Sleep Level] to a higher setting than t103 [Wake Level].



ATTENTION: Enabling the Sleep-Wake function can cause unexpected machine operation during the Wake mode. Equipment damage and/or personal injury can result if this parameter is used in an inappropriate application. In addition, all applicable local, national and international codes, standards, regulations or industry guidelines must be considered.

Options	0	"Disabled" (Default)	
	1	"0-10V Input"	Sleep enabled from 0-10V Analog Input 1
	2	"4-20mA Input"	Sleep enabled from 4-20 mA Analog Input 2
	3	"Command Freq"	Sleep enabled based on drive commanded frequency

t101 [Sleep Level]

Sets the analog input level the drive must reach to enter sleep mode.

Values	Default:	10.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

t102 [Sleep Time]

Sets the analog input time the drive must stay below to enter sleep mode.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t103 [Wake Level]

Sets the analog input level the drive must reach to wake from sleep mode.

Values	Default:	15.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Terminal Block Group *(continued)*

t104 [Wake Time]

Sets the analog input time the drive must stay above to wake from sleep mode.

Values	Default:	0.0 s
	Min/Max:	0.0/600.0 s
	Display:	0.1 s

t105 [Safety Open En]

PF 525 PowerFlex 525 only.

Sets the action when both safety inputs (Safety 1 and Safety 2) are disabled (de-energized – no power is applied).

Options	0	"FaultEnable" (Default)
	1	"FaultDisable"

Communications Group

C121 [Comm Write Mode]

Saves parameter values in active drive memory (RAM) or in drive non-volatile memory (EEPROM).



ATTENTION: If Automatic Drive Configuration (ADC) is used, this parameter must remain at its default value of 0 "Save".

IMPORTANT Parameter values set prior to setting 1 "RAM only" are saved in RAM.

Options	0	"Save" (Default)
	1	"RAM only"

C122 [Cmd Stat Select]

PF 525 PowerFlex 525 only.

Selects velocity-specific or position/fibers-specific Command and Status Word bit definitions for use over a communication network. See Writing (06) Logic Command Data on page 187 for more information. This parameter cannot be changed when an I/O connection is established through the communication adapter or the drive's embedded EtherNet/IP port.

Options	0	"Velocity" (Default)
	1	"Position"

C123 [RS485 Data Rate]

Sets the communications baud rate (bits/second) for the RS485 port. A reset or power cycle is required after selection is made.

Options	0	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19,200"
	5	"38,400"

C124 [RS485 Node Addr]

Sets the Modbus drive node number (address) for the RS485 port if using a network connection. A reset or power cycle is required after selection is made.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

C125 [Comm Loss Action] Related Parameter(s): P045

Sets the drive's response to a loss of connection or excessive communication errors on the RS485 port.

Options	0	"Fault" (Default)	
	1	"Coast Stop"	Stops drive using "Coast to stop".
	2	"Stop"	Stops drive using P045 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.

C126 [Comm Loss Time] Related Parameter(s): C125

Sets the time that the drive remains in communication loss with the RS485 port before taking the action specified in C125 [Comm Loss Action]. See Appendix C for more information.

IMPORTANT This setting is effective only if I/O that controls the drive is transmitted through the RS485 port.

Values	Default:	5.0 s
	Min/Max:	0.1/60.0 s
	Display:	0.1 s

Communications Group *(continued)*

C127 [RS485 Format]

Determines the details related to the specific Modbus protocol used by the drive. A reset or power cycle is required after selection is made.

Options	0	"RTU 8-N-1" (Default)
	1	"RTU 8-E-1"
	2	"RTU 8-O-1"
	3	"RTU 8-N-2"
	4	"RTU 8-E-2"
	5	"RTU 8-O-2"

C128 [EN Addr Sel] Related Parameter(s): C129-C132, C133-C136, C137-C140

PF 525 PowerFlex 525 only.

Enables the IP address, subnet mask and gateway address to be set with a BOOTP server. Identifies the connections that would be attempted on a reset or power cycle. A reset or power cycle is required after selection is made.

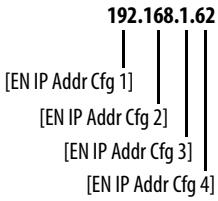
Options	1	"Parameters"
	2	"BOOTP" (Default)

C129 [EN IP Addr Cfg 1]
C130 [EN IP Addr Cfg 2]
C131 [EN IP Addr Cfg 3]
C132 [EN IP Addr Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes in the IP address. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

Values	Default:	0
	Min/Max:	0/255
	Display:	1

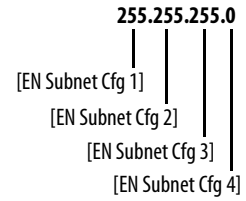
Communications Group *(continued)*

C133 [EN Subnet Cfg 1]
C134 [EN Subnet Cfg 2]
C135 [EN Subnet Cfg 3]
C136 [EN Subnet Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes of the subnet mask. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

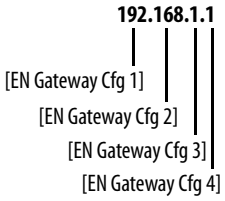
Values	Default:	0
	Min/Max:	0/255
	Display:	1

C137 [EN Gateway Cfg 1]
C138 [EN Gateway Cfg 2]
C139 [EN Gateway Cfg 3]
C140 [EN Gateway Cfg 4]

Related Parameter(s): C128

PF 525 PowerFlex 525 only.

Sets the bytes of the gateway address. A reset or power cycle is required after selection is made.



IMPORTANT C128 [EN Addr Sel] must be set to 1 "Parameters".

Values	Default:	0
	Min/Max:	0/255
	Display:	1

C141 [EN Rate Cfg]

PF 525 PowerFlex 525 only.

Sets the network data rate at which EtherNet/IP communicates. A reset or power cycle is required after selection is made.

Options	0	"Auto detect" (Default)
	1	"10Mbps Full"
	2	"10Mbps Half"
	3	"100Mbps Full"
	4	"100Mbps Half"

Communications Group *(continued)*

C143 [EN Comm Flt Actn] Related Parameter(s): P045, C145, C146, C147-C150

PF 525 PowerFlex 525 only.

Sets the action that the EtherNet/IP interface and drive takes if the EtherNet/IP interface detects that Ethernet communications have been disrupted.

IMPORTANT This setting is effective only if I/O that controls the drive is transmitted through the EtherNet/IP interface.

ATTENTION: Risk of injury or equipment damage exists. Parameter C143 [EN Comm Flt Actn] lets you determine the action of the EtherNet/IP interface and connected drive if communications are disrupted. By default, this parameter faults the drive. You can set this parameter so that the drive continues to run. Precautions should be taken to ensure that the setting of this parameter does not create a risk of injury or equipment damage. When commissioning the drive, verify that your system responds correctly to various situations (for example, a disconnected drive).

Options	0	"Fault" (Default)	
	1	"Stop"	Drive stops per P045 [Stop Mode] setting.
	2	"Zero Data"	Note: The Reference and Datalink values transmitted to the drive will be set to "0".
	3	"Hold Last"	Note: The Logic Command, Reference, and Datalink values transmitted to the drive will be held at their last value.
	4	"Send Flt Cfg"	Note: The Logic Command, Reference, and Datalink values will be transmitted to the drive as configured in C145, C146, and C147...C150.

C144 [EN Idle Flt Actn] Related Parameter(s): P045, C145, C146, C147-C150

PF 525 PowerFlex 525 only.

Sets the action that the EtherNet/IP interface and drive takes if the EtherNet/IP interface detects that the scanner is idle because the controller was switched to program mode.

ATTENTION: Risk of injury or equipment damage exists. Parameter C144 [EN Idle Flt Actn] lets you determine the action of the EtherNet/IP interface and connected drive if the scanner is idle. By default, this parameter faults the drive. you can set this parameter so that the drive continues to run. Precautions should be taken to ensure that the setting of this parameter does not create a risk of injury or equipment damage. When commissioning the drive, verify that your system responds correctly to various situations (for example, a disconnected drive).

Options	0	"Fault" (Default)	
	1	"Stop"	Drive stops per P045 [Stop Mode] setting.
	2	"Zero Data"	Note: The Reference and Datalink values transmitted to the drive will be set to "0".
	3	"Hold Last"	Note: The Logic Command, Reference, and Datalink values transmitted to the drive will be held at their last value.
	4	"Send Flt Cfg"	Note: The Logic Command, Reference, and Datalink values will be transmitted to the drive as configured in C145, C146, and C147...C150.

C145 [EN Flt Cfg Logic] Related Parameter(s): C143, C144

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the Logic Command data that is sent to the drive if any of the following is true:

– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.

– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

See Writing (06) Logic Command Data on page 187 for more information.

Values	Default:	0000
	Min/Max:	0000/FFFF
	Display:	0000

Communications Group *(continued)*

C146 [EN Flt Cfg Ref] Related Parameter(s): C143, C144

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the Reference data that is sent to the drive if any of the following is true:
– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.
– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

Values	Default:	0
	Min/Max:	0/50000
	Display:	1

C147 [EN Flt Cfg DL 1]
C148 [EN Flt Cfg DL 2]
C149 [EN Flt Cfg DL 3]
C150 [EN Flt Cfg DL 4]

PF 525 PowerFlex 525 only.

Sets the Ethernet Datalink Input data that is sent to the drive if any of the following is true:
– C143 [EN Comm Flt Actn] is set to 4 "Send Flt Cfg" and communications are disrupted.
– C144 [EN Idle Flt Actn] is set to 4 "Send Flt Cfg" and the scanner is put into Program or Test mode.

Values	Default:	0
	Min/Max:	0/65535
	Display:	1

C153 [EN Data In 1]
C154 [EN Data In 2]
C155 [EN Data In 3]
C156 [EN Data In 4]

PF 525 PowerFlex 525 only.

Datalink parameter number whose value is written from the embedded EtherNet/IP data table. This parameter cannot be changed when an I/O connection is established through the drive's embedded EtherNet/IP port.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C157 [EN Data Out 1]
C158 [EN Data Out 2]
C159 [EN Data Out 3]
C160 [EN Data Out 4]

PF 525 PowerFlex 525 only.

Datalink parameter number whose value is read from the embedded EtherNet/IP data table. This parameter cannot be changed when an I/O connection is established through the drive's embedded EtherNet/IP port.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

Communications Group *(continued)*

C161 [Opt Data In 1]
C162 [Opt Data In 2]
C163 [Opt Data In 3]
C164 [Opt Data In 4]

Datalink parameter number whose value is written from the High Speed Drive Serial Interface (HSDSI) data table. This parameter cannot be changed when an I/O connection is established through the communication adapter.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C165 [Opt Data Out 1]
C166 [Opt Data Out 2]
C167 [Opt Data Out 3]
C168 [Opt Data Out 4]

Datalink parameter number whose value is read from the HSDSI data table. This parameter cannot be changed when an I/O connection is established through the communication adapter.

Values	Default:	0
	Min/Max:	0/800
	Display:	1

C169 [MultiDrv Sel]

Sets the configuration of the drive that is in multi-drive mode. A reset or power cycle is required after selection is made.

Options	0	"Disabled" (Default)	No multi-drive master from the internal network option module or embedded Ethernet port. The drive can still function as a multi-drive slave or as a single drive (no multi-drive used).
	1	"Network Opt"	Multi-drive is enabled with the internal network option as a multi-drive master. The host drive is "Drive 0" and up to four slave drives can be daisy-chained from its RS485 port.
	2	"EtherNet/IP"(1)	Multi-drive is enabled with the embedded Ethernet port as the multi-drive master. The host drive is "Drive 0" and up to four slave drives can be daisy-chained from its RS485 port.

(1) Setting is specific to PowerFlex 525 drives only.

C171 [Drv 1 Addr]
C172 [Drv 2 Addr]
C173 [Drv 3 Addr]
C174 [Drv 4 Addr]

Related Parameter(s): C169

Sets the corresponding node addresses of the daisy-chained drives when C169 [MultiDrv Sel] is set to 1 "Network Opt" or 2 "EtherNet/IP". A reset or power cycle is required after selection is made.

Values	Default: Drv 1 Addr: Drv 2 Addr: Drv 3 Addr: Drv 4 Addr:	 2 3 4 5
	Min/Max:	1/247
	Display:	1

C175 [DSI I/O Cfg]

Sets the configuration of the Drives that are active in the multi-drive mode. Identifies the connections that would be attempted on a reset or power cycle. A reset or power cycle is required after selection is made.

Options	0	"Drive 0" (Default)
	1	"Drive 0-1"
	2	"Drive 0-2"
	3	"Drive 0-3"
	4	"Drive 0-4"

Logic Group

L180 [Stp Logic 0] **L181 [Stp Logic 1]**
L182 [Stp Logic 2] **L183 [Stp Logic 3]**
L184 [Stp Logic 4] **L185 [Stp Logic 5]**
L186 [Stp Logic 6] **L187 [Stp Logic 7]**

Related Parameter(s):

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Values	Default:	00F1
	Min/Max:	0000/FAFF
	Display	0001

See Appendix D and Appendix E for more information on applying Step Logic and Position StepLogic.

Parameters L180...L187 are only active if P047, P049, or P051 [Speed Referencex] is set to 13 "Step Logic" or 16 "Positioning". These parameters can be used to create a custom profile of frequency commands. Each "step" can be based on time, status of a Logic input or a combination of time and the status of a Logic input.

Digits 1...4 for each [Stp Logic x] parameter must be programmed according to the desired profile. A Logic input is established by setting a digital input, parameters t062, t063, t065...t068 [DigIn TermBlk xx] to 24 "Logic In 1" and/or 25 "Logic In 2" or by using Bits 6 and 7 of A560 [Enh Control Word].

A time interval between steps can be programmed using parameters L190...L197 [Stp Logic Time x]. See the table below for related parameters.

The speed for any step is programmed using parameters A410...A417 [Preset Freq x].

Step	StepLogic Parameter	Related Preset Frequency Parameter (Can be activated independent of StepLogic Parameters)	Related StepLogic Time Parameter (Active when L180...L187 Digit 1 or 2 are set to 1, b, C, d or E)
0	L180 [Stp Logic 0]	A410 [Preset Freq 0]	L190 [Stp Logic Time 0]
1	L181 [Stp Logic 1]	A411 [Preset Freq 1]	L191 [Stp Logic Time 1]
2	L182 [Stp Logic 2]	A412 [Preset Freq 2]	L192 [Stp Logic Time 2]
3	L183 [Stp Logic 3]	A413 [Preset Freq 3]	L193 [Stp Logic Time 3]
4	L184 [Stp Logic 4]	A414 [Preset Freq 4]	L194 [Stp Logic Time 4]
5	L185 [Stp Logic 5]	A415 [Preset Freq 5]	L195 [Stp Logic Time 5]
6	L186 [Stp Logic 6]	A416 [Preset Freq 6]	L196 [Stp Logic Time 6]
7	L187 [Stp Logic 7]	A417 [Preset Freq 7]	L197 [Stp Logic Time 7]

The position for any step is programmed using parameters L200...L214 [Step Units x].

Step	StepLogic Position Parameter
0	L200 [Step Units 0] & L201 [Step Units F 0]
1	L202 [Step Units 1] & L203 [Step Units F 1]
2	L204 [Step Units 2] & L205 [Step Units F 2]
3	L206 [Step Units 3] & L207 [Step Units F 3]
4	L208 [Step Units 4] & L209 [Step Units F 4]
5	L210 [Step Units 5] & L211 [Step Units F 5]
6	L212 [Step Units 6] & L213 [Step Units F 6]
7	L214 [Step Units 7] & L215 [Step Units F 7]

How StepLogic Works

The StepLogic sequence begins with a valid start command. A normal sequence always begins with L180 [Stp Logic 0].

Digit 1: Logic for next step

This digit defines the logic for the next step. When the condition is met the program advances to the next step. Step 0 follows Step 7. Example: Digit 1 is set to 3. When "Logic In 2" becomes active, the program advances to the next step.

Digit 2: Logic to jump to a different step

For all settings other than F, when the condition is met, the program overrides Digit 0 and jumps to the step defined by Digit 3.

Digit 3: Different step to jump

When the condition for Digit 2 is met, this digit setting determines the next step or to end the program.

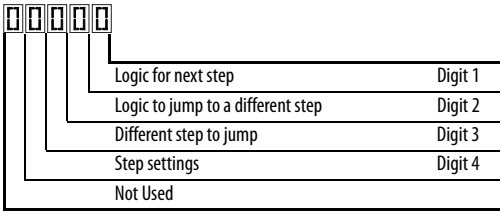
Digit 4: Step settings

This digit defines additional characteristics of each step.

Any StepLogic parameter can be programmed to control a relay or opto output, but you can not control different outputs based on the condition of different StepLogic commands.

StepLogic Settings

The logic for each function is determined by the four digits for each StepLogic parameter. The following is a listing of the available settings for each digit. See Appendix D for more information.



Velocity Control Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Positioning Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Direction From Home	Type of Command
0	Accel/Decel 1	Off	FWD	Absolute
1	Accel/Decel 1	Off	FWD	Incremental
2	Accel/Decel 1	Off	REV	Absolute
3	Accel/Decel 1	Off	REV	Incremental
4	Accel/Decel 1	On	FWD	Absolute
5	Accel/Decel 1	On	FWD	Incremental
6	Accel/Decel 1	On	REV	Absolute
7	Accel/Decel 1	On	REV	Incremental
8	Accel/Decel 2	Off	FWD	Absolute
9	Accel/Decel 2	Off	FWD	Incremental
A	Accel/Decel 2	Off	REV	Absolute
b	Accel/Decel 2	Off	REV	Incremental
C	Accel/Decel 2	On	FWD	Absolute
d	Accel/Decel 2	On	FWD	Incremental
E	Accel/Decel 2	On	REV	Absolute
F	Accel/Decel 2	On	REV	Incremental

Settings (Digit 3)

Setting	Description
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Settings (Digit 2 and 1)

Setting	Description
0	Skip Step (Jump Immediately)
1	Step Based on [Stp Logic Time x]
2	Step if “Logic In 1” is Active
3	Step if “Logic In 2” is Active
4	Step if “Logic In 1” is Not Active
5	Step if “Logic In 2” is Not Active
6	Step if either “Logic In 1” or “Logic In 2” is Active
7	Step if both “Logic In 1” and “Logic In 2” are Active
8	Step if neither “Logic In 1” nor “Logic In 2” is Active
9	Step if “Logic In 1” is Active and “Logic In 2” is Not Active
A	Step if “Logic In 2” is Active and “Logic In 1” is Not Active
b	Step after [Stp Logic Time x] and “Logic In 1” is Active
C	Step after [Stp Logic Time x] and “Logic In 2” is Active
d	Step after [Stp Logic Time x] and “Logic In 1” is Not Active
E	Step after [Stp Logic Time x] and “Logic In 2” is Not Active
F	Do Not Step/Ignore Digit 2 Settings

Logic Group *(continued)*

L190 [Stp Logic Time 0] **L191 [Stp Logic Time 1]**
L192 [Stp Logic Time 2] **L193 [Stp Logic Time 3]**
L194 [Stp Logic Time 4] **L195 [Stp Logic Time 5]**
L196 [Stp Logic Time 6] **L197 [Stp Logic Time 7]**

PF 525 PowerFlex 525 only.

Sets the time to remain in each step if the corresponding command word is set to "Step based on time".

Values	Default:	30.0 s
	Min/Max:	0.0/999.9 s
	Display:	0.1 s

L200 [Step Units 0] **L202 [Step Units 1]**
L204 [Step Units 2] **L206 [Step Units 3]**
L208 [Step Units 4] **L210 [Step Units 5]**
L212 [Step Units 6] **L214 [Step Units 7]**

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Sets the position in user-defined units the drive must reach at each step.

Values	Default:	0
	Min/Max:	0/6400
	Display:	1

Advanced Display Group

d360 [Analog In 0-10V] Related Parameter(s): t091, t092

Displays the 0-10V analog input as a percent of full scale.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d361 [Analog In 4-20mA] Related Parameter(s): t095, t096

Displays the 4-20 mA analog input as a percent of full scale.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d362 [Elapsed Time-hr] Related Parameter(s): A555

Displays the total elapsed powered-up time (in hours) since timer reset. The timer stops when it reaches the maximum value.

Values	Default:	Read Only
	Min/Max:	0/32767 hr
	Display:	1 hr

d363 [Elapsed Time-min] Related Parameter(s): d362, A555

Displays the total elapsed powered-up time (in minutes) since timer reset. Resets to zero when maximum value is reached and increments d362 [Elapsed Time-hr] by one.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 min
	Display:	0.1 min

d364 [Counter Status]

Displays the current value of the counter if enabled.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

d365 [Timer Status]

32 32 bit parameter.

Displays the current value of the timer if enabled.

Values	Default:	Read Only
	Min/Max:	0/9999 s
	Display:	1 s

d367 [Drive Type]

Used by Rockwell Automation field service personnel.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

Advanced Display Group *(continued)*

d368 [Testpoint Data] Related Parameter(s): A483

Displays the present value of the function selected in A483 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

d369 [Motor OL Level]

Displays the motor overload counter.

Values	Default:	Read Only
	Min/Max:	0.0/150.0%
	Display:	0.1%

d375 [Slip Hz Meter] Related Parameter(s): P032

Displays the current amount of slip or droop (absolute value) being applied to the motor frequency. Drives applies slip based on the setting for P032 [Motor NP Hertz].

Values	Default:	Read Only
	Min/Max:	0.0/25.0 Hz
	Display:	0.1 Hz

d376 [Speed Feedback]

32 32 bit parameter.

Displays the value of the actual motor speed whether measured by encoder/pulse train feedback or estimated.

Values	Default:	Read Only
	Min/Max:	0/64000 rpm
	Display:	1 rpm

d378 [Encoder Speed]

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Provides a monitoring point that reflects the speed measured from the feedback device. This shows the encoder or pulse train speed even if not used directly to control motor speed.

Values	Default:	Read Only
	Min/Max:	0/64000 rpm
	Display:	1 rpm

d380 [DC Bus Ripple]

Displays the real-time value of the DC bus ripple voltage.

Values	Default:	Read Only
	Min/Max:	0/410VDC for 230V AC drives; 820VDC for 460VAC drives; 1025VDC for 600VAC drives
	Display:	1V DC

d381 [Output Powr Fctr]

Displays the angle in electrical degrees between motor voltage and motor current.

Values	Default:	Read Only
	Min/Max:	0.0/180.0 deg
	Display:	0.1 deg

Advanced Display Group *(continued)*

d382 [Torque Current]

Displays the current value of the motor torque current measured by the drive.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

d383 [PID1 Fdbk Displ]

d385 [PID2 Fdbk Displ]

PF 525 PowerFlex 525 only.

Displays the active PID Feedback value.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d384 [PID1 Setpnt Disp]

d386 [PID2 Setpnt Disp]

PF 525 PowerFlex 525 only.

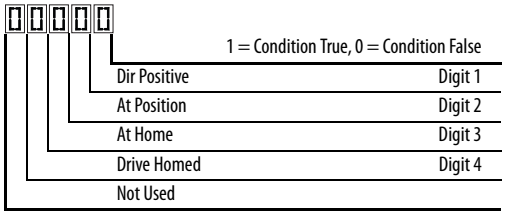
Displays the active PID Setpoint value.

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d387 [Position Status]

PF 525 PowerFlex 525 only.

Displays the present operating condition of the drive. When in Positioning mode, Bit 1 indicates positive or negative position in relation to Home.



Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

d388 [Units Traveled H]

Related Parameter(s): d387

Stop drive before changing this parameter.

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Displays the number of user-defined units traveled from the home position. See d387 [Position Status] for direction of travel.

Values	Default:	Read Only
	Min/Max:	0/64000
	Display:	1

Advanced Display Group *(continued)*

d389 [Units Traveled L] Related Parameter(s): d387

Stop drive before changing this parameter.

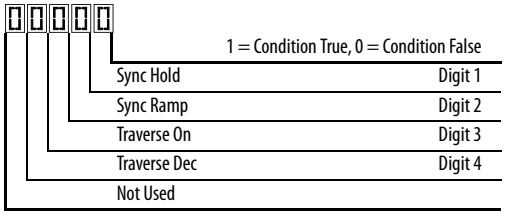
PF 525 PowerFlex 525 only.

Displays the number of user-defined units traveled from the home position. See d387 [Position Status] for direction of travel.

Values	Default:	Read Only
	Min/Max:	0.00/0.99
	Display:	0.01

d390 [Fiber Status]

Present status of the Fibers features.



Values	Default:	Read Only
	Min/Max:	0000/1111
	Display:	0000

d391 [Stp Logic Status] Related Parameter(s): P047, L180-L187

32 32 bit parameter.

PF 525 PowerFlex 525 only.

Displays the current step of the Step Logic profile as defined by parameters L180...L187 [Step Logic x] when P047 [Speed Reference1] is set to 13 “Step Logic” or 16 “Positioning”.

Values	Default:	Read Only
	Min/Max:	0/8
	Display:	1

Advanced Program Group

A410 [Preset Freq 0] **A411 [Preset Freq 1]**
A412 [Preset Freq 2] **A413 [Preset Freq 3]**
A414 [Preset Freq 4] **A415 [Preset Freq 5]**
A416 [Preset Freq 6] **A417 [Preset Freq 7]**

A418 [Preset Freq 8] **A419 [Preset Freq 9]**
A420 [Preset Freq 10] **A421 [Preset Freq 11]**
A422 [Preset Freq 12] **A423 [Preset Freq 13]**
A424 [Preset Freq 14] **A425 [Preset Freq 15]**

PF 525 PowerFlex 525 only.

Sets the frequency of the drive outputs to the programmed value when selected.

For PowerFlex 525

	Default Accel/Decel Used	Preset Input 1 (DigIn TermBlk 05)	Preset Input 2 (DigIn TermBlk 06)	Preset Input 3 (DigIn TermBlk 07)	Preset Input 4 (DigIn TermBlk 08)
Preset Setting 0[1]	1	0	0	0	0
Preset Setting 1	1	1	0	0	0
Preset Setting 2	2	0	1	0	0
Preset Setting 3	2	1	1	0	0
Preset Setting 4	1	0	0	1	0
Preset Setting 5	1	1	0	1	0
Preset Setting 6	2	0	1	1	0
Preset Setting 7	2	1	1	1	0
Preset Setting 8	1	0	0	0	1
Preset Setting 9	1	1	0	0	1
Preset Setting 10	2	0	1	0	1
Preset Setting 11	2	1	1	0	1
Preset Setting 12	1	0	0	1	1
Preset Setting 13	1	1	0	1	1
Preset Setting 14	2	0	1	1	1
Preset Setting 15	2	1	1	1	1

For PowerFlex 523

	Default Accel/Decel Used	Preset Input 1 (DigIn TermBlk 05)	Preset Input 2 (DigIn TermBlk 06)	Preset Input 3 (DigIn TermBlk 03)	–
Preset Setting 0[1]	1	0	0	0	–
Preset Setting 1	1	1	0	0	
Preset Setting 2	2	0	1	0	
Preset Setting 3	2	1	1	0	
Preset Setting 4	1	0	0	1	
Preset Setting 5	1	1	0	1	
Preset Setting 6	2	0	1	1	
Preset Setting 7	2	1	1	1	

(1) Preset Setting 0 is only available if P047, P049 or P051 [Speed Referencex] is set to 7 “Preset Freq”.

Values	Defaults:	
	Preset Freq 0:	0.00 Hz
	Preset Freq 1:	5.00 Hz
	Preset Freq 2:	10.00 HZ
	Preset Freq 3:	20.00 Hz
	Preset Freq 4:	30.00 Hz
	Preset Freq 5:	40.00 Hz
	Preset Freq 6:	50.00 Hz
	Preset Freq 7...15:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

Advanced Program Group *(continued)*

A426 [Keypad Freq] Related Parameter(s): P047, P049, P051

Provides the drive frequency command using the built-in keypad navigation. When P047, P049 or P051 [Speed Referencex] selects 2 "Keypad Freq", the value set in this parameter controls the frequency of the drive. The value of this parameter can also be changed when navigating with the keypad by pressing the Up or Down arrow keys.

Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A427 [MOP Freq]

Provides the drive frequency command using the built-in Motor Operated Potentiometer (MOP).

IMPORTANT Frequency is not written to non-volatile storage until drive is powered-down. If both MOP Up and MOP Down are applied at the same time, the inputs are ignored and the frequency is unchanged.

Values	Default:	60.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A428 [MOP Reset Sel]

Determines if the current MOP reference command is saved on power down.

Options	0 "Zero MOP Ref"	Resets the MOP frequency to zero on power down and stop.
	1 "Save MOP Ref" (Default)	

A429 [MOP Preload]

Determines the operation of the MOP function.

Options	0 "No preload" (Default)	
	1 "Preload"	Bumpless Transfer: whenever MOP mode is selected, the current output value of the speed is loaded.

A430 [MOP Time]

Sets the rate of change of the MOP reference.

Values	Default:	10.0 s
	Min/Max:	0.1/600.0 s
	Display:	0.1 s

A431 [Jog Frequency] Related Parameter(s): P044

Sets the output frequency when a jog command is issued.

Values	Default:	10.00 Hz
	Min/Max:	0.00/[Maximum Freq]
	Display:	0.01 Hz

A432 [Jog Accel/Decel]

Sets the acceleration and deceleration time used when in jog mode.

Values	Default:	10.00 s
	Min/Max:	0.01/600.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A433 [Purge Frequency] Related Parameter(s): t062, t063, t065-t068

Provides a fixed frequency command value when t062, t063, t065-t068 [DigIn TermBlk xx] is set to 40 "Purge".

Values	Default:	5.00 Hz
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

A434 [DC Brake Time] Related Parameter(s): P045, A435

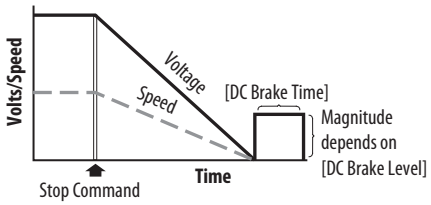
Sets the length of time that DC brake current is "injected" into the motor.

Values	Default:	0.0 s
	Min/Max:	0.0/99.9 s
	Display:	0.1 s

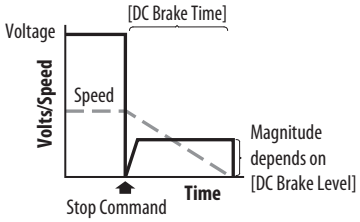
A435 [DC Brake Level] Related Parameter(s): P045

Defines the maximum DC brake current, in amps, applied to the motor when P045 [Stop Mode] is set to either 4 "Ramp" or 6 "DC Brake".

Ramp-to-Stop Mode



DC Injection Stop Mode

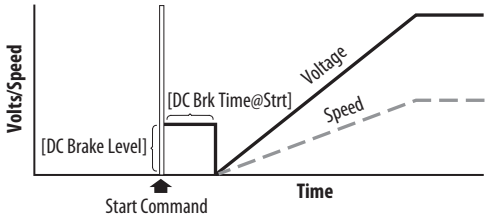


ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used. This feature should not be used with synchronous motors. Motors may be demagnetized during braking.

Values	Default:	Drive Rated Amps x 0.05
	Min/Max:	0.00/(Drive Rated Amps x 1.80)
	Display:	0.01 A

A436 [DC Brk Time@Strt] Related Parameter(s): P045, A435

Sets the length of time that DC brake current is "injected" into the motor after a valid start command is received.



Values	Default:	0.0 s
	Min/Max:	0.0/99.9 s
	Display:	0.1 s

Advanced Program Group *(continued)*

A437 [DB Resistor Sel]

Stop drive before changing this parameter.

Enables/disables external dynamic braking and selects the level of resistor protection.

Options	0	"Disabled" (Default)	
	1	"Norml RA Res"	5%
	2	"NoProtection"	100%
	3...99	"3...99% DutyCycle"	

A438 [DB Threshold]

Related Parameter(s): A437

Sets the DC bus voltage threshold for Dynamic Brake operation. If DC bus voltage rises above this level, Dynamic Brake turns on. Lower values makes the dynamic braking function more responsive but may result in nuisance Dynamic Brake activation.

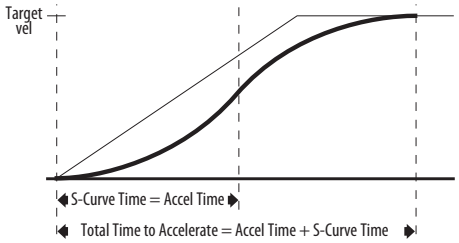
ATTENTION: Equipment damage may result if this parameter is set to a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 100% should be carefully evaluated to ensure that the Dynamic Brake resistor's wattage rating is not exceeded. In general, values less than 90% are not needed. This parameter's setting is especially important if parameter A437 [DB Resistor Sel] is set to 2 "NoProtection".

Values	Default:	100.0%
	Min/Max:	10.0/110.0%
	Display:	0.1%

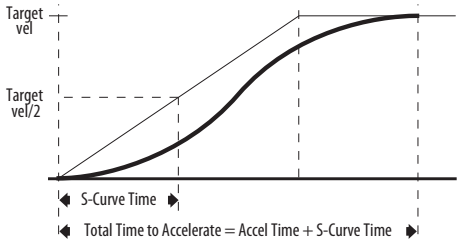
A439 [S Curve %]

Enables a fixed shape S-Curve that is applied to the acceleration and deceleration ramps (including jog).
S-Curve Time = (Accel or Decel Time) x (S-Curve Setting in percentage)

100% S-Curve



50% S-Curve



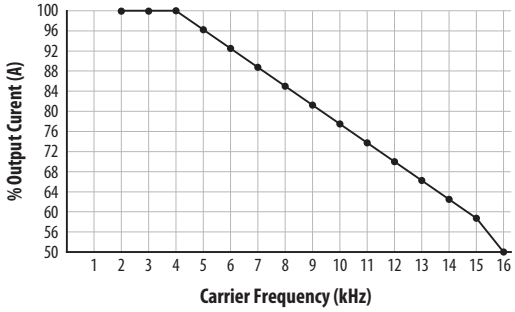
Example:
Accel Time = 10 s
S-Curve Setting = 30%
S-Curve Time = 10 x 0.3 = 3 s

Values	Default:	0%
	Min/Max:	0/100%
	Display:	1%

Advanced Program Group *(continued)*

A440 [PWM Frequency] Related Parameter(s): A540

Sets the carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting.



IMPORTANT Ignoring derating guidelines can cause reduced drive performance. The drive may automatically reduce the PWM carrier frequency at low output speeds, unless prevented from doing so by A540 [Var PWM Disable].

Values	Default:	4.0 kHz
	Min/Max:	2.0/16.0 kHz
	Display:	0.1 kHz

A441 [Droop Hertz@ FLA]

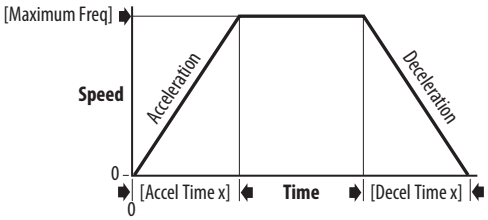
PF 525 PowerFlex 525 only.

Reduces the frequency based on current. This frequency is subtracted from the commanded output frequency. Generally Slip and Droop would not both be used, but if both are enabled they simply subtract from each other. Typically used in load sharing schemes.

Values	Default:	0.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A442 [Accel Time 2] Related Parameter(s): P044

Time for the drive to ramp from 0.0 Hz to P044 [Maximum Freq] if Accel Time 2 is selected.
Accel Rate = [Maximum Freq] / [Accel Time]



Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A443 [Decel Time 2] Related Parameter(s): P044

Time for the drive to ramp from P044 [Maximum Freq] to 0.0 Hz if Decel Time 2 is selected.
Decel Rate = [Maximum Freq] / [Decel Time]

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A444 [Accel Time 3]
A446 [Accel Time 4]

Sets the rate of acceleration for all speed increases when selected by digital inputs.

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A445 [Decel Time 3]
A447 [Decel Time 4]

Sets the rate of deceleration for all speed decreases when selected by digital inputs.

Values	Default:	10.00 s
	Min/Max:	0.00/600.00 s
	Display:	0.01 s

A448 [Skip Frequency 1]
A450 [Skip Frequency 2]
A452 [Skip Frequency 3]
A454 [Skip Frequency 4]

PF 525 PowerFlex 525 only.

Related Parameter(s): A449, A451, A453, A455

Works in conjunction with A449, A451, A453 and A455 [Skip Freq Band x] creating a range of frequencies at which the drive does not operate continuously.

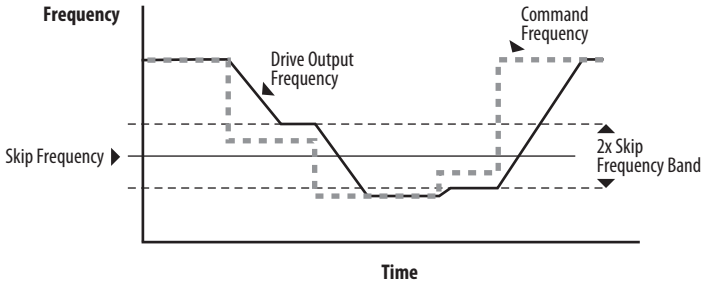
Values	Default:	0.0 Hz (Disabled)
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A449 [Skip Freq Band 1]
A451 [Skip Freq Band 2]
A453 [Skip Freq Band 3]
A455 [Skip Freq Band 4]

PF 525 PowerFlex 525 only.

Related Parameter(s): A448, A450, A452, A454

Determines the band around A448, A450, A452 and A454 [Skip Frequency x].



Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A456 [PID 1 Trim Hi]

A468 [PID 2 Trim Hi]

PF 525 PowerFlex 525 only.

Scales the upper value of the trim frequency when trim is active.

Values	Default:	60.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A457 [PID 1 Trim Lo]

A469 [PID 2 Trim Lo]

PF 525 PowerFlex 525 only.

Scales the lower value of the trim frequency when trim is active.

Values	Default:	0.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A458 [PID 1 Trim Sel]

A470 [PID 2 Trim Sel]

PF 525 PowerFlex 525 only.

Stop drive before changing this parameter.

Sets the PID output as trim to the source reference.

Options	0	"Disabled" (Default)	PID Trim is disabled.
	1	"TrimOn Pot"	
	2	"TrimOn Keypd"	
	3	"TrimOn DSI"	
	4	"TrimOn NetOp"	
	5	"TrimOn 0-10V"	
	6	"TrimOn 4-20"	
	7	"TrimOn Prset"	
	8	"TrimOn AnMlt"(1)	
	9	"TrimOn MOP"	
	10	"TrimOn Pulse"	
	11	"TrimOn SIgic"(1)	
	12	"TrimOn Encdr"(1)	
	13	"TrimOn ENet"(1)	

(1) Setting is specific to PowerFlex 525 drives only.

Advanced Program Group *(continued)*

A459 [PID 1 Ref Sel]

A471 [PID 2 Ref Sel]

PF 525 PowerFlex 525 only.

Stop drive before changing this parameter.

Selects the source of the PID reference.

Options	0	"PID Setpoint" (Default)
	1	"Drive Pot"
	2	"Keypad Freq"
	3	"Serial/DSI"
	4	"Network Opt"
	5	"0-10V Input"
	6	"4-20mA Input"
	7	"Preset Freq"
	8	"AnIgIn Multi"(1)
	9	"MOP Freq"
	10	"Pulse Input"
	11	"Step Logic"(1)
	12	"Encoder"(1)
	13	"EtherNet/IP"(1)

(1) Setting is specific to PowerFlex 525 drives only.

A460 [PID 1 Fdback Sel]

A472 [PID 2 Fdback Sel]

PF 525 PowerFlex 525 only.

Selects the source of the PID feedback.

Options	0	"0-10V Input" (Default)	Note: PID does not function with bipolar input. Negative voltages are ignored and treated as zero.
	1	"4-20mA Input"	
	2	"Serial/DSI"	
	3	"Network Opt"	
	4	"Pulse Input"	
	5	"Encoder"(1)	
	6	"EtherNet/IP"(1)	

(1) Setting is specific to PowerFlex 525 drives only.

A461 [PID 1 Prop Gain]

Related Parameter(s): A459, A471

A473 [PID 2 Prop Gain]

PF 525 PowerFlex 525 only.

Sets the value for the PID proportional component when the PID mode is enabled.

Values	Default:	0.01
	Min/Max:	0.00/99.99
	Display:	0.01

Advanced Program Group *(continued)*

A462 [PID 1 Integ Time] Related Parameter(s): A459, A471

A474 [PID 2 Integ Time]
PF 525 PowerFlex 525 only.

Sets the value for the PID integral component when PID mode is enabled.

Values	Default:	2.0 s
	Min/Max:	0.0/999.9 s
	Display:	0.1 s

A463 [PID 1 Diff Rate] Related Parameter(s): A459, A471

A475 [PID 2 Diff Rate]
PF 525 PowerFlex 525 only.

Sets the value (in 1/second) for the PID differential component when PID mode is enabled.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A464 [PID 1 Setpoint] Related Parameter(s): A459, A471

A476 [PID 2 Setpoint]
PF 525 PowerFlex 525 only.

Provides an internal fixed value for process setpoint when PID mode is enabled.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A465 [PID 1 Deadband]

A477 [PID 2 Deadband]
PF 525 PowerFlex 525 only.

Sets the lower limit of the PID output.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A466 [PID 1 Preload]

A478 [PID 2 Preload]
PF 525 PowerFlex 525 only.

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A467 [PID 1 Invert Err]

A479 [PID 2 Invert Err]
PF 525 PowerFlex 525 only.

Changes the sign of the PID error.

Options	0	"Normal" (Default)
	1	"Inverted"

Advanced Program Group *(continued)*

A481 [Process Disp Lo] Related Parameter(s): b010, P043

Sets the value displayed in b010 [Process Display] when the drive is running at P043 [Minimum Freq].

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A482 [Process Disp Hi] Related Parameter(s): b010, P044

Sets the value displayed in b010 [Process Display] when the drive is running at P044 [Maximum Freq].

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A483 [Testpoint Sel]

Used by Rockwell Automation field service personnel.

Values	Default:	400
	Min/Max:	0/FFFF
	Display:	1

A484 [Current Limit 1] Related Parameter(s): P033

Maximum output current allowed before current limiting occurs.

Values	Default:	Drive Rated Amps x 1.1 (Normal Duty); Drive Rated Amps x 1.5 (Heavy Duty)
	Min/Max:	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)
	Display:	0.1 A

A485 [Current Limit 2] Related Parameter(s): P033

PF 525 PowerFlex 525 only.

Maximum output current allowed before current limiting occurs.

Values	Default:	Drive Rated Amps x 1.1
	Min/Max:	0.0/Drive Rated Amps x 1.5 (Normal Duty); Drive Rated Amps x 1.8 (Heavy Duty)
	Display:	0.1 A

A486 [Shear Pin1 Level] Related Parameter(s): A487, A489

A488 [Shear Pin2 Level]

PF 525 PowerFlex 525 only.

Sets the value of current at which the shear pin fault occurs after the time set in A487, A489 [Shear Pin x Time]. Setting the value at 0.0 A disables this function.

Values	Default:	0.0 A (Disabled)
	Min/Max:	0.0/(Drive Rated Amps x 2)
	Display:	0.1 A

A487 [Shear Pin 1 Time] Related Parameter(s): A486, A488

A489 [Shear Pin 2 Time]

PF 525 PowerFlex 525 only.

Sets the continuous time the drive must be at or above the value set in A486, A488 [Shear Pinx Level] before a shear pin fault occurs.

Values	Default:	0.00 s
	Min/Max:	0.00/30.00 s
	Display:	0.01 s

Advanced Program Group *(continued)*

A490 [Load Loss Level] Related Parameter(s): A491

PF 525 PowerFlex 525 only.

Provides a software trip (Load Loss fault) when the current drops below this level for the time specified in A491 [Load Loss Time].

Values	Default:	0.0 A
	Min/Max:	0.0/Drive Rated Amps
	Display:	0.1 A

A491 [Load Loss Time] Related Parameter(s): A490

PF 525 PowerFlex 525 only.

Sets the required time for the current to be below A490 [Load Loss Level] before a Load Loss fault occurs.

Values	Default:	0 s
	Min/Max:	0/9999 s
	Display:	1 s

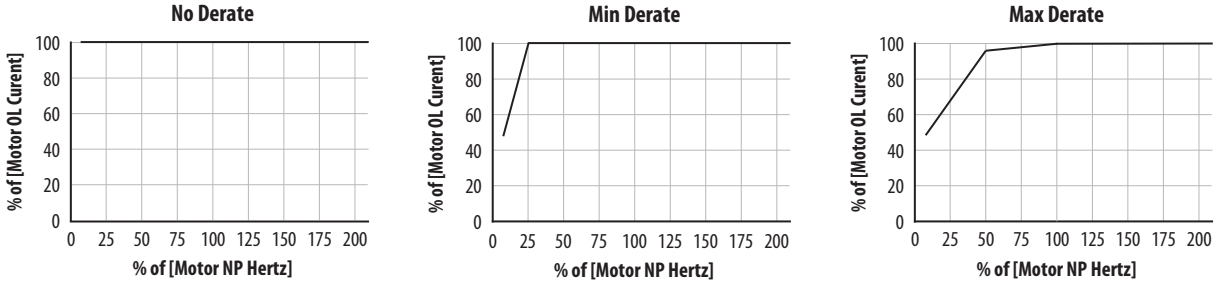
A492 [Stall Fault Time]

Sets the time that the drive remains in stall mode before a fault is issued.

Options	0	"60 Seconds" (Default)
	1	"120 Seconds"
	2	"240 Seconds"
	3	"360 Seconds"
	4	"480 Seconds"
	5	"Flt Disabled"

A493 [Motor OL Select] Related Parameter(s): P032, P033

Drive provides Class 10 overload protection. Settings 0...2 select the derating factor for the I^2t overload function.



Options	0	"No Derate" (Default)
	1	"Min. Derate"
	2	"Max. Derate"

A494 [Motor OL Ret]

Selects whether the motor overload counter is saved on power-down or reset on power-up.

Options	0	"Reset" (Default)
	1	"Save"

Advanced Program Group *(continued)*

A495 [Drive OL Mode]

Determines how the drive handles overload conditions that would otherwise cause the drive to fault.

Options	0	"Disabled"
	1	"Reduce CLim"
	2	"Reduce PWM"
	3	"Both-PWM 1st" (Default)

A496 [IR Voltage Drop] Related Parameter(s): P040

Value of volts dropped across the resistance of the motor stator (autotune) for induction motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/600.0VAC
	Display:	0.1VAC

A497 [Flux Current Ref] Related Parameter(s): P040

This is the current necessary for full motor flux. The value should be set to the full speed no-load current of the motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/(Drive Rated Amps x 1.4)
	Display:	0.01 A

A498 [Motor Rr]

PF 525 PowerFlex 525 only.

Rotor resistance of induction motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/655.35 ohm
	Display:	0.01 ohm

A499 [Motor Lm]

PF 525 PowerFlex 525 only.

Mutual Inductance of induction motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/6553.5 mH
	Display:	0.1 mH

A500 [Motor Lx]

PF 525 PowerFlex 525 only.

Leakage Inductance of induction motor.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/6553.5 mH
	Display:	0.1 mH

A509 [Speed Reg Sel] Related Parameter(s): A521, A522, A523, A524, A525, A526

PF 525 PowerFlex 525 only.

Determines if PI gain of the "Vector" control mode speed regulator is set automatically or manually. Parameters A521...A526 are set automatically by this parameter.

Options	0	"Automatic" (Default)
	1	"Manual"

Advanced Program Group *(continued)*

A510 [Freq 1]
A512 [Freq 2]
A514 [Freq 3]

PF 525 PowerFlex 525 only.

Sets the "Vector" control mode frequency.

Values	Default:	
	Freq 1:	8.33%
	Freq 2:	15.00%
	Freq 3:	20.00%
	Min/Max:	0.00/200.00%
	Display:	0.01%

A511 [Freq 1 BW]
A513 [Freq 2 BW]
A515 [Freq 3 BW]

PF 525 PowerFlex 525 only.

Speed control loop bandwidth for "Vector" control mode.

Values	Default:	10 Hz
	Min/Max:	0/40 Hz
	Display:	1 Hz

A521 [Freq 1 Kp]
A523 [Freq 2 Kp]
A525 [Freq 3 Kp]

Related Parameter(s): A509, A510

PF 525 PowerFlex 525 only.

Sets P-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during dynamic-state where motor is still accelerating. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.

Values	Default:	100.0%
	Min/Max:	0.0/500.0%
	Display:	0.1%

A522 [Freq 1 Ki]
A524 [Freq 2 Ki]
A526 [Freq 3 Ki]

Related Parameter(s): A509, A510

PF 525 PowerFlex 525 only.

Sets I-gain of "Vector" control mode when in frequency region 1, 2 or 3 for faster speed response during steady-state where motor is at its rated speed. If A509 [Speed Reg Sel] is set to 1 "Manual", these parameters can be changed.

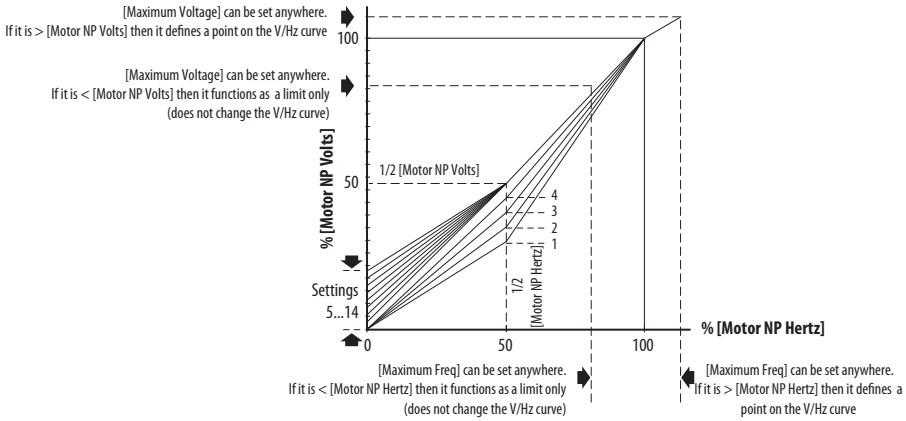
Values	Default:	0.100 s
	Min/Max:	0.000/10.000 s
	Display:	0.001 s

Advanced Program Group *(continued)*

A530 [Boost Select]

Related Parameter(s): b004, P031, P032, P039

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve. Only used for V/Hz and SVC control modes.

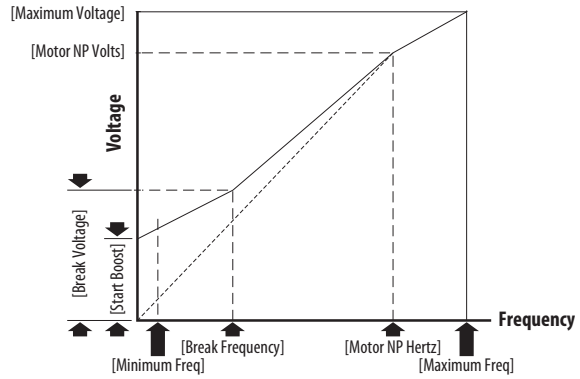


Options	0	"Custom V/Hz"	
	1	"30.0, VT"	Fan/Pump Curves (Variable Torque)
	2	"35.0, VT"	
	3	"40.0, VT"	
	4	"45.0, VT"	
	5	"0.0, no IR"	Boost Voltage (% of Base) (Constant Torque)
	6	"0.0" (Default for 400V and 600V drives, 5 HP and above)	
	7	"2.5, CT" (Default for 200V drives, 5 HP and above)	
	8	"5.0, CT" (Default for drives below 5 HP)	
	9	"7.5, CT"	
	10	"10.0, CT"	
	11	"12.5, CT"	
	12	"15.0, CT"	
	13	"17.5, CT"	
	14	"20.0, CT"	

Advanced Program Group *(continued)*

A531 [Start Boost] Related Parameter(s): P031, P032, P039, A530

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the V/Hz curve when A530 [Boost Select] = 0 "Custom V/Hz" and P039 [Torque Perf Mode] = 0 "V/Hz".



Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	0.1%

A532 [Break Voltage] Related Parameter(s): P031, P032, P039, A530, A533

Sets the voltage (in percent of [Base Frequency]) at the A533 [Break Frequency] if A530 [Boost Select] is set to 0 "Custom V/Hz".

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A533 [Break Frequency] Related Parameter(s): P031, P032, P039, A530, A532

Sets the frequency where A532 [Break Voltage] is applied if A530 [Boost Select] is set to 0 "Custom V/Hz".

Values	Default:	15.0 Hz
	Min/Max:	0.0/500.0 Hz
	Display:	0.1 Hz

A534 [Maximum Voltage] Related Parameter(s): b004

Sets the highest voltage the drive outputs.

Values	Default:	Drive Rated Volts
	Min:	10V AC (on 230V AC Drives); 20V AC (on 460V AC Drives); 25V AC (on 600V AC Drives)
	Max:	255V AC (on 230V AC Drives); 510V AC (on 460V AC Drives); 637.5V AC (on 600V AC Drives)
	Display:	1V AC

Advanced Program Group *(continued)*

A535 [Motor Fdbk Type]

Related Parameter(s): A537

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Selects the encoder type.

ATTENTION: The loss of analog input, encoder or other feedback may cause unintended speed or motion. Take appropriate precautions to guard against possible unintended speed or motion.

			Allowable Control Modes	Hardware Inputs
Options	0	"None" (Default)	For all motor types	–
	1	"Pulse Train"	All except Vector	[DigIn TermBlk 07] or Optional incremental encoder card (catalog number 25-ENC-1)
	2	"Single Chan"	All except Vector	Optional incremental encoder card (catalog number 25-ENC-1)
	3	"Single Check"	All except Vector	
	4	"Quadrature"	For all motor types	
	5	"Quad Check"	For all motor types	

A536 [Encoder PPR]

PF 525 PowerFlex 525 only.

Specifies the encoder Pulses Per Revolution (PPR) when an encoder is used.

Values	Default:	1024 PPR
	Min/Max:	1/20000 PPR
	Display:	1 PPR

A537 [Pulse In Scale]

Related Parameter(s): t065, t067, A535

Sets the scale factor/gain for the Pulse Input when t065 or t067 [DigIn TermBlk xx] is set to 52 "Pulse Train", or A535 [Motor Fdbk Type] is set to 1 "Pulse Train".
Input frequency (Hz) / Pulse in Scale = Output frequency (Hz)

Values	Default:	64
	Min/Max:	0/20000
	Display:	1

A538 [Ki Speed Loop]

PF 525 PowerFlex 525 only.

Sets the I-gain used in the PI calculation of the speed loop when feedback is used.

Values	Default:	2.0
	Min/Max:	0.0/400.0
	Display:	0.1

A539 [Kp Speed Loop]

PF 525 PowerFlex 525 only.

Sets the P-gain used in the PI calculation of the speed loop when feedback is used.

Values	Default:	5.0
	Min/Max:	0.0/200.0
	Display:	0.1

Advanced Program Group *(continued)*

A540 [Var PWM Disable] Related Parameter(s): A440

Stop drive before changing this parameter.

Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A440 [PWM Frequency].

Options	0	"Enabled" (Default)
	1	"Disabled"

A541 [Auto Rstrt Tries] Related Parameter(s): A542

Sets the maximum number of times the drive attempts to reset a fault and restart. See Chapter 4 for more information on faults and fault codes.

Clear a Type 1 fault and restart the drive.
1. Set A541 [Auto Rstrt Tries] to a value other than "0".
2. Set A542 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.
1. Set A541 [Auto Rstrt Tries] to a value other than "0".
2. Set A542 [Auto Rstrt Delay] to "0".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Values	Default:	0
	Min/Max:	0/9
	Display:	1

A542 [Auto Rstrt Delay] Related Parameter(s): A541

Sets the time between restart attempts if A541 [Auto Rstrt Tries] is not zero.

Values	Default:	1.0 s
	Min/Max:	0.0/120.0 s
	Display:	0.1 s

A543 [Start At PowerUp]

Stop drive before changing this parameter.

Enables/disables drive start on power up without a Start command being cycled. Requires a digital input configured for Run or Start and a valid start contact.

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	0	"Disabled" (Default)
	1	"Enabled"

A544 [Reverse Disable] Related Parameter(s): b006

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed.

Options	0	"Rev Enabled" (Default)
	1	"Rev Disabled"

A545 [Flying Start En]

Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.

Options	0	"Disabled" (Default)
	1	"Enabled" Catch and ramp to commanded speed at every drive start.

Advanced Program Group *(continued)*

A546 [FlyStrt CurLimit]

Used to determine when the drive has matched the motor frequency if flying start is enabled.

Values	Default:	150%
	Min/Max:	30/200%
	Display:	1%

A547 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	0	"Disabled"	No compensation.
	1	"Electrical" (Default)	Some drive/motor combinations have inherent instabilities which are exhibited as non-sinusodial motor currents. This setting attempts to correct this condition
	2	"Mechanical"	Some motor/load combinations have mechanical resonances which can be excited by the drive current regulator. This setting slows down the current regulator response and attempts to correct this condition.
	3	"Both"	

A548 [Power Loss Mode]

Sets the reaction to a loss of input power.

Options	0	"Coast" (Default)	Drive faults and motor coasts to a stop.
	1	"Decel"	Drive decelerates and attempts to keep the DC bus voltage above the undervoltage level.

A549 [Half Bus Enable]

Enables/disables the power ride through function which allows the drive to maintain power to the motor at 50% drive input voltage during short-term power sag conditions.



ATTENTION: To guard against drive damage, a minimum line impedance must be provided to limit inrush current when the power line recovers. The input impedance should be equal or greater than the equivalent of a 5% transformer with a VA rating 6 times the drive's input VA rating if Half Bus is enabled.

Options	0	"Disabled" (Default)
	1	"Enabled"

A550 [Bus Reg Enable]

Enables/disables the bus regulator.

Options	0	"Disabled"
	1	"Enabled" (Default)

A551 [Fault Clear]


Stop drive before changing this parameter.

Resets a fault and clears the fault queue.

Options	0	"Ready/Idle" (Default)	
	1	"Reset Fault"	Resets the active fault but does not clear any fault buffer.
	2	"Clear Buffer"	Resets the active fault and clears all fault buffers to "0".

A552 [Program Lock] Related Parameter(s): A553

Protects parameters against change by unauthorized personnel with a 4-digit password.

Values	Default:	0000
	Min/Max:	0000/9999
	Display:	1111

Advanced Program Group *(continued)*

A553 [Program Lock Mod] Related Parameter(s): A552

Determines the lock mode used in parameter A552 [Program Lock]. When set to 2 or 3, A552 [Program Lock] is added to the custom group to allow unlocking of parameters.

Options	0	"Full Lock" (Default)	All parameters are locked except [Program Lock].
	1	"Keypad Lock"	All parameters are locked except [Program Lock] from keypad access but can still be accessed over communications.
	2	"Custom Only"	All parameters are locked and hidden except custom group and [Program Lock].
	3	"KeyPd Custom"	All parameters are locked and hidden except custom group and [Program Lock] from keypad access but can still be accessed over communications.

A554 [Drv Ambient Sel]

Sets the maximum expected ambient of the drive when used above 50 °C. When ambient temperature is above 50 °C, the drive will apply necessary current derating.

Options	0	"Normal" (Default)	
	1	"55C"	
	2	"60C"	
	3	"65C +Fan Kit"	Fan kit required.
	4	"70C +Fan Kit"	

A555 [Reset Meters] Related Parameter(s): b019, b021, b022, b023, b024, b025, b026, d362, d363

Resets the values stored in the parameters that track fault times and energy usage.

Options	0	"Ready/Idle" (Default)	
	1	"Reset Meters"	Resets kWh, MWh, Accum kWh, Cost, and CO2 Sav parameter values.
	2	"Reset Time"	Resets min, hr, and x10 hr.

A556 [Text Scroll]

Sets the scrolling speed of the text in the LCD display.

Options	0	"Off"	No scroll.
	1	"Low Speed"	
	2	"Mid Speed" (Default)	
	3	"High Speed"	

A557 [Out Phas Loss En]

Enable/disable output phase loss detection.



ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	0	"Disable" (Default)
	1	"Enable"

A558 [Positioning Mode]

 Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Defines the positioning transition mode used for the position steps.

Options	0	"Time Steps" (Default)	Steps based on time.
	1	"Preset Input"	Preset inputs directly commands a given step.
	2	"Step Logic"	Use Step Logic Commands. Always start from Step 0.
	3	"Preset StpL"	Use Preset Inputs to determine starting step then Step Logic commands.
	4	"StpLogic-Lst"	Use Step Logic commands from last Step Logic step at last drive stop.

Advanced Program Group *(continued)*

A559 [Counts Per Unit]

PF 525 PowerFlex 525 only.

Sets the number of encoder counts equal to one user-defined unit.

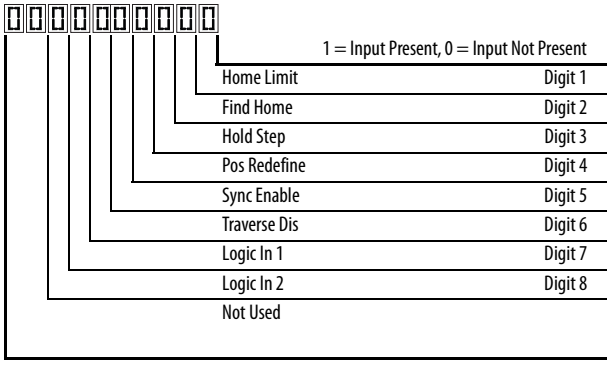
Values	Default:	4096
	Min/Max:	1/32000
	Display:	1

A560 [Enh Control Word]

Related Parameter(s): t062, t063, t065 - t068, A571

PF 525 PowerFlex 525 only.

Allows control of positioning and other functions through parameter control for use over comms. The functions replicate the digital input options and function in the same way.



Values	Default:		0000 0000
	Min/Max:		0000 0000/1111 1111
	Display:		0000 0000
Digits	0	"Home Limit"	In Positioning mode, this indicates the drive is at the home position
	1	"Find Home"	When set, the next start command causes the drive to find home. Set this bit to 0 after completing the homing routine.
	2	"Hold Step"	In Positioning mode, this input over-rides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released.
	3	"Pos Redefine"	In Positioning mode, this input resets the home position to the current position of the machine. Set this bit to 0 after completing the homing routine.
	4	"Sync Enable"	Must be used in order to hold the existing frequency when Sync Time is set to enable speed synchronization. When this bit is reset to zero the drive accelerates to the new commanded frequency based on A571 [Sync Time] setting.
	5	"Traverse Dis"	When set the traverse function is disabled.
	6	"Logic In 1"	This provides an identical function as the "Logic In1" Digital Input option. This bit is logically ORed with a digital input t062, t063, t065-t068 [DigIn TermBlk xx] set to 24 "Logic In1". It can be used to move through the Step-Logic functions (speed or position) using comms control without requiring actual digital input transitions.
	7	"Logic In 2"	This provides and identical function as the "Logic In2" Digital Input option. This bit is logically ORed with a digital input t062, t063, t065-t068 [DigIn TermBlk xx] set to 25 "Logic In2". It can be used to move through the Step-Logic functions (speed or position) using comms control without requiring actual digital input transitions.

A561 [Home Save]

PF 525 PowerFlex 525 only.

Determines whether the current position is saved on power down.

Options	0	"Home Reset" (Default)	Position resets to zero on power up.
	1	"Home Saved"	

Advanced Program Group *(continued)*

A562 [Find Home Freq]

PF 525 PowerFlex 525 only.

Sets the maximum frequency the drive uses when "Find Home" is issued.

Values	Default:	10.0 Hz
	Min/Max:	0.1/500.0 Hz
	Display:	0.1 Hz

A563 [Find Home Dir]

Stop drive before changing this parameter.

PF 525 PowerFlex 525 only.

Sets the direction the drive commands when "Find Home" is issued.

Options	0	"Forward" (Default)
	1	"Reverse"

A564 [Encoder Pos Tol]

PF 525 PowerFlex 525 only.

Sets the "At Position" and the "At Home' tolerance around the encoder count. The value is added to and subtracted from the target encoder unit value to create the tolerance range.

Values	Default:	100
	Min/Max:	1/50000
	Display:	1

A565 [Pos Reg Filter]

PF 525 PowerFlex 525 only.

Sets the error signal filter in the position regulator.

Values	Default:	8
	Min/Max:	0/15
	Display:	1

A566 [Pos Reg Gain]

PF 525 PowerFlex 525 only.

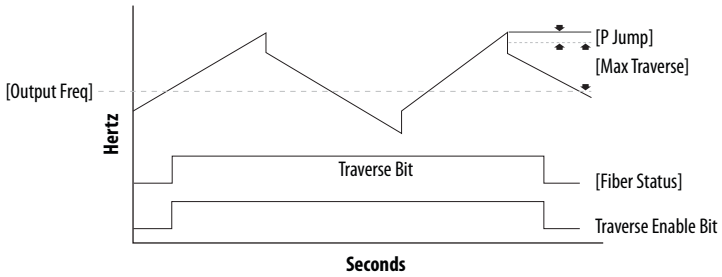
Sets the gain adjustment for the position regulator.

Values	Default:	3.0
	Min/Max:	0.0/200.0
	Display:	0.1

Advanced Program Group *(continued)*

A567 [Max Traverse]

Sets the amplitude of triangle wave speed modulation.



Values	Default:	0.00 Hz
	Min/Max:	0.00/300.00 Hz
	Display:	0.01 Hz

A568 [Traverse Inc] Related Parameter(s): A567

Sets the time required for the Traverse function to accelerate from the minimum to the maximum traverse frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 s
	Min/Max:	0.00/300.00 s
	Display:	0.01 s

A569 [Traverse Dec] Related Parameter(s): A567

Sets the time required for the Traverse function to decelerate from the maximum to the minimum traverse frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 s
	Min/Max:	0.00/300.00 s
	Display:	0.01 s

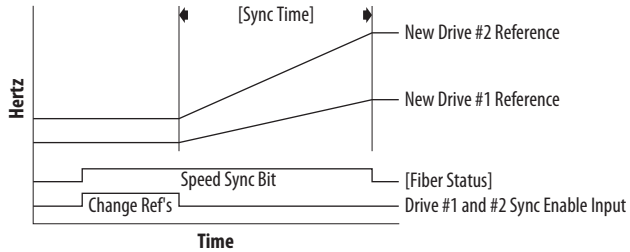
A570 [P Jump] Related Parameter(s): A567

Sets the frequency amplitude that is added to or subtracted from the commanded frequency. See the diagram at A567 [Max Traverse].

Values	Default:	0.00 Hz
	Min/Max:	0.00/300.00 Hz
	Display:	0.01 Hz

A571 [Sync Time] Related Parameter(s): t062, t063, t065 - t068, A560

Enables the function that holds the drive at the current frequency even if the commanded frequency changes. Used with t062, t063, t065-t068 [DigIn TermBlk xx] 32 "Sync Enable".



Values	Default:	0.0 s
	Min/Max:	0.0/3200.0 s
	Display:	0.1 s

Advanced Program Group *(continued)*

A572 [Speed Ratio]

Stop drive before changing this parameter.

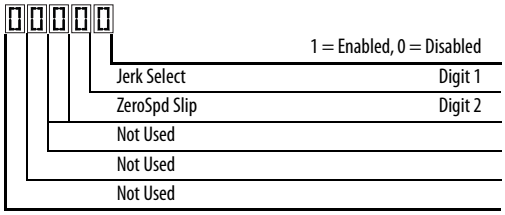
Scales the drive speed command.

Values	Default:	1.00
	Min/Max:	0.01/99.99
	Display:	0.01

A573 [Mtr Options Cfg]

(With FRN 2.xx and later.)

Sets the configuration of the motor option.



Options	Description
Jerk Select	Limits the rate of change to the velocity reference for improved current limiting. Set to 0 "Disabled" for positioning type applications with fast Accel or Decel times.
ZeroSpd Slip	Sets slip compensation to 0.0 Hz when the following conditions are met: • Commanded speed = 0.00 Hz • Status of drive = "At speed" • ZeroSpd Slip = 1 "Enabled"

Values	Default:	11
	Min/Max:	00/11
	Display:	00

Network Parameter Group

This group contains parameters for the network option card that is installed.

Refer to the network option card's user manual for more information on the available parameters.

Modified Parameter Group

This group contains parameters that have their values changed from the factory default.

When a parameter has its default value changed, it is automatically added to this group. When a parameter has its value changed back to the factory default, it is automatically removed from this group.

Fault and Diagnostic Group

F604 [Fault 4 Code]
F605 [Fault 5 Code]
F606 [Fault 6 Code]
F607 [Fault 7 Code]
F608 [Fault 8 Code]
F609 [Fault 9 Code]
F610 [Fault10 Code]

Related Parameter(s): b007-b009

A code that represents a drive fault. The codes appear in these parameters in the order they occur (b007 [Fault 1 Code] = the most recent fault). Repetitive faults are only recorded once.

Values	Default:	Read Only
	Min/Max:	F0/F127
	Display:	F0

F611 [Fault 1 Time-hr] **F612 [Fault 2 Time-hr]**
F613 [Fault 3 Time-hr] **F614 [Fault 4 Time-hr]**
F615 [Fault 5 Time-hr]

F616 [Fault 6 Time-hr] **F617 [Fault 7 Time-hr]**
F618 [Fault 8 Time-hr] **F619 [Fault 9 Time-hr]**
F620 [Fault10 Time-hr]

PF 525 PowerFlex 525 only.

Related Parameter(s): d362

Displays the value of d362 [Elapsed Time-hr] when the fault occurs.

Values	Default:	Read Only
	Min/Max:	0/32767 hr
	Display:	1 hr

F621 [Fault 1 Time-min] **F622 [Fault 2 Time-min]**
F623 [Fault 3 Time-min] **F624 [Fault 4 Time-min]**
F625 [Fault 5 Time-min]

F626 [Fault 6 Time-min] **F627 [Fault 7 Time-min]**
F628 [Fault 8 Time-min] **F629 [Fault 9 Time-min]**
F630 [Fault10 Time-min]

PF 525 PowerFlex 525 only.

Related Parameter(s): d363

Displays the value of d363 [Elapsed Time-min] when the fault occurs.

Values	Default:	Read Only
	Min/Max:	0.0/320.0 min
	Display:	0.1 min

F631 [Fault 1 Freq] **F632 [Fault 2 Freq]**
F633 [Fault 3 Freq] **F634 [Fault 4 Freq]**
F635 [Fault 5 Freq]

F636 [Fault 6 Freq] **F637 [Fault 7 Freq]**
F638 [Fault 8 Freq] **F639 [Fault 9 Freq]**
F640 [Fault10 Freq]

PF 525 PowerFlex 525 only.

Related Parameter(s): b001

Displays and stores the value of b001 [Output Freq] with the most recent 10 faults occurred.
[Fault 1 Freq] stores the most recent fault, [Fault 2 Freq] stores the second most recent fault and [Fault 3 Freq] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

Fault and Diagnostic Group *(continued)*

F641 [Fault 1 Current] **F642 [Fault 2 Current]**
F643 [Fault 3 Current] **F644 [Fault 4 Current]**
F645 [Fault 5 Current]

F646 [Fault 6 Current] **F647 [Fault 7 Current]**
F648 [Fault 8 Current] **F649 [Fault 9 Current]**
F650 [Fault10 Current]

PF 525 PowerFlex 525 only.

Related Parameter(s): b003

Displays and stores the value of b003 [Output Current] with the most recent 10 faults occurred.
[Fault 1 Current] stores the most recent fault, [Fault 2 Current] stores the second most recent fault and [Fault 3 Current] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps x 2)
	Display:	0.01 A

F651 [Fault 1 BusVolts] **F652 [Fault 2 BusVolts]**
F653 [Fault 3 BusVolts] **F654 [Fault 4 BusVolts]**
F655 [Fault 5 BusVolts]

F656 [Fault 6 BusVolts] **F657 [Fault 7 BusVolts]**
F658 [Fault 8 BusVolts] **F659 [Fault 9 BusVolts]**
F660 [Fault10 BusVolts]

PF 525 PowerFlex 525 only.

Related Parameter(s): b005

Displays and stores the value of b005 [DC Bus Voltage] with the most recent 10 faults occurred.
[Fault 1 BusVolts] stores the most recent fault, [Fault2 BusVolts] stores the second most recent fault and [Fault 3 BusVolts] stores the third most recent fault.

Values	Default:	Read Only
	Min/Max:	0/1200VDC
	Display:	1VDC

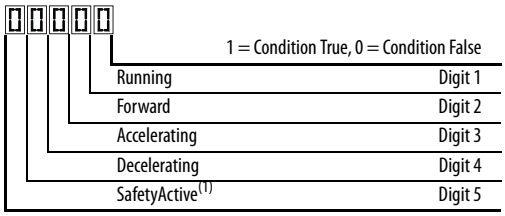
F661 [Status @ Fault 1] **F662 [Status @ Fault 2]**
F663 [Status @ Fault 3] **F664 [Status @ Fault 4]**
F665 [Status @ Fault 5]

F666 [Status @ Fault 6] **F667 [Status @ Fault 7]**
F668 [Status @ Fault 8] **F669 [Status @ Fault 9]**
F670 [Status @ Fault10]

PF 525 PowerFlex 525 only.

Related Parameter(s): b006

Displays the value of b006 [Drive Status] with the most recent 10 faults occurred.
[Status@ Fault 1] stores the most recent fault, [Status@ Fault 2] stores the second most recent fault and [Status@ Fault 3] stores the third most recent fault.



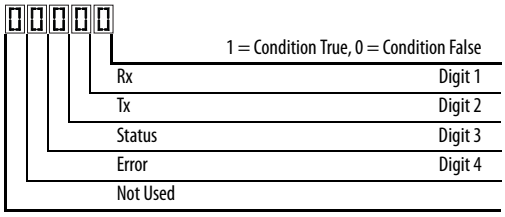
(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0/0x1F
	Display:	1

Fault and Diagnostic Group *(continued)*

F681 [Comm Sts - DSI]

Displays the status of the RS485 serial (DSI) port to the drive.



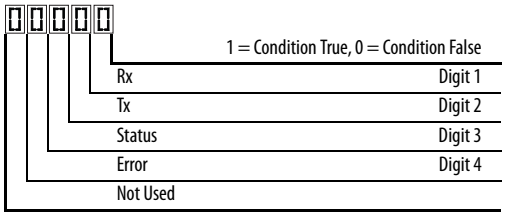
Digit 3 (Connection Status)	
0	"Not Active"
1	"Modbus slave network (external Modbus master)"
2	"Modbus multi-drive w/ internal com option master"
3	"Modbus multi-drive w/ embedded com master"(1)
4	"DSI peripheral connected"
5...8	"Reserved"
9	"RS-485 network faulted"

(1) Setting is specific to PowerFlex 525 drives only.

Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

F682 [Comm Sts - Opt]

Displays the status of the internal communication to the drive.



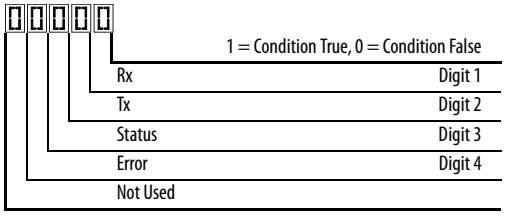
Digit 3 = "Internal Com option"	
0	"Not Active (no connection)"
1	"Internal option connected/active"
2...8	"Reserved"
9	"Internal com option faulted"

Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

F683 [Com Sts-Emb Enet]

PF 525 PowerFlex 525 only.

Displays the status of the embedded EtherNet/IP interface to the drive.



Digit 3 = "Embedded EtherNet/IP"	
0	"Not Active (no connection)"
1	"Embedded EtherNet/IP active"
2-8	"Reserved"
9	"Embedded EtherNet/IP faulted"

Values	Default:	Read Only
	Min/Max:	0000/1911
	Display:	0000

F684 [EN Addr Src]

PF 525 PowerFlex 525 only.

Displays the actual source of the Ethernet configuration (IP address, subnet mask, and gateway address).

Options	1 "Parameters"	Read Only
	2 "BOOTP"	

Fault and Diagnostic Group *(continued)*

F685 [EN Rate Act]

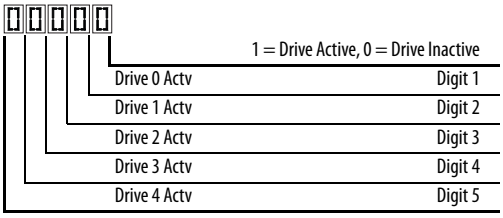
PF 525 PowerFlex 525 only.

Displays the network data rate currently used by the embedded EtherNet/IP interface.

Options	0	"No Link"	Read Only
	1	"10Mbps Full"	
	2	"10Mbps Half"	
	3	"100Mbps Full"	
	4	"100Mbps Half"	
	5	"Dup IP Addr"	
	6	"Disabled"	

F686 [DSI I/O Act]

Displays the Drives that are active in Multi-Drive mode.



Value	Default:	Read Only
	Min/Max:	00000/11111
	Display:	00000

F687 [HW Addr 1]
F688 [HW Addr 2]
F689 [HW Addr 3]
F690 [HW Addr 4]
F691 [HW Addr 5]
F692 [HW Addr 6]

PF 525 PowerFlex 525 only.

Shows the MAC address for the embedded EtherNet/IP interface.

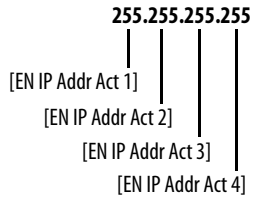
Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

Fault and Diagnostic Group *(continued)*

F693 [EN IP Addr Act 1]
F694 [EN IP Addr Act 2]
F695 [EN IP Addr Act 3]
F696 [EN IP Addr Act 4]

PF 525 PowerFlex 525 only.

Shows the actual IP address used by the embedded EtherNet/IP interface at the time. This indicates 0 if no address is set.

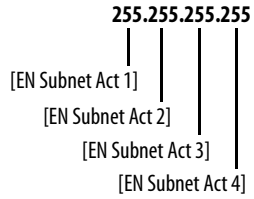


Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

F697 [EN Subnet Act 1]
F698 [EN Subnet Act 2]
F699 [EN Subnet Act 3]
F700 [EN Subnet Act 4]

PF 525 PowerFlex 525 only.

Shows the actual subnet mask used by the embedded EtherNet/IP interface at the time. This will indicate 0 if no address is set.

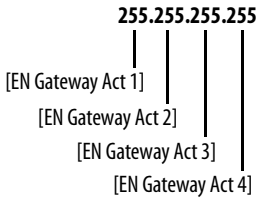


Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

F701 [EN Gateway Act 1]
F702 [EN Gateway Act 2]
F703 [EN Gateway Act 3]
F704 [EN Gateway Act 4]

PF 525 PowerFlex 525 only.

Shows the actual gateway address used by the embedded EtherNet/IP interface at the time. This will indicate 0 if no address is set.



Values	Default:	Read Only
	Min/Max:	0/255
	Display:	1

Fault and Diagnostic Group *(continued)*

F705 [Drv 0 Logic Cmd]
F709 [Drv 1 Logic Cmd]
F713 [Drv 2 Logic Cmd]
F717 [Drv 3 Logic Cmd]
F721 [Drv 4 Logic Cmd]

In multi-drive mode, this is the logic command being transmitted to drive 0/1/2/3/4/.
In single-drive mode, this is the logic command being used by the drive (whether HS-DSI, EtherNet/IP, or DSI) at the time. If comms control is NOT being used, and the drive is in single-drive mode, then this parameter will show 0.

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

F706 [Drv 0 Reference]
F710 [Drv 1 Reference]
F714 [Drv 2 Reference]
F718 [Drv 3 Reference]
F722 [Drv 4 Reference]

In multi-drive mode, this is the reference being transmitted to drive 0/1/2/3/4.
In single-drive mode, this is the reference being used by the drive (whether HS-DSI, EtherNet/IP, or DSI) at the time. If comms control is NOT being used, and the drive is in single-drive mode, then this parameter will show 0.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

F707 [Drv 0 Logic Sts]
F711 [Drv 1 Logic Sts]
F715 [Drv 2 Logic Sts]
F719 [Drv 3 Logic Sts]
F723 [Drv 4 Logic Sts]

In multi-drive mode, this is the logic status being received from drive 0/1/2/3/4.
In single-drive mode, this is the logic status of the drive at the time.

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1

F708 [Drv 0 Feedback]
F712 [Drv 1 Feedback]
F716 [Drv 2 Feedback]
F720 [Drv 3 Feedback]
F724 [Drv 4 Feedback]

In multi-drive mode, this is the feedback being received from drive 0/1/2/3/4.
In single-drive mode, this is the feedback of the drive at the time.

Values	Default:	Read Only
	Min/Max:	0.00/500.00 Hz
	Display:	0.01 Hz

F725 [EN Rx Overruns]

PF 525 PowerFlex 525 only.

A count of the number of receive overrun errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

Fault and Diagnostic Group *(continued)*

F726 [EN Rx Packets]

PF 525 PowerFlex 525 only.

A count of the number of receive packets reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F727 [EN Rx Errors]

PF 525 PowerFlex 525 only.

A count of the number of receive errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F728 [EN Tx Packets]

PF 525 PowerFlex 525 only.

A count of the number of transmitted packets reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F729 [EN Tx Errors]

PF 525 PowerFlex 525 only.

A count of the number of transmit errors reported by the embedded EtherNet/IP interface.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F730 [EN Missed IO Pkt]

PF 525 PowerFlex 525 only.

The number of I/O packets missed.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

F731 [DSI Errors]

The number of total DSI errors.

Values	Default:	Read Only
	Min/Max:	0/65535
	Display:	1

AppView Parameter Groups

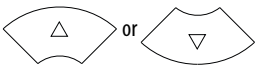
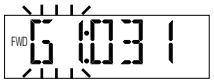
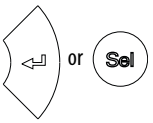
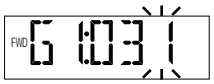
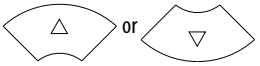
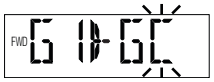
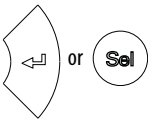
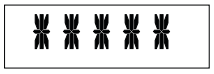
AppView parameter groups provide a simple starting point for using the PowerFlex 520-series drives by grouping certain commonly used parameters based on different types of applications. Use these parameter groups to quickly and easily setup the PowerFlex 520-series drive for your application.

AppView parameter groups are available for the following applications:

- Conveyor
- Mixer
- Compressor
- Centrifugal Pump
- Blower/Fan
- Extruder
- Positioning (PowerFlex 525 only)
- Textile/Fiber

You cannot add or remove parameters to or from the AppView parameter groups. If you require quick access to additional parameters to what is already included in the different AppView parameter groups, use the CustomView parameter group instead.

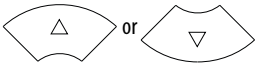
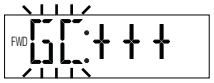
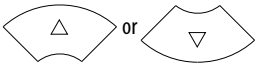
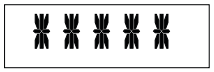
The parameters in the AppView parameter groups can be quickly added to the CustomView parameter group by doing the following:

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to an AppView group (G1...G8).		
2.	Press Enter or Sel to enter a group. The right most digit of the last viewed parameter in that group will flash.		
3.	Press the Up Arrow or Down Arrow to scroll to the command G1->GC.		
4.	Press Enter or Sel to add all the parameters in this AppView group to the CustomView group. The LCD display will show a confirmation.		

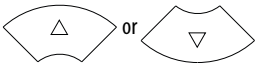
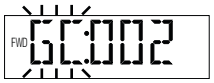
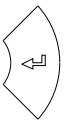
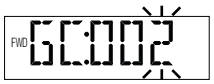
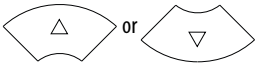
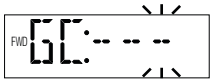
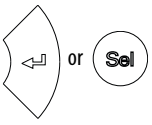
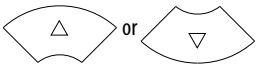
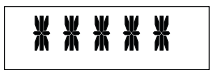
CustomView Parameter Group

CustomView allows you to quickly access only the parameters needed for your application by storing them in a custom parameter group. Add your frequently used parameters to this group, then hide all other parameters with A552 [Program Lock] to simplify your drive configuration process.

Up to 100 parameters can be stored in the CustomView parameter group. You can copy one entire AppView parameter group to the CustomView parameter group as shown on page 137 or add individual parameters as show below.

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to the CustomView group (GC).		
2.	Press Enter to view the parameters that can be added to the CustomView group.		
3.	Press the Up Arrow or Down Arrow to scroll through the list of parameters.		
4.	Press Enter to add the parameter to the CustomView group. The LCD display will show a confirmation.		

To delete parameters from the CustomView parameter group:

Step		Key(s)	Example Displays
1.	Press the Up Arrow or Down Arrow to scroll to the CustomView group (GC).		
2.	Press Enter to view the parameters that are in the CustomView group.		
3.	Press the Up Arrow or Down Arrow to scroll to the command GC---.		
4.	Press Enter or Sel to view the parameters that are stored in the CustomView group.		
5.	Press the Up Arrow or Down Arrow to scroll through the list of parameters.		
6.	Press Enter to delete the parameter from the CustomView group. The LCD display will show a confirmation.		

TIP The Connected Components Workbench software can be used to speed up this process with drag and drop functionality.

Parameter Cross Reference by Name

Parameter Name	No.
10V Bipolar Enbl[1]	093
2-Wire Mode	064
Accel Time 1	041
Accel Time 2	442
Accel Time 3	444
Accel Time 4	446
Accum CO2 Sav	026
Accum Cost Sav	025
Accum kWh Sav	024
Analog In 0-10V	360
Analog In 4-20mA	361
Analog In Filter	099
Analog Out High[1]	089
Analog Out Sel[1]	088
Anlg In 0-10V Hi	092
Anlg In 0-10V Lo	091
Anlg In mA Loss	097
Anlg In V Loss	094
Anlg In4-20mA Hi	096
Anlg In4-20mA Lo	095
Anlg Loss Delay	098
Anlg Out Setpt[1]	090
Auto Rstrt Delay	542
Auto Rstrt Tries	541
Autotune	040
Average kWh Cost	052
Average Power	020
Boost Select	530
Break Frequency	533
Break Voltage	532
Bus Reg Enable	550
Cmd Stat Select[1]	122
Com Sts-Emb Enet[1]	683
Comm Loss Action	125
Comm Loss Time	126
Comm Sts - DSI	681
Comm Sts - Opt	682
Comm Write Mode	121
Commanded Freq	002
Compensation	547
Contrl In Status	013
Control Source	012
Control SW Ver	029
Control Temp	028
Counter Status	364
Counts Per Unit[1]	559
Current Limit 1	484
Current Limit 2[1]	485
DB Resistor Sel	437
DB Threshold	438
DC Brake Level	435
DC Brake Time	434
DC Brk Time@Strt	436
DC Bus Ripple	380
DC Bus Voltage	005
Decel Time 1	042
Decel Time 2	443
Decel Time 3	445
Decel Time 4	447
Dig In Status	014
DigIn TermBlk 02	062
DigIn TermBlk 03	063
DigIn TermBlk 05	065
DigIn TermBlk 06	066
DigIn TermBlk 07[1]	067
DigIn TermBlk 08[1]	068
Drive OL Mode	495
Drive Status	006
Drive Temp	027
Drive Type	367
Droop Hertz@ FLA[1]	441
Drv 0 Feedback	708
Drv 0 Logic Cmd	705
Drv 0 Logic Sts	707
Drv 0 Reference	706
Drv 1 Addr	171
Drv 1 Feedback	712
Drv 1 Logic Cmd	709
Drv 1 Logic Sts	711
Drv 1 Reference	710
Drv 2 Addr	172
Drv 2 Feedback	716
Drv 2 Logic Cmd	713
Drv 2 Logic Sts	715
Drv 2 Reference	714
Drv 3 Addr	173
Drv 3 Feedback	720
Drv 3 Logic Cmd	717
Drv 3 Logic Sts	719
Drv 3 Reference	718
Drv 4 Addr	174
Drv 4 Feedback	724
Drv 4 Logic Cmd	721
Drv 4 Logic Sts	723
Drv 4 Reference	722
Drv Ambient Sel	554
DSI Errors	731
DSI I/O Act	686
DSI I/O Cfg	175
Elapsed kWh	021
Elapsed MWh	022
Elapsed Run Time	019
Elapsed Time-hr	362
Elapsed Time-min	363
EM Brk Off Delay	086
EM Brk On Delay	087
EN Addr Sel[1]	128
EN Addr Src[1]	684
EN Comm Flt Actn[1]	143
EN Data In 1[1]	153
EN Data In 2[1]	154
EN Data In 3[1]	155
EN Data In 4[1]	156
EN Data Out 1[1]	157
EN Data Out 2[1]	158
EN Data Out 3[1]	159
EN Data Out 4[1]	160
EN Flt Cfg DL 1[1]	147
EN Flt Cfg DL 2[1]	148
EN Flt Cfg DL 3[1]	149
EN Flt Cfg DL 4[1]	150
EN Flt Cfg Logic[1]	145
EN Flt Cfg Ref[1]	146
EN Gateway Act 1[1]	701
EN Gateway Act 2[1]	702
EN Gateway Act 3[1]	703
EN Gateway Act 4[1]	704
EN Gateway Cfg 1[1]	137
EN Gateway Cfg 2[1]	138
EN Gateway Cfg 3[1]	139
EN Gateway Cfg 4[1]	140
EN Idle Flt Actn[1]	144
EN IP Addr Act 1[1]	693
EN IP Addr Act 2[1]	694
EN IP Addr Act 3[1]	695
EN IP Addr Act 4[1]	696
EN IP Addr Cfg 1[1]	129
EN IP Addr Cfg 2[1]	130
EN IP Addr Cfg 3[1]	131
EN IP Addr Cfg 4[1]	132
EN Missed IO Pkt[1]	730

(1) Parameter is specific to PowerFlex 525 drives only.

Parameter Name	No.
EN Rate Act[1]	685
EN Rate Cfg[1]	141
EN Rx Errors[1]	727
EN Rx Overruns[1]	725
EN Rx Packets[1]	726
EN Subnet Act 1[1]	697
EN Subnet Act 2[1]	698
EN Subnet Act 3[1]	699
EN Subnet Act 4[1]	700
EN Subnet Cfg 1[1]	133
EN Subnet Cfg 2[1]	134
EN Subnet Cfg 3[1]	135
EN Subnet Cfg 4[1]	136
EN Tx Errors[1]	729
EN Tx Packets[1]	728
Encoder Pos Tol[1]	564
Encoder PPR[1]	536
Encoder Speed[1]	378
Energy Saved	023
Enh Control Word[1]	560
Fault 1 BusVolts	651
Fault 1 Code	007
Fault 1 Current	641
Fault 1 Freq	631
Fault 1 Time-hr	611
Fault 1 Time-min	621
Fault 2 BusVolts	652
Fault 2 Code	008
Fault 2 Current	642
Fault 2 Freq	632
Fault 2 Time-hr	612
Fault 2 Time-min	622
Fault 3 BusVolts	653
Fault 3 Code	009
Fault 3 Current	643
Fault 3 Freq	633
Fault 3 Time-hr	613
Fault 3 Time-min	623
Fault 4 BusVolts	654
Fault 4 Code	604
Fault 4 Current	644
Fault 4 Freq	634
Fault 4 Time-hr	614
Fault 4 Time-min	624
Fault 5 BusVolts	655
Fault 5 Code	605
Fault 5 Current	645
Fault 5 Freq	635

Parameter Name	No.
Fault 5 Time-hr	615
Fault 5 Time-min	625
Fault 6 BusVolts[1]	656
Fault 6 Code[1]	606
Fault 6 Current[1]	646
Fault 6 Freq[1]	636
Fault 6 Time-hr[1]	616
Fault 6 Time-min[1]	626
Fault 7 BusVolts[1]	657
Fault 7 Code[1]	607
Fault 7 Current[1]	647
Fault 7 Freq[1]	637
Fault 7 Time-hr[1]	617
Fault 7 Time-min[1]	627
Fault 8 BusVolts[1]	658
Fault 8 Code[1]	608
Fault 8 Current[1]	648
Fault 8 Freq[1]	638
Fault 8 Time-hr[1]	618
Fault 8 Time-min[1]	628
Fault 9 BusVolts[1]	659
Fault 9 Code[1]	609
Fault 9 Current[1]	649
Fault 9 Freq[1]	639
Fault 9 Time-hr[1]	619
Fault 9 Time-min[1]	629
Fault Clear	551
Fault10 BusVolts[1]	660
Fault10 Code[1]	610
Fault10 Current[1]	650
Fault10 Freq[1]	640
Fault10 Time-hr[1]	620
Fault10 Time-min[1]	630
Fiber Status	390
Find Home Dir[1]	563
Find Home Freq[1]	562
Flux Current Ref	497
Flying Start En	545
FlyStrt CurLimit	546
Freq 1[1]	510
Freq 1 BW[1]	511
Freq 1 Ki[1]	522
Freq 1 Kp[1]	521
Freq 2[1]	512
Freq 2 BW[1]	513
Freq 2 Ki[1]	524
Freq 2 Kp[1]	523
Freq 3[1]	514

Parameter Name	No.
Freq 3 BW[1]	515
Freq 3 Ki[1]	526
Freq 3 Kp[1]	525
Half Bus Enable	549
Home Save[1]	561
HW Addr 1[1]	687
HW Addr 2[1]	688
HW Addr 3v	689
HW Addr 4[1]	690
HW Addr 5[1]	691
HW Addr 6[1]	692
IR Voltage Drop	496
Jog Accel/Decel	432
Jog Frequency	431
Keypad Freq	426
Ki Speed Loop[1]	538
Kp Speed Loop[1]	539
Language	30
Load Loss Level[1]	490
Load Loss Time[1]	491
Max Traverse	567
Maximum Freq	044
Maximum Voltage	534
Minimum Freq	043
MOP Freq	427
MOP Preload	429
MOP Reset Sel	428
MOP Time	430
Motor Fdbk Type[1]	535
Motor Lm[1]	499
Motor Lx[1]	500
Motor NP FLA	034
Motor NP Hertz	032
Motor NP Poles	035
Motor NP Power[1]	037
Motor NP RPM	036
Motor NP Volts	031
Motor OL Current	033
Motor OL Level	369
Motor OL Ret	494
Motor OL Select	493
Motor Rr[1]	498
Mtr Options Cfg	573
MultiDrv Sel	169
Opt Data In 1	161
Opt Data In 2	162
Opt Data In 3	163
Opt Data In 4	164

(1) Parameter is specific to PowerFlex 525 drives only.

Parameter Name	No.
Opt Data Out 1	165
Opt Data Out 2	166
Opt Data Out 3	167
Opt Data Out 4	168
Opto Out Logic(1)	075
Opto Out1 Level(1)	070
Opto Out1 Sel(1)	069
Opto Out2 Level(1)	073
Opto Out2 Sel(1)	072
Out Phas Loss En	557
Output Current	003
Output Freq	001
Output Power	017
Output Powr Fctr	381
Output RPM	015
Output Speed	016
Output Voltage	004
P Jump	570
PID 1 Deadband	465
PID 1 Diff Rate	463
PID 1 Fdback Sel	460
PID 1 Integ Time	462
PID 1 Invert Err	467
PID 1 Preload	466
PID 1 Prop Gain	461
PID 1 Ref Sel	459
PID 1 Setpoint	464
PID 1 Trim Hi	456
PID 1 Trim Lo	457
PID 1 Trim Sel	458
PID1 Fdbk Displ	383
PID1 Setpnt Disp	384
PID 2 Deadband(1)	477
PID 2 Diff Rate(1)	475
PID 2 Fdback Sel(1)	472
PID 2 Integ Time(1)	474
PID 2 Invert Err(1)	479
PID 2 Preload(1)	478
PID 2 Prop Gain(1)	473
PID 2 Ref Sel(1)	471
PID 2 Setpoint(1)	476
PID 2 Trim Hi(1)	468
PID 2 Trim Lo(1)	469
PID 2 Trim Sel(1)	470
PID2 Fdbk Displ(1)	385
PID2 Setpnt Disp(1)	386
Pos Reg Filter(1)	565
Pos Reg Gain(1)	566

Parameter Name	No.
Position Status(1)	387
Positioning Mode(1)	558
Power Loss Mode	548
Power Saved	018
Preset Freq 0	410
Preset Freq 1	411
Preset Freq 2	412
Preset Freq 3	413
Preset Freq 4	414
Preset Freq 5	415
Preset Freq 6	416
Preset Freq 7	417
Preset Freq 8(1)	418
Preset Freq 9(1)	419
Preset Freq 10(1)	420
Preset Freq 11(1)	421
Preset Freq 12(1)	422
Preset Freq 13(1)	423
Preset Freq 14(1)	424
Preset Freq 15(1)	425
Process Disp Hi	482
Process Disp Lo	481
Process Display	010
Program Lock	552
Program Lock Mod	553
Pulse In Scale	537
Purge Frequency	433
PWM Frequency	440
Relay 1 Off Time	080
Relay 1 On Time	079
Relay Out1 Level	077
Relay Out1 Sel	076
Relay 2 Off Time(1)	085
Relay 2 On Time(1)	084
Relay Out2 Level(1)	082
Relay Out2 Sel(1)	081
Reset Meters	555
Reset to Defalts	053
Reverse Disable	544
RS485 Data Rate	123
RS485 Format	127
RS485 Node Addr	124
S Curve %	439
Safety Open En(1)	105
Shear Pin 1 Time	487
Shear Pin1 Level	486
Shear Pin 2 Time(1)	489
Shear Pin2 Level(1)	488

Parameter Name	No.
Skip Freq Band 1	449
Skip Freq Band 2	451
Skip Freq Band 3(1)	453
Skip Freq Band 4(1)	455
Skip Frequency 1	448
Skip Frequency 2	450
Skip Frequency 3(1)	452
Skip Frequency 4(1)	454
Sleep Level	101
Sleep Time	102
Sleep-Wake Sel	100
Slip Hz Meter	375
Speed Feedback	376
Speed Ratio	572
Speed Reference1	047
Speed Reference2	049
Speed Reference3	051
Speed Reg Sel(1)	509
Stall Fault Time	492
Start At PowerUp	543
Start Boost	531
Start Source 1	046
Start Source 2	048
Start Source 3	050
Status @ Fault 1	661
Status @ Fault 2	662
Status @ Fault 3	663
Status @ Fault 4	664
Status @ Fault 5	665
Status @ Fault 6(1)	666
Status @ Fault 7(1)	667
Status @ Fault 8(1)	668
Status @ Fault 9(1)	669
Status @ Fault10(1)	670
Step Units 0(1)	200
Step Units 1(1)	202
Step Units 2(1)	204
Step Units 3(1)	206
Step Units 4(1)	208
Step Units 5(1)	210
Step Units 6(1)	212
Step Units 7(1)	214
Stop Mode	045
Stp Logic 0(1)	180
Stp Logic 1(1)	181
Stp Logic 2(1)	182
Stp Logic 3(1)	183
Stp Logic 4(1)	184

(1) Parameter is specific to PowerFlex 525 drives only.

Parameter Name	No.
Stp Logic 5[1]	185
Stp Logic 6[1]	186
Stp Logic 7[1]	187
Stp Logic Status[1]	391
Stp Logic Time 0[1]	190
Stp Logic Time 1[1]	191
Stp Logic Time 2[1]	192
Stp Logic Time 3[1]	193
Stp Logic Time 4[1]	194

Parameter Name	No.
Stp Logic Time 5[1]	195
Stp Logic Time 6[1]	196
Stp Logic Time 7[1]	197
Sync Time	571
Testpoint Data	368
Testpoint Sel	483
Text Scroll	556
Timer Status	365
Torque Current	382

Parameter Name	No.
Torque Perf Mode	039
Traverse Dec	569
Traverse Inc	568
Units Traveled H[1]	388
Units Traveled L[1]	389
Var PWM Disable	540
Voltage Class	038
Wake Level	103
Wake Time	104

(1) Parameter is specific to PowerFlex 525 drives only.

Troubleshooting

This chapter provides information to guide you in troubleshooting the PowerFlex 520-series drive. Included is a listing and description of drive faults with possible solutions, when applicable.

For information on...	See page...
Drive Status	143
Faults	143
Fault Descriptions	145
Common Symptoms and Corrective Actions	148



ATTENTION: Risk of injury or equipment damage exists. Drive does not contain user-serviceable components. Do not disassemble drive chassis.

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral LCD display.

See Display and Control Keys on page 58 for information on drive status indicators and controls.

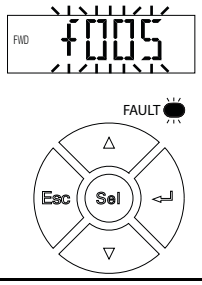
Faults

A fault is a condition that stops the drive. There are two fault types.

Fault Types

Type	Fault Description	
1	Auto-Reset/Run	When this type of fault occurs, and A541 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A542 [Auto Rstrt Delay], begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
2	Non-Resettable	This type of fault may require drive or motor repair, or is caused by wiring or programming errors. The cause of the fault must be corrected before the fault can be cleared.

Fault Indication

Condition	Display
Drive is indicating a fault. The integral LCD display provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator (LED) Press the Esc key to regain control of the display.	

Manually Clearing Faults

Step	Key(s)
1. Press Esc to acknowledge the fault. The fault information will be removed so that you can use the integral keypad. Access b007 [Fault 1 Code] to view the most recent fault information. 2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared. See Fault Types, Descriptions and Actions on page 145. 3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".	

Automatically Clearing Faults

Option/Step	
Clear a Type 1 fault and restart the drive. 1. Set A541 [Auto Rstrt Tries] to a value other than "0". 2. Set A542 [Auto Rstrt Delay] to a value other than "0". **Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.** 1. Set A541 [Auto Rstrt Tries] to a value other than "0". 2. Set A542 [Auto Rstrt Delay] to "0".	



ATTENTION: Equipment damage and/or personal injury may result if these parameters are used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Auto Restart (Reset/Run)

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. This allows remote or "unattended" operation. Only certain faults are allowed to be reset. Certain faults (Type 2) that indicate possible drive component malfunction are not resettable. Fault types are listed in the table Fault Types on page 143. See Fault Descriptions on page 145 for more information.

Use caution when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F000	No Fault	–	No fault present.	–
F002	Auxiliary Input	1	External trip (Auxiliary) input.	• Check remote wiring. • Verify communications programming for intentional fault.
F003	Power Loss	2	Single phase operation detected with excessive load.	• Monitor the incoming AC line for low voltage or line power interruption. • Check input fuses. • Reduce load.
F004	UnderVoltage	1	DC bus voltage fell below the minimum value.	Monitor the incoming AC line for low voltage or line power interruption.
F005	OverVoltage	1	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
F006	Motor Stalled	1	Drive is unable to accelerate or decelerate motor.	• Increase P041, A442, A444, A446 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A484, A485 [Current Limit x] for too long. • Check for overhauling load.
F007	Motor Overload	1	Internal electronic overload trip.	• An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. • Verify A530 [Boost Select] setting.
F008	Heatsink OvrTmp	1	Heatsink/Power Module temperature exceeds a predefined value.	• Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded the rated ambient temperature. • Check fan.
F009	CC OvrTmp	1	Control module temperature exceeds a predefined value.	• Check product ambient temperature. • Check for airflow obstruction. • Check for dirt or debris. • Check fan.
F012	HW OverCurrent	2	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A530 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F013	Ground Fault	1[3]	A current path to earth ground has been detected at one or more of the drive output terminals.	Check the motor and external wiring to the drive output terminals for a grounded condition.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F015[1]	Load Loss	2	The output torque current is below the value programmed in A490 [Load Loss Level] for a time period greater than the time programmed in A491 [Load Loss Time].	• Verify connections between motor and load. • Verify level and time requirements
F021	Output Ph Loss	1	Output Phase Loss (if enabled). Configure with A557 [Out Phas Loss En].	• Verify motor wiring. • Verify motor.
F029	Analog In Loss	1	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with t094 [Anlg In V Loss] or t097 [Anlg In mA Loss].	• Check for broken/loose connections at inputs. • Check parameters.
F033	Auto Rstrt Tries	2	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A541 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F038	Phase U to Gnd	2	A phase to ground fault has been detected between the drive and motor in this phase.	• Check the wiring between the drive and motor. • Check motor for grounded phase. • Replace drive if fault cannot be cleared.
F039	Phase V to Gnd			
F040	Phase W to Gnd			
F041	Phase UV Short	2	Excessive current has been detected between these two output terminals.	• Check the motor and drive output terminal wiring for a shorted condition. • Replace drive if fault cannot be cleared.
F042	Phase UW Short			
F043	Phase VW Short			
F048	Params Defaulted	1	The drive was commanded to write default values to EEPROM.	• Clear the fault or cycle power to the drive. • Program the drive parameters as needed.
F059[1]	Safety Open	1	Both of the safety inputs (Safety 1, Safety 2) are not enabled. Configure with t105 [Safety Open En].	• Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+.
F063	SW OverCurrent	1	Programmed A486, A488 [Shear Pinx Level] has been exceeded for a time period greater than the time programmed in A487, A489 [Shear Pin x Time].	• Verify connections between motor and load. • Verify level and time requirements.
F064	Drive Overload	2	Drive overload rating has been exceeded.	Reduce load or extend Accel Time.
F070	Power Unit	2	Failure has been detected in the drive power section.	• Check maximum ambient temperature has not been exceeded. • Cycle power. • Replace drive if fault cannot be cleared.
F071	DSI Net Loss	2	Control over the Modbus or DSI communication link has been interrupted.	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status.
F072	Opt Net Loss	2	Control over the network option card's remote network has been interrupted.	• Cycle power. • Check communications cabling. • Check network adapter setting. • Check external network status.
F073[1]	EN Net Loss	2	Control through the embedded EtherNet/IP adapter has been interrupted.	• Cycle power. • Check communications cabling. • Check EtherNet/IP setting. • Check external network status.
F080	Autotune Failure	2	The autotune function was either cancelled by the user or failed.	Restart procedure.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F081	DSI Comm Loss	2	Communications between the drive and the Modbus or DSI master device have been interrupted.	• Cycle power. • Check communications cabling. • Check Modbus or DSI setting. • Check Modbus or DSI status. • Modify using C125 [Comm Loss Action]. • Connecting I/O terminals C1 and C2 to ground may improve noise immunity. • Replace wiring, Modbus master device, or control module.
F082	Opt Comm Loss	2	Communications between the drive and the network option card have been interrupted.	• Cycle power. • Reinstall option card in drive. • Modify using C125 [Comm Loss Action]. • Replace wiring, port expander, option card, or control module.
F083[1]	EN Comm Loss	2	Internal communications between the drive and the embedded EtherNet/IP adapter have been interrupted.	• Cycle power. • Check EtherNet/IP setting. • Check drive's Ethernet settings and diagnostic parameters. • Modify using C125 [Comm Loss Action]. • Replace wiring, Ethernet switch, or control module.
F091[1]	Encoder Loss	2	Requires differential encoder. One of the 2 encoder channel signals is missing.	• Check Wiring. • If P047, P049, P051 [Speed Referencex] = 16 "Positioning" and A535 [Motor Fdbk Type] = 5 "Quad Check", swap the Encoder channel inputs or swap any two motor leads. • Replace encoder.
F094	Function Loss	2	"Freeze-Fire" (Function Loss) input is inactive, input to the programmed terminal is open.	Close input to the terminal and cycle power.
F100	Parameter Chksum	2	Drive parameter non-volatile storage is corrupted.	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F101	External Storage	2	External non-volatile storage has failed.	Set P053 [Reset To Defalts] to 2 "Factory Rset".
F105	C Connect Err	2	Control module was disconnected while drive was powered.	Clear fault and verify all parameter settings. Do not remove or install the control module while power is applied.
F106	Incompat C-P	2	The PowerFlex 525 control module does not support power modules with 0.25 HP power rating.	• Change to a different power module. • Change to a PowerFlex 523 control module.
F107	Replaced C-P	2	The control module could not recognize the power module. Hardware failure.	• Change to a different power module. • Replace control module if changing power module does not work.
F109	Mismatch C-P	2	The control module was mounted to a different drive type power module.	Set P053 [Reset To Defalts] to 3 "Power Reset".
F110	Keypad Membrane	2	Keypad membrane failure / disconnected.	• Cycle power. • Replace control module if fault cannot be cleared.
F111[1]	Safety Hardware	2	Safety input enable hardware malfunction. One of the safety inputs is not enabled.	• Check safety input signals. If not using safety, verify and tighten jumper for I/O terminals S1, S2 and S+. • Replace control module if fault cannot be cleared.
F114	uC Failure	2	Microprocessor failure.	• Cycle power. • Replace control module if fault cannot be cleared.

Fault Types, Descriptions and Actions

No.	Fault	Type[2]	Description	Action
F122	I/O Board Fail	2	Failure has been detected in the drive control and I/O section.	• Cycle power. • Replace drive or control module if fault cannot be cleared.
F125	Flash Update Req	2	The firmware in the drive is corrupt, mismatched, or incompatible with the hardware.	Perform a firmware flash update operation to attempt to load a valid set of firmware.
F126	NonRecoverablErr	2	A non-recoverable firmware or hardware error was detected. The drive was automatically stopped and reset.	• Clear fault or cycle power to the drive. • Replace drive or control module if fault cannot be cleared.
F127	DSIFlashUpdatReq	2	A critical problem with the firmware was detected and the drive is running using backup firmware that only supports DSI communications.	Perform a firmware flash update operation using DSI communications to attempt to load a valid set of firmware.

(1) This fault is not applicable to PowerFlex 523 drives.
(2) See Fault Types for more information.
(3) This fault may be cleared by the auto-restart routine and will be attempted only once. It ignores the value set in parameter A541 [Auto Rstrt Tries].

Common Symptoms and Corrective Actions

The drive is designed to start from the keypad when shipped. For a basic test of drive operation:

1. Remove all user I/O wire.
2. Verify safety terminals (S1, S2 and S+) jumper is in place and tightened.
3. Verify wire jumper is in place between I/O terminals 01 and 11.
4. Verify that the three jumpers are in their proper default positions on the control board. See PowerFlex 525 Control I/O Wiring Block Diagram on page 39 for more information.
5. Reset default parameter values by setting P053 [Reset Defalts] to 2 “Factory Rset”.
6. If safe to do so for your application, press Start on drive keypad. Drive will run according to the speed potentiometer.

Motor does not Start.

Cause(s)	Indication	Corrective Action
No output voltage to the motor.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects. Check the motor. • Verify that the motor is connected properly. Check the control input signals. • Verify that a Start signal is present. If 2-Wire control is used, verify that either the Run Forward or Run Reverse signal is active, but not both. • Verify that I/O Terminal 01 is active. • Verify that P046, P048, P050 [Start Source x] matches your configuration. • Verify that A544 [Reverse Disable] is not prohibiting movement. • Verify that safety inputs (Safety 1 and Safety 2) are active.
Improper boost setting at initial start-up.	None	Set A530 [Boost Select] to 2 "35.0, VT".
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".
Incorrect programming. • P046, P048, P050 [Start Source x] is set incorrectly.	None	Check setting for b012 [Control Source].
Incorrect input wiring. See page 42 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	• Wire inputs correctly and/or install jumper. • If the PowerFlex 525 Safe-Torque-Off function is used, verify that inputs are active. • If 2-wire or 3-wire mode is used, verify that t062 [DigIn TermBlk 02] and t063 [DigIn TermBlk 03] are set properly.
Incorrect Sink/Source jumper setting.	None	Set switch to match wiring scheme.

Drive does not Start from Start or Run Inputs wired to the terminal block.

Cause(s)	Indication	Corrective Action
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop if P045 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A551 [Fault Clear] to 1 "Reset Fault" or 2 "Clear Buffer". • Cycle digital input if t062, t063, t065...t068 [DigIn TermBlk xx] is set to 13 "Clear Fault".
Incorrect programming. • P046, P048, P050 [Start Source x] is set incorrectly. • t062, t063 [DigIn TermBlk 02/03] is set incorrectly.	None	Check parameter settings.
Incorrect input wiring. See page 42 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	• Wire inputs correctly and/or install jumper. • If the PowerFlex 525 Safe-Torque-Off function is used, verify that inputs are active.
Incorrect Sink/Source jumper setting.	None	Set switch to match wiring scheme.

Drive does not respond to changes in speed command.

Cause(s)	Indication	Corrective Action
No value is coming from the source of the command.	The drive "Run" indicator is lit and output is 0 Hz.	• Check b012 [Control Source] for correct source. • If the source is an analog input, check wiring and use a meter to check for presence of signal. • Check b002 [Commanded Freq] to verify correct command.
Incorrect reference source is being selected by remote device or digital inputs.	None	• Check b012 [Control Source] for correct source. • Check b014 [Dig In Status] to see if inputs are selecting an alternate source. Verify settings for t062, t063, t065-t068 [DigIn TermBlk xx]. • Check P047, P049, P051 [Speed Referencex] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 46. • Verify communications if used.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P041, A442, A444, A446 [Accel Time x].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	• Compare b003 [Output Current] with A484, A485 [Current Limit x]. • Remove excess load or reprogram P041, A442, A444, A446 [Accel Time x]. • Check for improper A530 [Boost Select] setting.
Speed command source or value is not as expected.	None	• Verify b002 [Commanded Freq]. • Check b012 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	• Check P044 [Maximum Freq] to ensure that speed is not limited by programming. • Verify programming of A572 [Speed Ratio].
Torque performance does not match motor characteristics.	None	• Set motor nameplate full load amps in parameter P034 [Motor NP FLA]. • Perform P040 [Autotune] "Static Tune" or "Rotate Tune" procedure. • Set P039 [Torque Perf Mode] to 0 "V/Hz".

Motor operation is unstable.

Cause(s)	Indication	Corrective Action
Motor data was incorrectly entered.	None	1. Correctly enter motor nameplate data into P031, P032 and P033. 2. Enable A547 [Compensation]. 3. Use A530 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Reverse is disabled.	None	Check A544 [Reverse Disable].
Digital input is not selected for reversing control.	None	Check [DigIn TermBlk xx] (See page 82). Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring (See page 42).
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.

Drive does not power up.

Cause(s)	Indication	Corrective Action
No input power to drive.	None	• Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects.
Control module is not connected properly to power module.	None	1. Remove power. 2. Verify that the control module is properly and fully installed on the power module. 3. Reapply power.

Motor is rotating at zero Hz or slip frequency is not correct.

Cause(s)	Indication	Corrective Action
Incorrect speed calculation.	Improper speed.	• Verify P032 [Motor NP Hertz]. • Reduce boost with A530 [Boost Select]. • Set P036 [Motor NP RPM] to motor synchronous speed.

Notes:

Supplemental Drive Information

For information on...	See page...
Certifications	153
Environmental Specifications	154
Technical Specifications	155
Power Specifications	158

Certifications

Certifications	PowerFlex 523	PowerFlex 525
c-UL-us	Listed to UL508C and CAN/CSA-C22.2 No. 14-05.	
C-Tick N223	Australian Communications and Media Authority In conformity with the following: Radiocommunications Act: 1992 Radiocommunications Standard: 2008 Radiocommunications Labelling Notice: 2008 Standards applied: EN 61800-3:2004 +A1:2012	
CE	In conformity with the following European Directives: EMC Directive (2004/108/EC) Low Voltage Directive (2006/95/EC) Standards applied: EN 61800-3:2004 +A1:2012 EN 61800-5-1:2007	
TUV	Not applicable	TÜV Rheinland Standards applied: EN ISO 13849-1:2008 EN 61800-5-2:2007 EN 61508 PARTS 1-7:2010 EN 62061:2005 EN 60204-1:2009 Certified to ISO 13849-1 SIL2/PLd with embedded Safe-Torque-Off function Meets Functional Safety (FS) when used with embedded Safe-Torque-Off function
ATEX **II (2) G D**	Not applicable	Certified to ATEX directive 94/9/EC Group II Category (2) GD Applications with ATEX Approved Motors
KCC	Korean Registration of Broadcasting and Communications Equipment Compliant with the following standards: Article 58-2 of Radio Waves Act, Clause 3	
GOST-R	Russian GOST-R Certificate no. POCC US.ME92.H00040	
AC 156	Tested by Trentec to be compliant with AC156 Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components and 2003 International Building Code for worst-case seismic level for USA excluding site class F	

Certifications	PowerFlex 523	PowerFlex 525
EPRI 	Electric Power Research Institute Certified compliant with the following standards: SEMI F47 IEC 61000-4-34	
Lloyds Register	Not applicable	Lloyd's Register Type Approval Certificate 12/10068(E1)
RoHS	Compliant with the European "Restriction of Hazardous Substances" Directive	
The drive is also designed to meet the appropriate portions of the following specifications: NFPA 70 - US National Electrical Code NEMA ICS 7.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.		

Environmental Specifications

Specifications	PowerFlex 523	PowerFlex 525
Altitude: Without derating: With derating:	See Current Derating Curves on page 17 for derating guidelines. 1000 m (3300 ft) max. Up to 4000 m (13,200 ft) max., with the exception of 600V drives at 2000 m (6600 ft) max.	
Max. Surrounding Air Temperature Without derating: With derating:	See Current Derating Curves on page 17 for derating guidelines. -20...50 °C (-4...122 °F) -20...60 °C (-4...140 °F) or -20...70 °C (-4...158 °F) with optional Control Module Fan kit.	
Storage Temperature: Frame A...D: Frame E:	 -40...85 °C (-40...185 °F) -40...70 °C (-40...158 °F)	
Atmosphere:		

IMPORTANT Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.

Relative Humidity:	0...95% noncondensing
Shock: Vibration:	Complies with IEC 60068-2-27 Complies with IEC 60068-2-6:1995

Frame Size	Operating and Nonoperating		Nonoperating (Transportation)	
	Force (Shock/Vibration)	Mounting Type	Force (Shock/Vibration)	Mounting Type
A	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
B	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
C	15 g / 2 g	DIN rail or screw	30 g/ 2.5 g	Screw only
D	15 g / 2 g	Screw only	30 g/ 2.5 g	Screw only
E	15 g / 1.5 g	Screw only	30 g/ 2.5 g	Screw only

Conformal Coating:	Complies with: IEC 60721-3-3 to level 3C2 (chemical and gases only)
Surrounding Environment Pollution Degree Pollution Degree 1 & 2:	See Pollution Degree Ratings According to EN 61800-5-1 on page 49 for descriptions. All enclosures acceptable.
Sound Pressure Level (A-weighted) Frame A & B: Frame C: Frame D: Frame E:	Measurements are taken 1 m from the drive. Maximum 53 dBA Maximum 57 dBA Maximum 64 dBA Maximum 68 dBA

Technical Specifications

Protection

Specifications	PowerFlex 523	PowerFlex 525
Bus Overvoltage Trip		
100...120V AC Input:	405V DC bus (equivalent to 150V AC incoming line)	
200...240V AC Input:	405V DC bus (equivalent to 290V AC incoming line)	
380...480V AC Input:	810V DC bus (equivalent to 575V AC incoming line)	
525...600V AC Input:	1005V DC bus (equivalent to 711V AC incoming line)	
Bus Undervoltage Trip		
100...120V AC Input:	190V DC bus (equivalent to 75V AC incoming line)	
200...240V AC Input:	190V DC bus (equivalent to 150V AC incoming line)	
380...480V AC Input:	390V DC bus (equivalent to 275V AC incoming line)	
525...600V AC Input		
P038 = 3 "600V":	487V DC bus (equivalent to 344V AC incoming line)	
P038 = 2 "480V":	390V DC bus (equivalent to 275V AC incoming line)	
Power Ride-Thru:	100 ms	
Logic Control Ride-Thru:	0.5 s minimum, 2 s typical	
Electronic Motor Overload Protection:	Provides class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A) (2). UL 508C File 29572.	
Overcurrent:	200% hardware limit, 300% instantaneous fault	
Ground Fault Trip:	Phase-to-ground on drive output	
Short Circuit Trip:	Phase-to-phase on drive output	

Electrical

Specifications	PowerFlex 523	PowerFlex 525
Voltage Tolerance:	-15% / +10%	
Frequency Tolerance:	47...63 Hz	
Input Phases:	Three-phase input provides full rating. Single-phase input provides 35% rating on three-phase drives.	
Displacement Power Factor:	0.98 across entire speed range	
Maximum Short Circuit Rating:	100,000 Amps Symmetrical	
Actual Short Circuit Rating:	Determined by AIC Rating of installed fuse/circuit breaker	
Transistor Type:	Isolated Gate Bipolar Transistor (IGBT)	
Internal DC Bus Choke	Only for Frame E drive ratings	
200...240V AC Input:	11 kW (15 HP)	
380...480V AC Input:	15...18.5 kW (20...25 HP) – Heavy Duty	
525...600V AC Input:	15...18.5 kW (20...25 HP) – Heavy Duty	

Control

Specifications	PowerFlex 523	PowerFlex 525
Method	Sinusoidal PWM, Volts/Hertz, Sensorless Vector Control, Economizer SVC motor control and Closed Loop Velocity Vector Control (Closed Loop Velocity Vector Control is not applicable to PowerFlex 523 drives)	
Carrier Frequency	2...16 kHz, Drive rating based on 4 kHz	
Frequency Accuracy		
Digital Input:	Within ±0.05% of set output frequency	
Analog Input:	Within 0.5% of maximum output frequency, 10-Bit resolution	
Analog Output:	–	±2% of full scale, 10-Bit resolution
Performance		
V/Hz (Volts per Hertz):	±1% of base speed across a 60:1 speed range	
SVC (Sensorless Vector):	±0.5% of base speed across a 100:1 speed range	
SVC Economizer:	±0.5% of base speed across a 100:1 speed range	
VVC (Velocity Vector Control):	±0.5% of base speed across a 60:1 speed range – Not applicable to PowerFlex 523 drives	

Specifications	PowerFlex 523	PowerFlex 525
Performance with Encoder	–	
SVC (Sensorless Vector):		±0.1% of base speed across a 100:1 speed range
SVC Economizer:		±0.1% of base speed across a 100:1 speed range
VVC (Velocity Vector Control):		±0.1% of base speed across a 1000:1 speed range
Output Voltage Range:	0V to rated motor voltage	
Output Frequency Range:	0...500 Hz (programmable)	
Efficiency:	97.5% (typical)	
Stop Modes:	Multiple programmable stop modes including – Ramp, Coast, DC-Brake, and Ramp-to-Stop	
Accel/Decel:	Four independently programmable accel and decel times. Each time may be programmed from 0...600 s in 0.01 s increments.	
Intermittent Overload		
Normal Duty:	–	110% Overload capability for up to 60 s, 150% for up to 3 s Applies for power rating above 15 kW (20 HP) only. Based on 480V drive rating.
Heavy Duty:	150% Overload capability for up to 60 s, 180% for up to 3 s (200% programmable)	

Control Inputs

Specifications		PowerFlex 523	PowerFlex 525
Digital	Bandwidth:	10 Rad/s for open and closed loop	
	Quantity:	(1) Dedicated for stop (4) Programmable	(1) Dedicated for stop (6) Programmable
	Current:	6 mA	
	Type		
	Source Mode (SRC):	18...24V = ON, 0...6V = OFF	
	Sink Mode (SNK):	0...6V = ON, 18...24V = OFF	
	Pulse Train		
	Quantity:	(1) Shared with one of the programmable digital input terminals.	
	Input Signal:	Transistor contact (open collector)	
	Input Frequency:	0...100 kHz	
	Current Consumption:	7 mA @ 24V DC maximum	
Analog:	Quantity:	(2) Isolated, 0-10V and 4-20mA	(2) Isolated, -10-10V and 4-20mA
	Specification		
	Resolution:	10-bit	
	0-10V DC Analog:	100k ohm input impedance	
	4-20mA Analog:	250 ohm input impedance	
	External Pot:	1...10k ohm, 2 W minimum	

Control Outputs

Specifications		PowerFlex 523	PowerFlex 525
Relay:	Quantity:	(1) Programmable Form C	(2) 1 Programmable Form A and 1 Programmable Form B
	Specification		
	Resistive Rating:	3.0 A @ 30V DC, 3.0 A @ 125V, 3.0 A @ 240V AC	
	Inductive Rating:	0.5 A @ 30V DC, 0.5 A @ 125V, 0.5 A @ 240V AC	

Specifications		PowerFlex 523	PowerFlex 525
Opto:	Quantity:	–	(2) Programmable
	Specification:		30V DC, 50 mA Non-inductive
Analog	Quantity:	–	(1) Non-Isolated 0-10V or 4-20 mA
	Specification Resolution: 0-10V DC Analog: 4-20 mA Analog:		 10-bit 1 k ohm minimum 525 ohm maximum

Encoder

Specifications	PowerFlex 523	PowerFlex 525
Type:	–	Incremental, dual channel
Supply:		12V, 250 mA
Quadrature:		90 °, ±27 ° @ 25 °C
Duty Cycle:		50%, +10%
Requirements:		Encoders must be line driver type, quadrature (dual channel) or pulse (single channel), 3.5...26V DC output, single-ended or differential and capable of supplying a minimum of 10 mA per channel. Allowable input is DC up to a maximum frequency of 250 kHz. The encoder I/O automatically scales to allow 5V, 12V and 24V DC nominal voltages.

Power Specifications

Watts Loss

PowerFlex 520-Series Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	Output Current (A)	Total Watts Loss
100...120V, 50/60 Hz 1-Phase	1.6	20.0
	2.5	27.0
	4.8	53.0
	6.0	67.0
200...240V, 50/60 Hz 1-Phase	1.6	20.0
	2.5	29.0
	4.8	50.0
	8.0	81.0
	11.0	111.0
200...240V, 50/60 Hz 1-Phase w/ EMC Filter	1.6	20.0
	2.5	29.0
	4.8	53.0
	8.0	84.0
	11.0	116.0
200...240V, 50/60 Hz 3-Phase	1.6	20.0
	2.5	29.0
	5.0	50.0
	8.0	79.0
	11.0	107.0
	17.5	148.0
	24.0	259.0
	32.2	323.0
	48.3	584.0
	62.1	708.0
380...480V, 50/60 Hz 3-Phase	1.4	27.0
	2.3	37.0
	4.0	62.0
	6.0	86.0
	10.5	129.0
	13.0	170.0
	17.0	221.0
	24.0	303.0
	30.0	387.0
380...480V, 50/60 Hz 3-Phase w/ EMC Filter	1.4	27.0
	2.3	37.0
	4.0	63.0
	6.0	88.0
	10.5	133.0
	13.0	175.0
	17.0	230.0
	24.0	313.0
	30.0	402.0
	37.0	602.0
	43.0	697.0

PowerFlex 520-Series Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	Output Current (A)	Total Watts Loss
525...600V, 50/60 Hz 3-Phase	0.9	22.0
	1.7	32.0
	3.0	50.0
	4.2	65.0
	6.6	95.0
	9.9	138.0
	12.0	164.0
	19.0	290.0
	22.0	336.0
	27.0	466.0
	32.0	562.0

Input Current Scaling (Optional)

You can use a higher drive rating by scaling the input current based on the output current required for your application.

PowerFlex 520-Series Input Current Scaled By Motor Current

PowerFlex 523	PowerFlex 525	Output				Input			
Catalog Number	Catalog Number	1	2	3	4	5	6	7	8
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output									
25A-V1P6N104	–	1.6	1.3	1.0	0.8	6.4	5.2	4.0	3.2
25A-V2P5N104	25B-V2P5N104	2.5	2.0	1.6	1.3	9.6	7.7	6.2	4.8
25A-V4P8N104	25B-V4P8N104	4.8	3.8	3.1	2.4	19.2	15.4	12.5	9.6
25A-V6P0N104	25B-V6P0N104	6.0	4.8	3.9	3.0	24.0	19.2	15.6	12.0
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output									
25A-A1P6N104	–	1.6	1.3	1.0	0.8	5.3	4.3	3.4	2.7
25A-A2P5N104	25B-A2P5N104	2.5	2.0	1.6	1.3	6.5	5.2	4.2	3.3
25A-A4P8N104	25B-A4P8N104	4.8	3.8	3.1	2.4	10.7	8.6	7.0	5.4
25A-A8P0N104	25B-A8P0N104	8.0	6.4	5.2	4.0	18.0	14.4	11.7	9.0
25A-A011N104	25B-A011N104	11.0	8.8	7.2	5.5	22.9	18.3	14.9	11.5
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output									
25A-A1P6N114	–	1.6	1.3	1.0	0.8	5.3	4.3	3.4	2.7
25A-A2P5N114	25B-A2P5N114	2.5	2.0	1.6	1.3	6.5	5.2	4.2	3.3
25A-A4P8N114	25B-A4P8N114	4.8	3.8	3.1	2.4	10.7	8.6	7.0	5.4
25A-A8P0N114	25B-A8P0N114	8.0	6.4	5.2	4.0	18.0	14.4	11.7	9.0
25A-A011N114	25B-A011N114	11.0	8.8	7.2	5.5	22.9	18.3	14.9	11.5
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output									
25A-B1P6N104	–	1.6	1.3	1.0	0.8	1.9	1.5	1.2	1.0
25A-B2P5N104	25B-B2P5N104	2.5	2.0	1.6	1.3	2.7	2.2	1.8	1.4
25A-B5P0N104	25B-B5P0N104	5.0	4.0	3.2	2.5	5.8	4.6	3.8	2.9
25A-B8P0N104	25B-B8P0N104	8.0	6.4	5.2	4.0	9.5	7.6	6.2	4.8
25A-B011N104	25B-B011N104	11.0	8.8	7.2	5.5	13.8	11.0	9.0	6.9
25A-B017N104	25B-B017N104	17.5	14.0	11.4	8.8	21.1	16.9	13.7	10.6
25A-B024N104	25B-B024N104	24.0	19.2	15.6	12.0	26.6	21.3	17.3	13.3
25A-B032N104	25B-B032N104	32.2	25.8	20.9	16.1	34.8	27.8	22.6	17.4
25A-B048N104	25B-B048N104	48.3	38.6	31.4	24.2	44.0	35.2	28.6	22.0
25A-B062N104	25B-B062N104	62.1	49.7	40.4	31.1	56.0	44.8	36.4	28.0

PowerFlex 520-Series Input Current Scaled By Motor Current

PowerFlex 523	PowerFlex 525	Output				Input			
Catalog Number	**Catalog Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output									
25A-D1P4N104	25B-D1P4N104	1.4	1.1	0.9	0.7	1.9	1.5	1.2	1.0
25A-D2P3N104	25B-D2P3N104	2.3	1.8	1.5	1.2	3.2	2.6	2.1	1.6
25A-D4P0N104	25B-D4P0N104	4.0	3.2	2.6	2.0	5.7	4.6	3.7	2.9
25A-D6P0N104	25B-D6P0N104	6.0	4.8	3.9	3.0	7.5	6.0	4.9	3.8
25A-D010N104	25B-D010N104	10.5	8.4	6.8	5.3	13.8	11.0	9.0	6.9
25A-D013N104	25B-D013N104	13.0	10.4	8.5	6.5	15.4	12.3	10.0	7.7
25A-D017N104	25B-D017N104	17.0	13.6	11.1	8.5	18.4	14.7	12.0	9.2
25A-D024N104	25B-D024N104	24.0	19.2	15.6	12.0	26.4	21.1	17.2	13.2
25A-D030N104	25B-D030N104	30.0	24.0	19.5	15.0	33.0	26.4	21.5	16.5
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output									
25A-D1P4N114	25B-D1P4N114	1.4	1.1	0.9	0.7	1.9	1.5	1.2	1.0
25A-D2P3N114	25B-D2P3N114	2.3	1.8	1.5	1.2	3.2	2.6	2.1	1.6
25A-D4P0N114	25B-D4P0N114	4.0	3.2	2.6	2.0	5.7	4.6	3.7	2.9
25A-D6P0N114	25B-D6P0N114	6.0	4.8	3.9	3.0	7.5	6.0	4.9	3.8
25A-D010N114	25B-D010N114	10.5	8.4	6.8	5.3	13.8	11.0	9.0	6.9
25A-D013N114	25B-D013N114	13.0	10.4	8.5	6.5	15.4	12.3	10.0	7.7
25A-D017N114	25B-D017N114	17.0	13.6	11.1	8.5	18.4	14.7	12.0	9.2
25A-D024N114	25B-D024N114	24.0	19.2	15.6	12.0	26.4	21.1	17.2	3.2
25A-D030N114	25B-D030N114	30.0	24.0	19.5	15.0	33.0	26.4	21.5	16.5
25A-D037N114	25B-D037N114	37.0	29.6	24.1	18.5	33.7	27.0	21.9	16.9
25A-D043N114	25B-D043N114	43.0	34.4	28.0	21.5	38.9	31.1	25.3	19.5
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output									
25A-E0P9N104	25B-E0P9N104	0.9	0.7	0.6	0.5	1.2	1.0	0.8	0.6
25A-E1P7N104	25B-E1P7N104	1.7	1.4	1.1	0.9	2.3	1.8	1.5	1.2
25A-E3P0N104	25B-E3P0N104	3.0	2.4	2.0	1.5	3.8	3.0	2.5	1.9
25A-E4P2N104	25B-E4P2N104	4.2	3.4	2.7	2.1	5.3	4.2	3.4	2.7
25A-E6P6N104	25B-E6P6N104	6.6	5.3	4.3	3.3	8.0	6.4	5.2	4.0
25A-E9P9N104	25B-E9P9N104	9.9	7.9	6.4	5.0	11.2	9.0	7.3	5.6
25A-E012N104	25B-E012N104	12.0	9.6	7.8	6.0	13.5	10.8	8.8	6.8
25A-E019N104	25B-E019N104	19.0	15.2	12.4	9.5	24.0	19.2	15.6	12.0
25A-E022N104	25B-E022N104	22.0	17.6	14.3	11.0	27.3	21.8	17.7	13.7
25A-E027N104	25B-E027N104	27.0	21.6	17.6	13.5	24.7	19.8	16.1	12.4
25A-E032N104	25B-E032N104	32.0	25.6	20.8	16.0	29.2	23.4	19.0	14.6

Accessories and Dimensions

Product Selection

Catalog Number Description

25B	-	V	2P5	N	1	0	4
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Version

PowerFlex 520-Series Drive Ratings

Output Ratings					Input Voltage Range	Frame Size	PowerFlex 523	PowerFlex 525
Normal Duty		Heavy Duty		Output Current (A)				
HP	kW	HP	kW				Catalog No.	Catalog No.
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	85...132	A	25A-V1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	85...132	A	25A-V2P5N104	25B-V2P5N104
1.0	0.75	1.0	0.75	4.8	85...132	B	25A-V4P8N104	25B-V4P8N104
1.5	1.1	1.5	1.1	6.0	85...132	B	25A-V6P0N104	25B-V6P0N104
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-A1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-A2P5N104	25B-A2P5N104
1.0	0.75	1.0	0.75	4.8	170...264	A	25A-A4P8N104	25B-A4P8N104
2.0	1.5	2.0	1.5	8.0	170...264	B	25A-A8P0N104	25B-A8P0N104
3.0	2.2	3.0	2.2	11.0	170...264	B	25A-A011N104	25B-A011N104
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-A1P6N114	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-A2P5N114	25B-A2P5N114
1.0	0.75	1.0	0.75	4.8	170...264	A	25A-A4P8N114	25B-A4P8N114
2.0	1.5	2.0	1.5	8.0	170...264	B	25A-A8P0N114	25B-A8P0N114
3.0	2.2	3.0	2.2	11.0	170...264	B	25A-A011N114	25B-A011N114
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output								
0.25	0.2	0.25	0.2	1.6	170...264	A	25A-B1P6N104[2]	–
0.5	0.4	0.5	0.4	2.5	170...264	A	25A-B2P5N104	25B-B2P5N104
1.0	0.75	1.0	0.75	5.0	170...264	A	25A-B5P0N104	25B-B5P0N104
2.0	1.5	2.0	1.5	8.0	170...264	A	25A-B8P0N104	25B-B8P0N104
3.0	2.2	3.0	2.2	11.0	170...264	A	25A-B011N104	25B-B011N104
5.0	4.0	5.0	4.0	17.5	170...264	B	25A-B017N104	25B-B017N104
7.5	5.5	7.5	5.5	24.0	170...264	C	25A-B024N104	25B-B024N104
10.0	7.5	10.0	7.5	32.2	170...264	D	25A-B032N104	25B-B032N104
15.0	11.0	10.0	7.5	48.3	170...264	E	25A-B048N104	25B-B048N104
20.0	15.0	15.0	11.0	62.1	170...264	E	25A-B062N104	25B-B062N104
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output[1]								
0.5	0.4	0.5	0.4	1.4	323...528	A	25A-D1P4N104[2]	25B-D1P4N104[2]
1.0	0.75	1.0	0.75	2.3	323...528	A	25A-D2P3N104	25B-D2P3N104
2.0	1.5	2.0	1.5	4.0	323...528	A	25A-D4P0N104	25B-D4P0N104
3.0	2.2	3.0	2.2	6.0	323...528	A	25A-D6P0N104	25B-D6P0N104
5.0	4.0	5.0	4.0	10.5	323...528	B	25A-D010N104	25B-D010N104

PowerFlex 520-Series Drive Ratings

Output Ratings					Input Voltage Range	Frame Size	PowerFlex 523	PowerFlex 525
Normal Duty		Heavy Duty		Output Current (A)				
HP	kW	HP	kW				Catalog No.	Catalog No.
7.5	5.5	7.5	5.5	13.0	323...528	C	25A-D013N104	25B-D013N104
10.0	7.5	10.0	7.5	17.0	323...528	C	25A-D017N104	25B-D017N104
15.0	11.0	15.0	11.0	24.0	323...528	D	25A-D024N104	25B-D024N104
20.0	15.0	15.0	11.0	30.0	323...528	D	25A-D030N104	25B-D030N104
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output								
0.5	0.4	0.5	0.4	1.4	323...528	A	25A-D1P4N114	25B-D1P4N114
1.0	0.75	1.0	0.75	2.3	323...528	A	25A-D2P3N114	25B-D2P3N114
2.0	1.5	2.0	1.5	4.0	323...528	A	25A-D4P0N114	25B-D4P0N114
3.0	2.2	3.0	2.2	6.0	323...528	A	25A-D6P0N114	25B-D6P0N114
5.0	4.0	5.0	4.0	10.5	323...528	B	25A-D010N114	25B-D010N114
7.5	5.5	7.5	5.5	13.0	323...528	C	25A-D013N114	25B-D013N114
10.0	7.5	10.0	7.5	17.0	323...528	C	25A-D017N114	25B-D017N114
15.0	11.0	15.0	11.0	24.0	323...528	D	25A-D024N114	25B-D024N114
20.0	15.0	15.0	11.0	30.0	323...528	D	25A-D030N114	25B-D030N114
25.0	18.5	20.0	15.0	37.0	323...528	E	25A-D037N114	25B-D037N114
30.0	22.0	25.0	18.5	43.0	323...528	E	25A-D043N114	25B-D043N114
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output								
0.5	0.4	0.5	0.4	0.9	446...660	A	25A-E0P9N104(2)	25B-E0P9N104(2)
1.0	0.75	1.0	0.75	1.7	446...660	A	25A-E1P7N104	25B-E1P7N104
2.0	1.5	2.0	1.5	3.0	446...660	A	25A-E3P0N104	25B-E3P0N104
3.0	2.2	3.0	2.2	4.2	446...660	A	25A-E4P2N104	25B-E4P2N104
5.0	4.0	5.0	4.0	6.6	446...660	B	25A-E6P6N104	25B-E6P6N104
7.5	5.5	7.5	5.5	9.9	446...660	C	25A-E9P9N104	25B-E9P9N104
10.0	7.5	10.0	7.5	12.0	446...660	C	25A-E012N104	25B-E012N104
15.0	11.0	15.0	11.0	19.0	446...660	D	25A-E019N104	25B-E019N104
20.0	15.0	15.0	11.0	22.0	446...660	D	25A-E022N104	25B-E022N104
25.0	18.5	20.0	15.0	27.0	446...660	E	25A-E027N104	25B-E027N104
30.0	22.0	25.0	18.5	32.0	446...660	E	25A-E032N104	25B-E032N104

(1) A non-filtered drive is not available for 380...480V AC 25 HP (18.5 kW) and 30 HP (22.0 kW) ratings. Filtered drives are available, however you must verify that the application will support a filtered drive.

(2) These drive ratings do not come with a heatsink cooling fan and are in accordance with design specifications.

Dynamic Brake Resistors

Drive Ratings			Minimum Resistance Ω ±10%	Resistance Ω ±5%	Catalog No.(1)(2)
Input Voltage	HP	kW			
100...120V 50/60 Hz 1-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	1.5	1.1	41	91	AK-R2-091P500
200...240V 50/60 Hz 1-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	2.0	1.5	41	91	AK-R2-091P500
	3.0	2.2	32	47	AK-R2-047P500

Dynamic Brake Resistors

Drive Ratings			Minimum Resistance Ω ±10%	Resistance Ω ±5%	Catalog No.(1)(2)
Input Voltage	**HP**	**kW**			
200...240V 50/60 Hz 3-Phase	0.25	0.2	56	91	AK-R2-091P500
	0.5	0.4	56	91	AK-R2-091P500
	1.0	0.75	56	91	AK-R2-091P500
	2.0	1.5	41	91	AK-R2-091P500
	3.0	2.2	32	47	AK-R2-047P500
	5.0	4.0	18	47	AK-R2-047P500
	7.5	5.5	16	30	AK-R2-030P1K2
	10.0	7.5	14	30	AK-R2-030P1K2
	15.0	11.0	14	15	AK-R2-030P1K2(3)
	20.0	15.0	10	15	AK-R2-030P1K2(3)
380...480V 50/60 Hz 3-Phase	0.5	0.4	89	360	AK-R2-360P500
	1.0	0.75	89	360	AK-R2-360P500
	2.0	1.5	89	360	AK-R2-360P500
	3.0	2.2	89	120	AK-R2-120P1K2
	5.0	4.0	47	120	AK-R2-120P1K2
	7.5	5.5	47	120	AK-R2-120P1K2
	10.0	7.5	47	120	AK-R2-120P1K2
	15.0	11.0	43	60	AK-R2-120P1K2(3)
	20.0	15.0	43	60	AK-R2-120P1K2(3)
	25.0	18.5	27	40	AK-R2-120P1K2(4)
	30.0	22.0	27	40	AK-R2-120P1K2(4)
525...600V 50/60 Hz 3-Phase	0.5	0.4	112	360	AK-R2-360P500
	1.0	0.75	112	360	AK-R2-360P500
	2.0	1.5	112	360	AK-R2-360P500
	3.0	2.2	112	120	AK-R2-120P1K2
	5.0	4.0	86	120	AK-R2-120P1K2
	7.5	5.5	59	120	AK-R2-120P1K2
	10.0	7.5	59	120	AK-R2-120P1K2
	15.0	11.0	59	60	AK-R2-120P1K2(3)
	20.0	15.0	59	60	AK-R2-120P1K2(3)
	25.0	18.5	53	60	AK-R2-120P1K2(3)
	30.0	22.0	34	40	AK-R2-120P1K2(4)

(1) The resistors listed in this tables are rated for 5% duty cycle.

(2) Use of Rockwell Automation resistors is always recommended. The resistors listed have been carefully selected for optimizing performance in a variety of applications. Alternative resistors may be used, however, care must be taken when making a selection. See the PowerFlex Dynamic Braking Resistor Calculator, publication PFLEX-AT001.

(3) Requires two resistors wired in parallel.

(4) Requires three resistors wired in parallel.

EMC Line Filters

Drive Ratings					
Input Voltage	**HP**	**kW**	**Current (A)**	**Frame Size**	**Catalog No.**
100...120V 50/60 Hz 1-Phase	0.25	0.2	1.6	A	25-RF011-AL
	0.5	0.4	2.5	A	25-RF011-AL
	1.0	0.75	4.8	B	25-RF023-BL
	1.5	1.1	6.0	B	25-RF023-BL

EMC Line Filters

Drive Ratings					
Input Voltage	**HP**	**kW**	**Current (A)**	**Frame Size**	**Catalog No.**
200...240V 50/60 Hz 1-Phase	0.25	0.2	1.6	A	25-RF011-AL
	0.5	0.4	2.5	A	25-RF011-AL
	1.0	0.75	4.8	A	25-RF011-AL
	2.0	1.5	8.0	B	25-RF023-BL
	3.0	2.2	11.0	B	25-RF023-BL
200...240V 50/60 Hz 3-Phase	0.25	0.2	1.6	A	25-RF014-AL
	0.5	0.4	2.5	A	25-RF014-AL
	1.0	0.75	5.0	A	25-RF014-AL
	2.0	1.5	8.0	A	25-RF014-AL
	3.0	2.2	11.0	A	25-RF014-AL
	5.0	4.0	17.5	B	25-RF021-BL
	7.5	5.5	24.0	C	25-RF027-CL
	10.0	7.5	32.2	D	25-RF035-DL
	15.0	11.0	48.3	E	25-RF056-EL
	20.0	15.0	62.1	E	25-RF056-EL
380...480V 50/60 Hz 3-Phase	0.5	0.4	1.4	A	25-RF7P5-AL
	1.0	0.75	2.3	A	25-RF7P5-AL
	2.0	1.5	4.0	A	25-RF7P5-AL
	3.0	2.2	6.0	A	25-RF7P5-AL
	5.0	4.0	10.5	B	25-RF014-BL
	7.5	5.5	13.0	C	25-RF018-CL
	10.0	7.5	17.0	C	25-RF018-CL
	15.0	11.0	24.0	D	25-RF033-DL
	20.0	15.0	30.0	D	25-RF033-DL
	25.0	18.5	37.0	E	25-RF039-EL
	30.0	22.0	43.0	E	25-RF039-EL(1)
525...600V 50/60 Hz 3-Phase	0.5	0.4	0.9	A	25-RF8P0-BL(2)
	1.0	0.75	1.7	A	25-RF8P0-BL(2)
	2.0	1.5	3.0	A	25-RF8P0-BL(2)
	3.0	2.2	4.2	A	25-RF8P0-BL(2)
	5.0	4.0	6.6	B	25-RF8P0-BL
	7.5	5.5	9.9	C	25-RF014-CL
	10.0	7.5	12.0	C	25-RF014-CL
	15.0	11.0	19.0	D	25-RF027-DL
	20.0	15.0	22.0	D	25-RF027-DL
	25.0	18.5	27.0	E	25-RF029-EL
	30.0	22.0	32.0	E	25-RF029-EL(1)

(1) EMC Line Filter size is based on the input current of the drive. See the tables on page 25 and page 26 for more information.

(2) This 600V drive rating needs to be matched with a frame B EMC Line Filter.

EMC Plates

Item	Description	Frame Size	Catalog No.
EMC Plate	Optional grounding plate for shielded cables.	A	25-EMC1-FA
		B	25-EMC1-FB
		C	25-EMC1-FC
		D	25-EMC1-FD
		E	25-EMC1-FE

Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog No.
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2S
LCD Display, Remote Handheld	Digital speed control Full numeric keyboard CopyCat capable IP 30 (NEMA Type 1) Includes 1.0 meter cable Panel mount with optional Bezel Kit	22-HIM-A3
Bezel Kit	Panel mount for LCD Display, Remote Handheld unit, IP 30 (NEMA Type 1) Includes 2.0 m DSI cable	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 m (3.3 ft)	22-HIM-H10
	2.9 m (9.51 ft)	22-HIM-H30

IP 30/NEMA 1/UL Type 1 Kit

Item	Description	Frame Size	Catalog No.
IP 30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP 30/NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	A	25-JBAA
		B	25-JBAB
		C	25-JBAC
		D	25-JBAD
		E	25-JBAE

Control Module Fan Kit

Item	Description	Frame Size	Catalog No.
Control Module Fan Kit	For use with drive in environments with ambient temperatures up to 70 °C or horizontal mounting.	A...D	25-FAN1-70C
		E	25-FAN2-70C

Incremental Encoder Input Option

Item	Description	Catalog No.
Incremental Encoder	Incremental encoder input option board.	25-ENC-1

Bulletin 160 to PowerFlex 520-Series Mounting Adapter Plate

Item	Description	B160 Frame Size	Catalog No.
Mounting Adapter Plate	For use with drive when replacing Bulletin 160 drives in existing installations to a PowerFlex 520-Series drive. Select the catalog number based on the frame size of your Bulletin 160 drive.	A	25-MAP-FA
		B	25-MAP-FB

Replacement Parts

PowerFlex 520-Series Power Module

Item	Description
PowerFlex 520-Series Power Module	Replacement power module for use with PowerFlex 520-Series drives. Includes: • Power Module • Power Module Front Cover • Power Terminal Guard • Heatsink Fan

Output Ratings					Input Voltage Range	Frame Size	Catalog No.
Normal Duty		Heavy Duty		Output Current (A)			
HP	kW	HP	kW				
100...120V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	85...132	A	25-PM1-V1P6
0.5	0.4	0.5	0.4	2.5	85...132	A	25-PM1-V2P5
1.0	0.75	1.0	0.75	4.8	85...132	B	25-PM1-V4P8
1.5	1.1	1.5	1.1	6.0	85...132	B	25-PM1-V6P0
200...240V AC (-15%, +10%) – 1-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM1-A1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM1-A2P5
1.0	0.75	1.0	0.75	4.8	170...264	A	25-PM1-A4P8
2.0	1.5	2.0	1.5	8.0	170...264	B	25-PM1-A8P0
3.0	2.2	3.0	2.2	11.0	170...264	B	25-PM1-A011
200...240V AC (-15%, +10%) – 1-Phase Input with EMC Filter, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM2-A1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM2-A2P5
1.0	0.75	1.0	0.75	4.8	170...264	A	25-PM2-A4P8
2.0	1.5	2.0	1.5	8.0	170...264	B	25-PM2-A8P0
3.0	2.2	3.0	2.2	11.0	170...264	B	25-PM2-A011
200...240V AC (-15%, +10%) – 3-Phase Input, 0...230V 3-Phase Output							
0.25	0.2	0.25	0.2	1.6	170...264	A	25-PM1-B1P6
0.5	0.4	0.5	0.4	2.5	170...264	A	25-PM1-B2P5
1.0	0.75	1.0	0.75	5.0	170...264	A	25-PM1-B5P0
2.0	1.5	2.0	1.5	8.0	170...264	A	25-PM1-B8P0
3.0	2.2	3.0	2.2	11.0	170...264	A	25-PM1-B011
5.0	4.0	5.0	4.0	17.5	170...264	B	25-PM1-B017
7.5	5.5	7.5	5.5	24.0	170...264	C	25-PM1-B024
10.0	7.5	10.0	7.5	32.2	170...264	D	25-PM1-B032
15.0	11.0	10.0	7.5	48.3	170...264	E	25-PM1-B048
20.0	15.0	15.0	11.0	62.1	170...264	E	25-PM1-B062
380...480V AC (-15%, +10%) – 3-Phase Input, 0...460V 3-Phase Output							
0.5	0.4	0.5	0.4	1.4	323...528	A	25-PM1-D1P4
1.0	0.75	1.0	0.75	2.3	323...528	A	25-PM1-D2P3
2.0	1.5	2.0	1.5	4.0	323...528	A	25-PM1-D4P0
3.0	2.2	3.0	2.2	6.0	323...528	A	25-PM1-D6P0
5.0	4.0	5.0	4.0	10.5	323...528	B	25-PM1-D010
7.5	5.5	7.5	5.5	13.0	323...528	C	25-PM1-D013
10.0	7.5	10.0	7.5	17.0	323...528	C	25-PM1-D017
15.0	11.0	15.0	11.0	24.0	323...528	D	25-PM1-D024
20.0	15.0	15.0	11.0	30.0	323...528	D	25-PM1-D030

Output Ratings					Input Voltage Range	Frame Size	Catalog No.
Normal Duty		Heavy Duty		Output Current (A)			
HP	kW	HP	kW				
380...480V AC (-15%, +10%) – 3-Phase Input with EMC Filter, 0...460V 3-Phase Output							
0.5	0.4	0.5	0.4	1.4	323...528	A	25-PM2-D1P4
1.0	0.75	1.0	0.75	2.3	323...528	A	25-PM2-D2P3
2.0	1.5	2.0	1.5	4.0	323...528	A	25-PM2-D4P0
3.0	2.2	3.0	2.2	6.0	323...528	A	25-PM2-D6P0
5.0	4.0	5.0	4.0	10.5	323...528	B	25-PM2-D010
7.5	5.5	7.5	5.5	13.0	323...528	C	25-PM2-D013
10.0	7.5	10.0	7.5	17.0	323...528	C	25-PM2-D017
15.0	11.0	15.0	11.0	24.0	323...528	D	25-PM2-D024
20.0	15.0	15.0	11.0	30.0	323...528	D	25-PM2-D030
25.0	18.5	20.0	15.0	37.0	323...528	E	25-PM2-D037
30.0	22.0	25.0	18.5	43.0	323...528	E	25-PM2-D043
525...600V AC (-15%, +10%) – 3-Phase Input, 0...575V 3-Phase Output							
0.5	0.4	0.5	0.4	0.9	446...660	A	25-PM1-E0P9
1.0	0.75	1.0	0.75	1.7	446...660	A	25-PM1-E1P7
2.0	1.5	2.0	1.5	3.0	446...660	A	25-PM1-E3P0
3.0	2.2	3.0	2.2	4.2	446...660	A	25-PM1-E4P2
5.0	4.0	5.0	4.0	6.6	446...660	B	25-PM1-E6P6
7.5	5.5	7.5	5.5	9.9	446...660	C	25-PM1-E9P9
10.0	7.5	10.0	7.5	12.0	446...660	C	25-PM1-E012
15.0	11.0	15.0	11.0	19.0	446...660	D	25-PM1-E019
20.0	15.0	15.0	11.0	22.0	446...660	D	25-PM1-E022
25.0	18.5	20.0	15.0	27.0	446...660	E	25-PM1-E027
30.0	22.0	25.0	18.5	32.0	446...660	E	25-PM1-E032

PowerFlex 520-Series Control Module

Item	Description	Frame Size	Catalog No.
PowerFlex 523 Control Module	Replacement control module for use with PowerFlex 520-Series drives. Includes: • Control Module • Control Module Front Cover	A...E	25A-CTM1
PowerFlex 525 Control Module			25B-CTM1

Other Parts

Item	Description	Frame Size	Catalog No.
PowerFlex 523 Control Module Front Cover	Replacement cover for the control module I/O terminals, EtherNet/IP and DSI ports.	A...E	25A-CTMFC1
PowerFlex 525 Control Module Front Cover			25B-CTMFC1
PowerFlex 520-Series Power Module Front Cover	Replacement cover for the PowerFlex 520-Series power module.	B	25-PMFC-FB
		C	25-PMFC-FC
		D	25-PMFC-FD
		E	25-PMFC-FE
PowerFlex 520-Series Power Terminal Guard	Replacement finger guard for power terminals.	A	25-PTG1-FA
		B	25-PTG1-FB
		C	25-PTG1-FC
		D	25-PTG1-FD
		E	25-PTG1-FE

Other Parts

Item	Description	Frame Size	Catalog No.
PowerFlex 520-Series Heatsink Fan Kit	Replacement fan for drive power module.	A	25-FAN1-FA
		B	25-FAN1-FB
		C	25-FAN1-FC
		D	25-FAN1-FD
		E	25-FAN1-FE

Communication Option Kits and Accessories

Item	Description	Catalog No.
Communication Adapters	Embedded communication options for use with the PowerFlex 520-Series drives: • DeviceNet™ • Dual Port EtherNet/IP™ • PROFIBUS™ DP-V1	 25-COMM-D 25-COMM-E2P 25-COMM-P
Compact I/O Module	Three channel	1769-SM2
Universal Serial Bus™ (USB) Converter Module	Provides serial communication with DF1 protocol for use with Connected Components Workbench software. Includes: • 2 m USB cable (1) • 20-HIM-H10 cable (1) • 22-HIM-H10 cable (1)	1203-USB
Serial Converter Module (RS485 to RS232)	Provides serial communication with DF1 protocol for use with Connected Components Workbench software. Includes: • DSI to RS232 serial converter (1) • 1203-SFC serial cable (1) • 22-RJ45CBL-C20 cable (1)	22-SCM-232
DSI Cable	2.0 m RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 m serial cable with a locking low profile connector to connect to the serial converter and a 9-pin sub-miniature D female connector to connect to a computer.	1203-SFC
Splitter Cable	RJ45 one to two port splitter cable (Modbus only)	AK-U0-RJ45-SC1
Terminating Resistors	RJ45 120 Ohm resistors (2 pieces)	AK-U0-RJ45-TR1
Terminal Block	RJ45 Two position terminal block (5 pieces)	AK-U0-RJ45-TB2P
Connected Components Workbench Software (Download or DVD-ROM)	Windows-based software packages for programming and configuring Allen-Bradley drives and other Rockwell Automation products. Compatibility: Windows XP, Windows Vista and Windows 7	http://ab.rockwellautomation.com/programmable-controllers/connected-components-workbench-software

Bulletin 1321-3R Series Line Reactors

Output Ratings[1]				Input Line Reactor[3][4]		Output Line Reactor[3][4]	
Normal Duty		Heavy Duty		IP00 (Open Style)	IP11 (NEMA/UL Type 1)	IP00 (Open Style)	IP11 (NEMA/UL Type 1)
HP	kW	HP	kW	Catalog No.	Catalog No.	Catalog No.	Catalog No.
200...240V 50/60 Hz 1-Phase[2]							
0.25	0.2	0.25	0.2	1321-3R4-A	1321-3RA4-A	1321-3R2-D	1321-3RA2-D
0.5	0.4	0.5	0.4	1321-3R8-A	1321-3RA8-A	1321-3R2-D	1321-3RA2-D
1.0	0.75	1.0	0.75	1321-3R8-A	1321-3RA8-A	1321-3R4-A	1321-3RA4-A
2.0	1.5	2.0	1.5	1321-3R18-A	1321-3RA18-A	1321-3R8-A	1321-3RA8-A
3.0	2.2	3.0	2.2	1321-3R18-A	1321-3RA18-A	1321-3R12-A	1321-3RA12-A
200...240V 50/60 Hz 3-Phase							
0.25	0.2	0.25	0.2	1321-3R2-D	1321-3RA2-D	1321-3R2-D	1321-3RA2-D
0.5	0.4	0.5	0.4	1321-3R2-D	1321-3RA2-D	1321-3R2-D	1321-3RA2-D

Bulletin 1321-3R Series Line Reactors

Output Ratings[1]				Input Line Reactor[3][4]		Output Line Reactor[3][4]	
Normal Duty		Heavy Duty		IP00 (Open Style)	IP11 (NEMA/UL Type 1)	IP00 (Open Style)	IP11 (NEMA/UL Type 1)
HP	kW	HP	kW	Catalog No.	Catalog No.	Catalog No.	Catalog No.
1.0	0.75	1.0	0.75	1321-3R4-A	1321-3RA4-A	1321-3R4-A	1321-3RA4-A
2.0	1.5	2.0	1.5	1321-3R8-A	1321-3RA8-A	1321-3R8-A	1321-3RA8-A
3.0	2.2	3.0	2.2	1321-3R12-A	1321-3RA12-A	1321-3R12-A	1321-3RA12-A
5.0	4.0	5.0	4.0	1321-3R18-A	1321-3RA18-A	1321-3R18-A	1321-3RA18-A
7.5	5.5	7.5	5.5	1321-3R25-A	1321-3RA25-A	1321-3R25-A	1321-3RA25-A
10.0	7.5	10.0	7.5	1321-3R35-A	1321-3RA35-A	1321-3R35-A	1321-3RA35-A
15.0	11.0	10.0	7.5	1321-3R45-A	1321-3RA45-A	1321-3R45-A	1321-3RA45-A
20.0	15.0	15.0	11.0	1321-3R55-A (ND) 1321-3R45-A (HD)	1321-3RA55-A (ND) 1321-3RA45-A (HD)	1321-3R55-A (ND) 1321-3R45-A (HD)	1321-3RA55-A (ND) 1321-3RA45-A (HD)
380...480V 50/60 Hz 3-Phase							
0.5	0.4	0.5	0.4	1321-3R2-B	1321-3RA2-B	1321-3R2-B	1321-3RA2-B
1.0	0.75	1.0	0.75	1321-3R4-C	1321-3RA4-C	1321-3R4-C	1321-3RA4-C
2.0	1.5	2.0	1.5	1321-3R4-B	1321-3RA4-B	1321-3R4-B	1321-3RA4-B
3.0	2.2	3.0	2.2	1321-3R8-C	1321-3RA8-C	1321-3R8-C	1321-3RA8-C
5.0	4.0	5.0	4.0	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
7.5	5.5	7.5	5.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
10.0	7.5	10.0	7.5	1321-3R18-B	1321-3RA18-B	1321-3R18-B	1321-3RA18-B
15.0	11.0	15.0	11.0	1321-3R25-B	1321-3RA25-B	1321-3R25-B	1321-3RA25-B
20.0	15.0	15.0	11.0	1321-3R35-B (ND) 1321-3R25-B (HD)	1321-3RA35-B (ND) 1321-3RA25-B (HD)	1321-3R35-B (ND) 1321-3R25-B (HD)	1321-3RA35-B (ND) 1321-3RA25-B (HD)
25.0	18.5	20.0	15.0	1321-3R35-B	1321-3RA35-B	1321-3R35-B	1321-3RA35-B
30.0	22.0	25.0	18.5	1321-3R45-B (ND) 1321-3R35-B (HD)	1321-3RA45-B (ND) 1321-3RA35-B (HD)	1321-3R45-B (ND) 1321-3R35-B (HD)	1321-3RA45-B (ND) 1321-3RA35-B (HD)
525...600V 50/60 Hz 3-Phase							
0.5	0.4	0.5	0.4	1321-3R1-C	1321-3RA1-C	1321-3R1-C	1321-3RA1-C
1.0	0.75	1.0	0.75	1321-3R2-B	1321-3RA2-B	1321-3R2-B	1321-3RA2-B
2.0	1.5	2.0	1.5	1321-3R4-C	1321-3RA4-C	1321-3R4-C	1321-3RA4-C
3.0	2.2	3.0	2.2	1321-3R4-B	1321-3RA4-B	1321-3R4-B	1321-3RA4-B
5.0	4.0	5.0	4.0	1321-3R8-C	1321-3RA8-C	1321-3R8-C	1321-3RA8-C
7.5	5.5	7.5	5.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
10.0	7.5	10.0	7.5	1321-3R12-B	1321-3RA12-B	1321-3R12-B	1321-3RA12-B
15.0	11.0	15.0	11.0	1321-3R18-B	1321-3RA18-B	1321-3R18-B	1321-3RA18-B
20.0	15.0	15.0	11.0	1321-3R25-B (ND) 1321-3R18-B (HD)	1321-3RA25-B (ND) 1321-3RA18-B (HD)	1321-3R25-B (ND) 1321-3R18-B (HD)	1321-3RA25-B (ND) 1321-3RA18-B (HD)
25.0	18.5	20.0	15.0	1321-3R35-C (ND) 1321-3R25-C (HD)	1321-3RA35-C (ND) 1321-3RA25-C (HD)	1321-3R35-C (ND) 1321-3R25-C (HD)	1321-3RA35-C (ND) 1321-3RA25-C (HD)
30.0	22.0	25.0	18.5	1321-3R35-C (ND) 1321-3R25-B (HD)	1321-3RA35-C (ND) 1321-3RA25-B (HD)	1321-3R35-C (ND) 1321-3R25-B (HD)	1321-3RA35-C (ND) 1321-3RA25-B (HD)

(1) Normal Duty and Heavy Duty ratings for 15 HP (11 kW) and below are identical except for 200...240V 3-Phase 15 HP (11 kW) drive.

(2) Standard 3-phase reactors can be used for 1-phase applications by routing each of the two supply conductors through an outside coil and leaving the center open.

(3) Catalog numbers listed are for 3% impedance at 60 Hz. 5% impedance reactor types are also available. See publication 1321-TD001.

(4) Input line reactors were sized based on the NEC fundamental motor amps. Output line reactors were sized based on the VFD rated output currents.

Product Dimensions

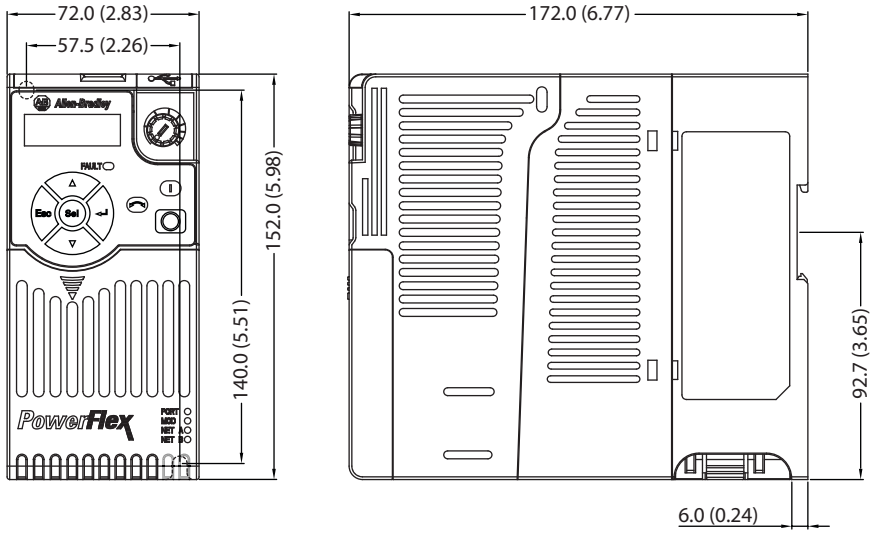
The PowerFlex 520-series drive is available in five frame sizes. See the PowerFlex 520-Series Drive Ratings on page 161 for information on power ratings.

PowerFlex 520-Series Drive Weight

Frame Size	Weight (kg/lb)
A	1.1 / 2.4
B	1.6 / 3.5
C	2.3 / 5.0
D	3.9 / 8.6
E	12.9 / 28.4

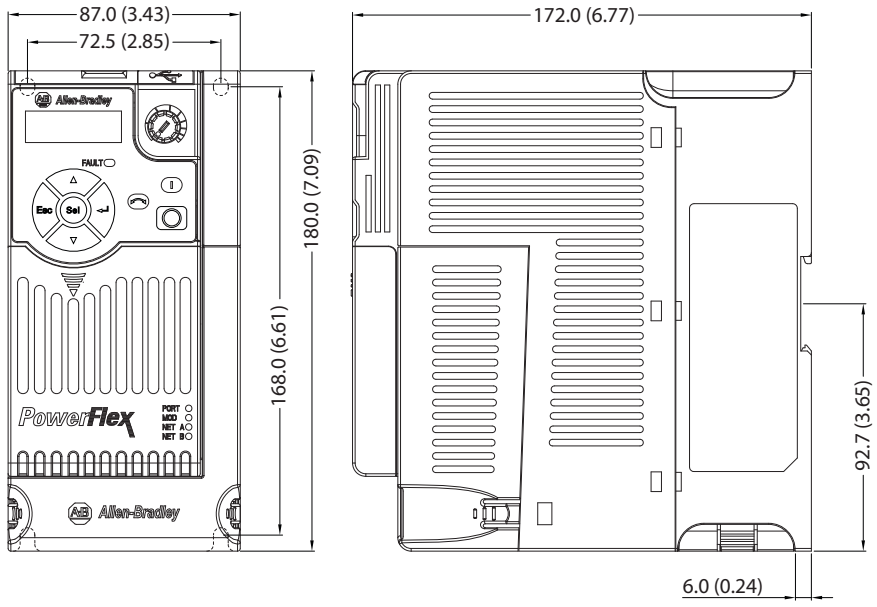
IP 20/Open Type – Frame A

Dimensions are in millimeters and (inches)



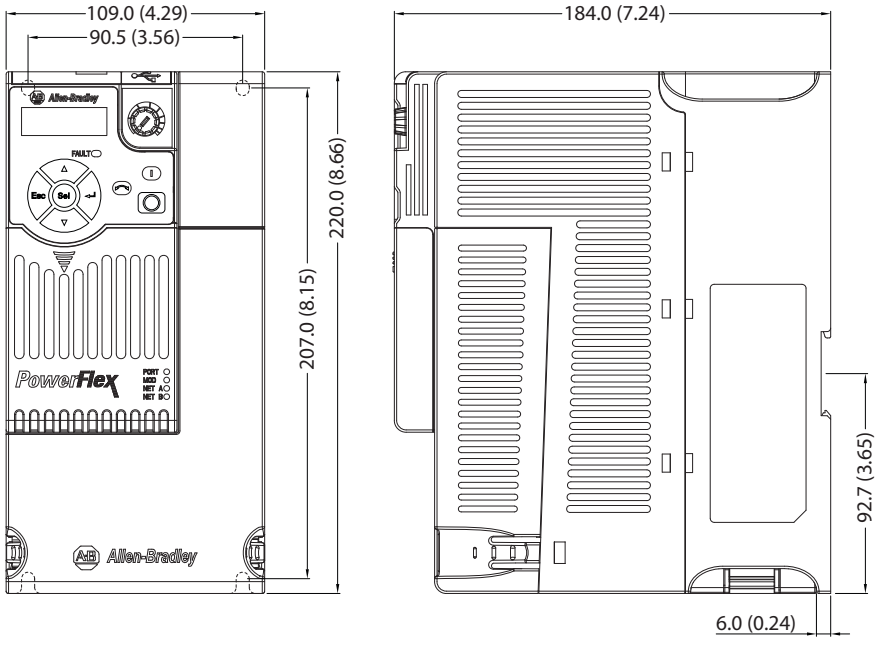
IP 20/Open Type – Frame B

Dimensions are in millimeters and (inches)



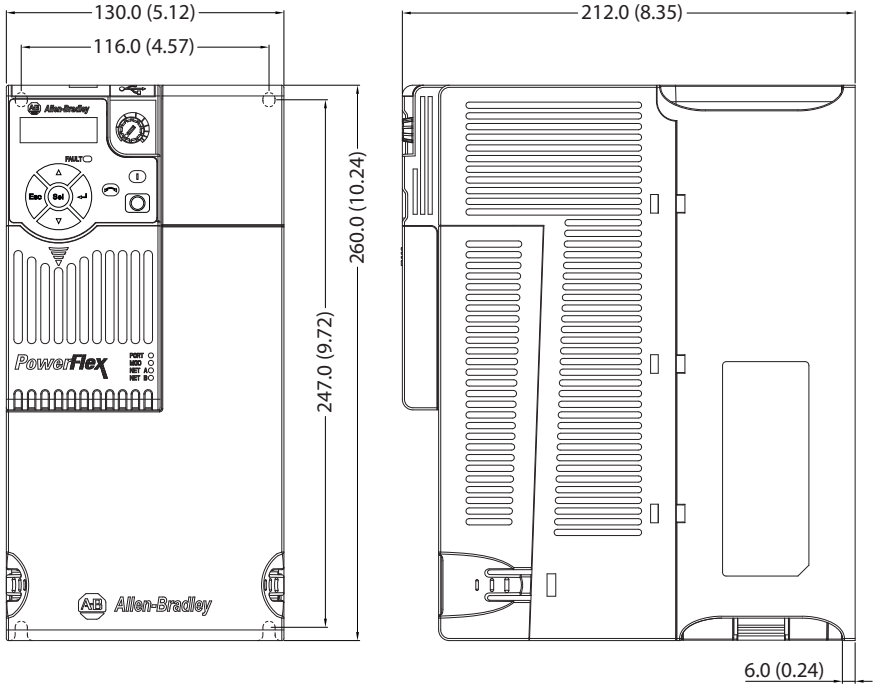
IP 20/Open Type – Frame C

Dimensions are in millimeters and (inches)



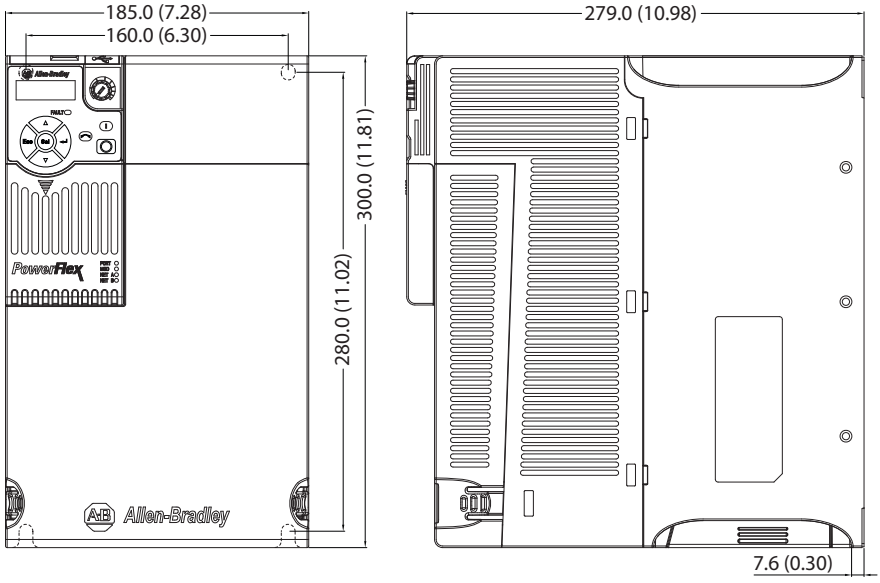
IP 20/Open Type – Frame D

Dimensions are in millimeters and (inches)



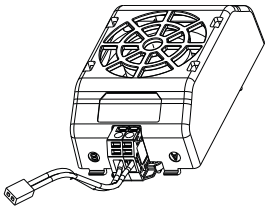
IP 20/Open Type – Frame E

Dimensions are in millimeters and (inches)

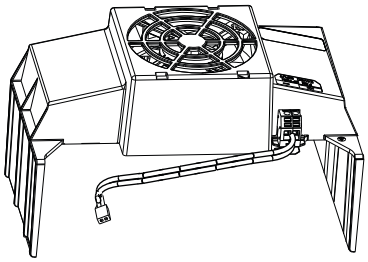


Control Module Fan Kit

25-FAN1-70C



25-FAN2-70C

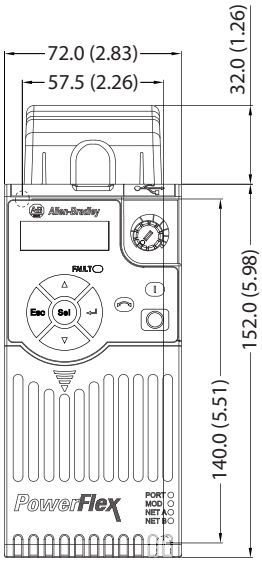


Specifications	25-FAN1-70C	25-FAN2-70C
Rated Voltage	24V DC	
Operation Voltage	14...27.6V DC	
Input Current	0.1 A	0.15 A
Speed (Reference)	7000 rpm	4500 ± 10% rpm
Maximum Air Flow (At zero static pressure)	0.575 m^3/min	1.574 m^3/min
Maximum Air Pressure (At zero air flow)	7.70 mmH_2O	9.598 mmH_2O
Acoustical Noise	40.5 dB-A	46.0 dB-A
Insulation Type	UL Class A	
Frame Size	Frame A...D	Frame E
Wire Size	0.32 mm^2 (22 AWG)	
Torque	0.29...0.39 Nm (2.6...3.47 lb-in.)	

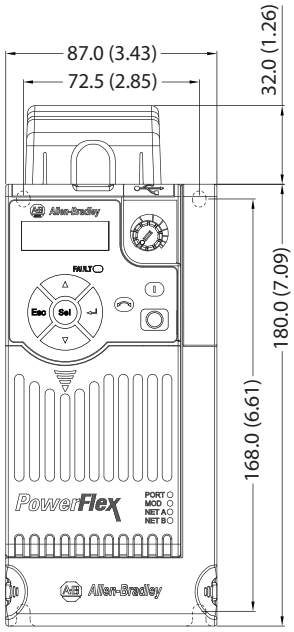
IP 20/Open Type with Control Module Fan Kit – Frame A...C

Dimensions are in millimeters and (inches)

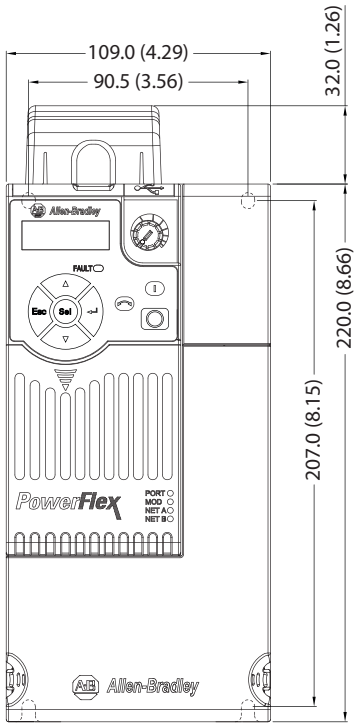
Frame A



Frame B



Frame C

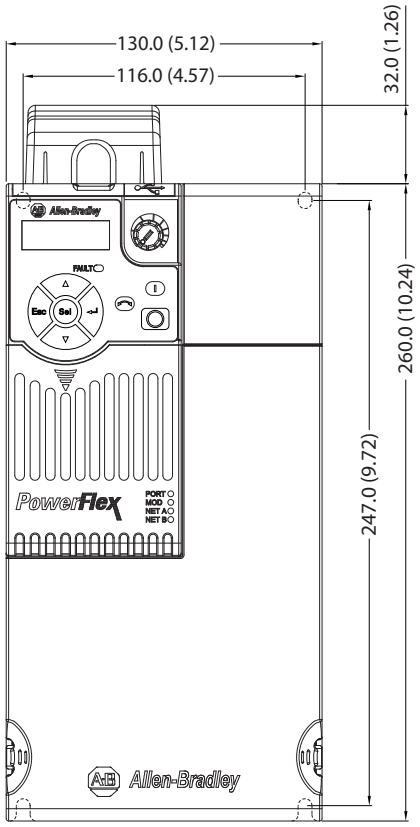


IMPORTANT An external 24V DC power source is required when using the Control Module Fan Kit with drive frames A, B, and C.

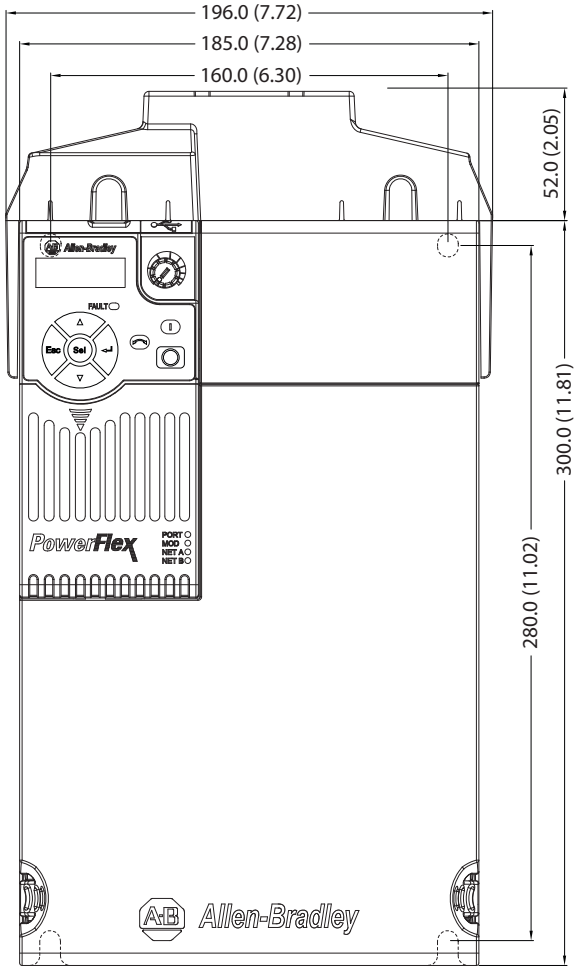
IP 20/Open Type with Control Module Fan Kit – Frame D...E

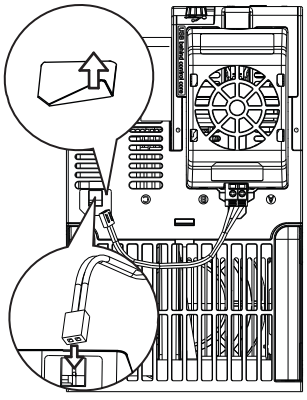
Dimensions are in millimeters and (inches)

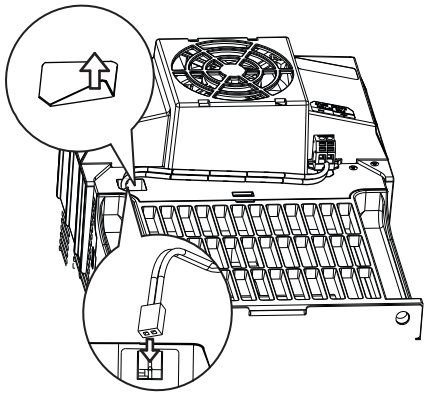
Frame D



Frame E



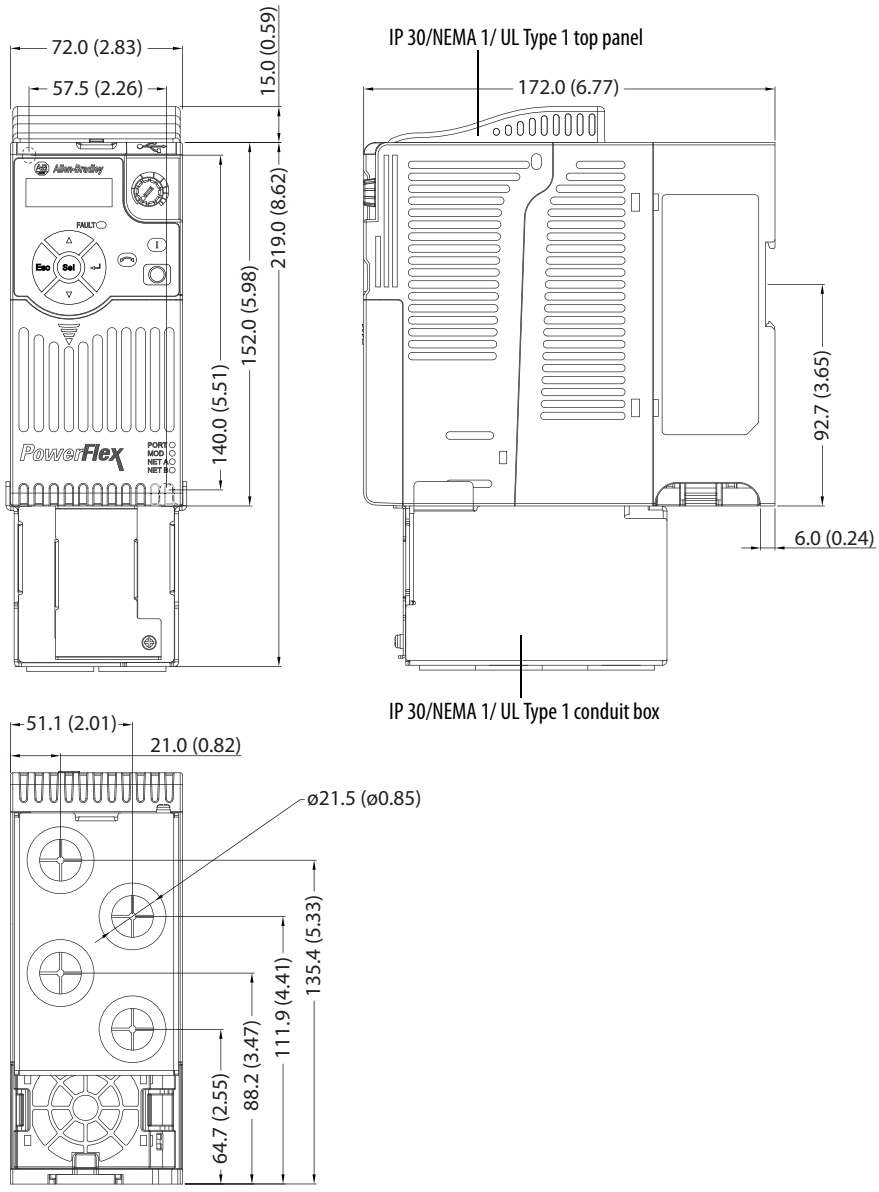




IMPORTANT Remove the label to access the built-in 24V supply on drive frames D and E for use with the Control Module Fan Kit.

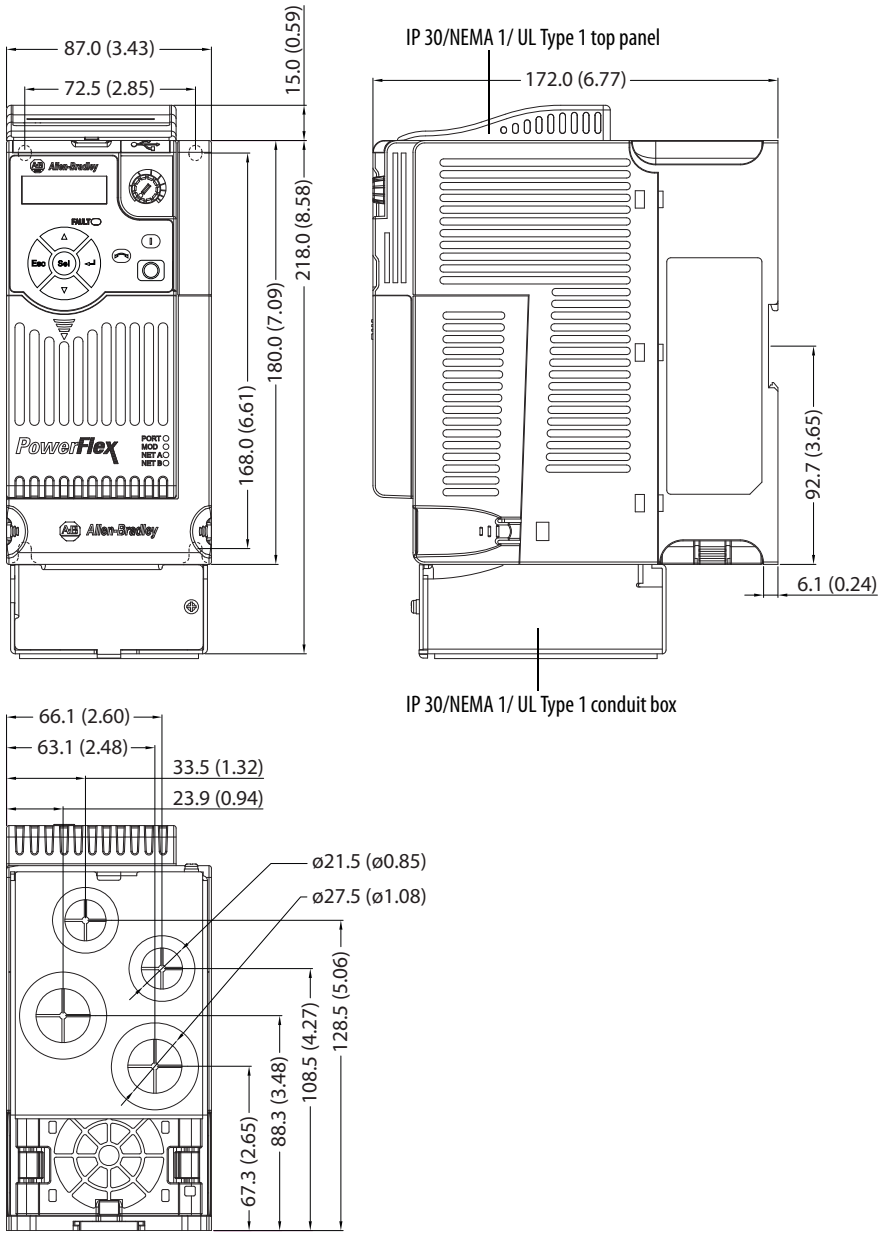
IP 30/NEMA 1/UL Type 1 – Frame A

Dimensions are in millimeters and (inches)



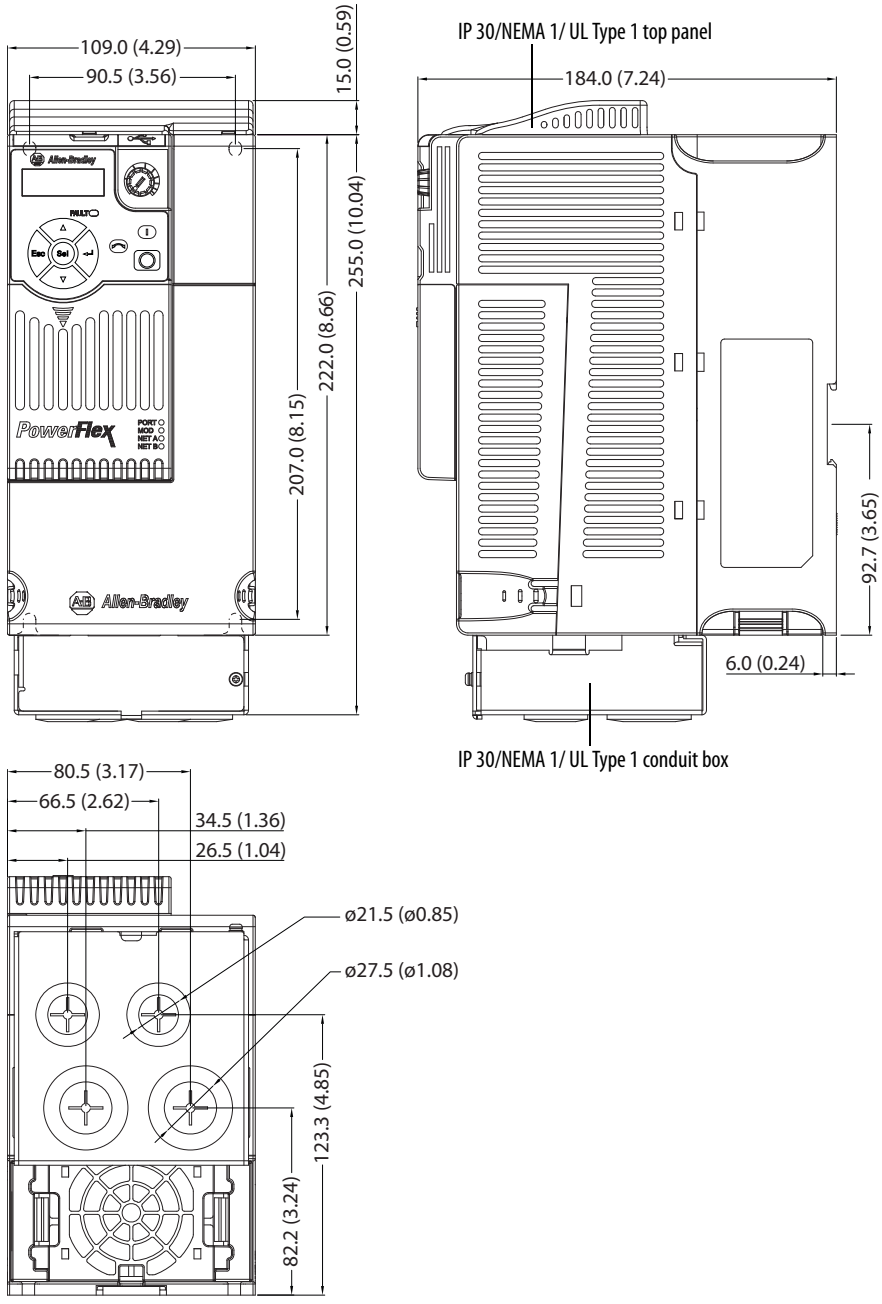
IP 30/NEMA 1/UL Type 1 – Frame B

Dimensions are in millimeters and (inches)



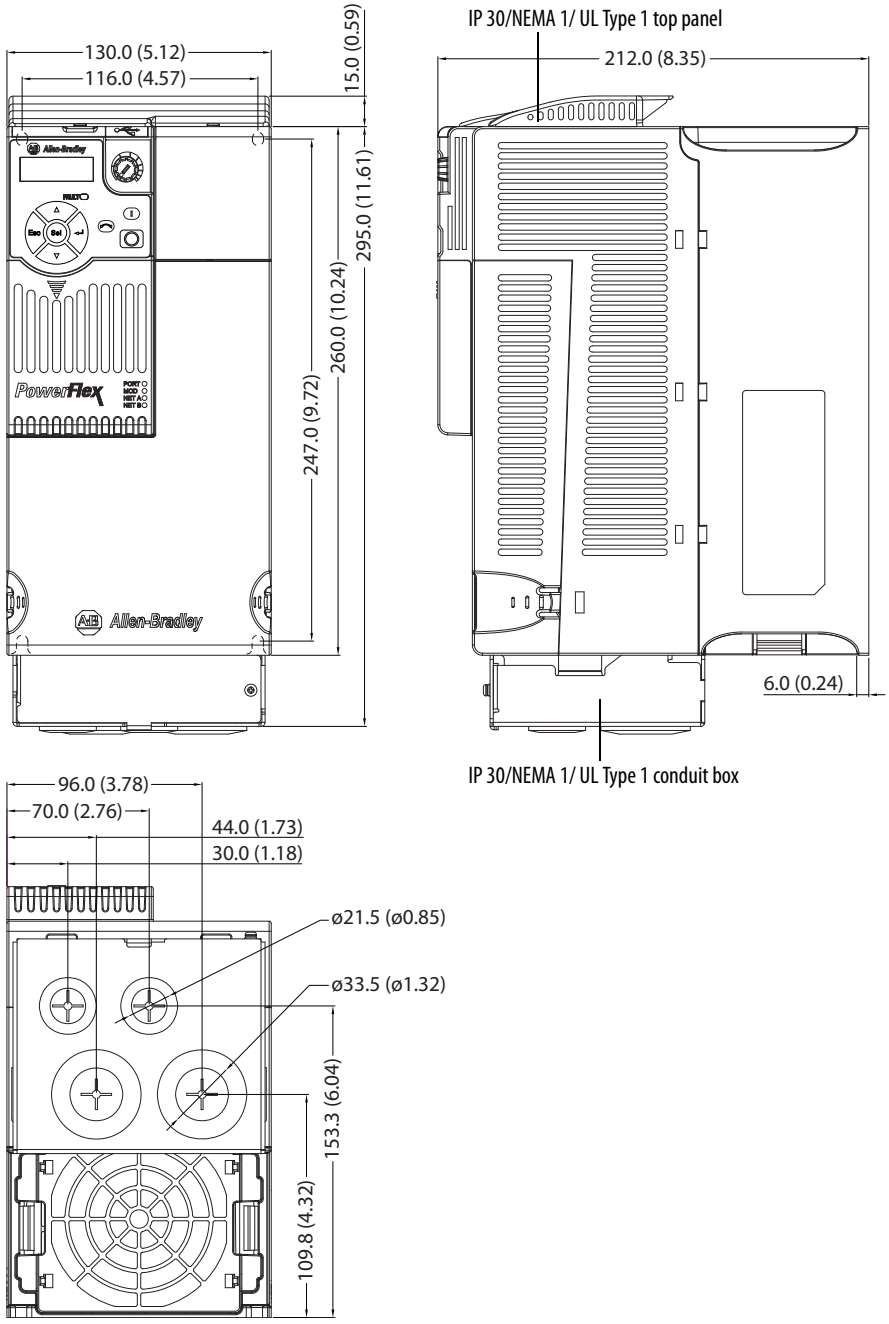
IP 30/NEMA 1/UL Type 1 – Frame C

Dimensions are in millimeters and (inches)



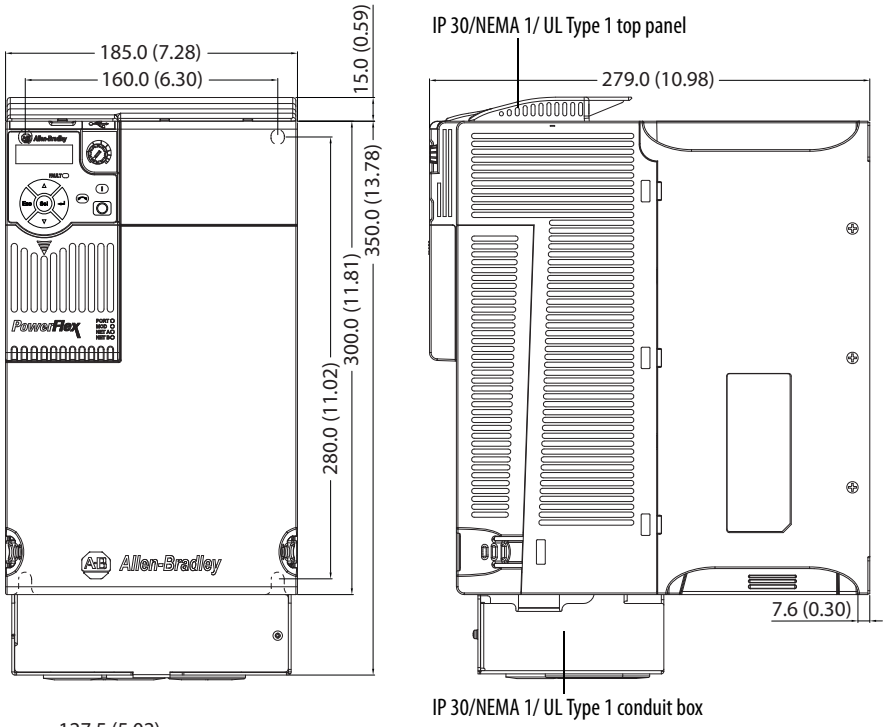
IP 30/NEMA 1/UL Type 1 – Frame D

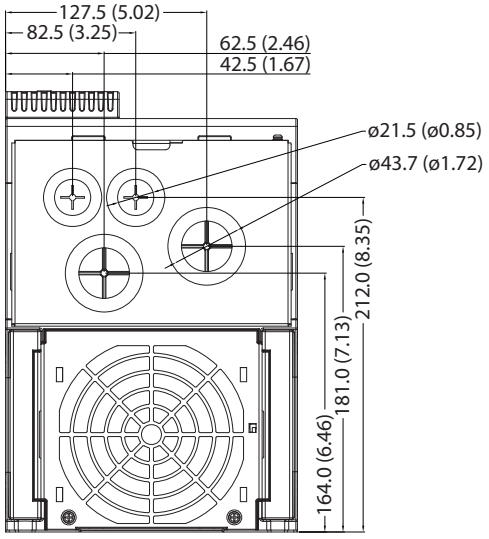
Dimensions are in millimeters and (inches)



IP 30/NEMA 1/UL Type 1 – Frame E

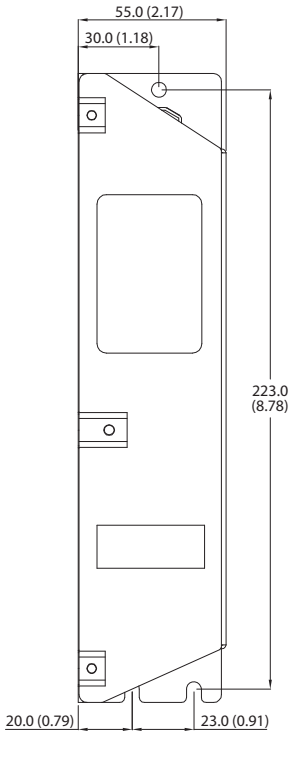
Dimensions are in millimeters and (inches)



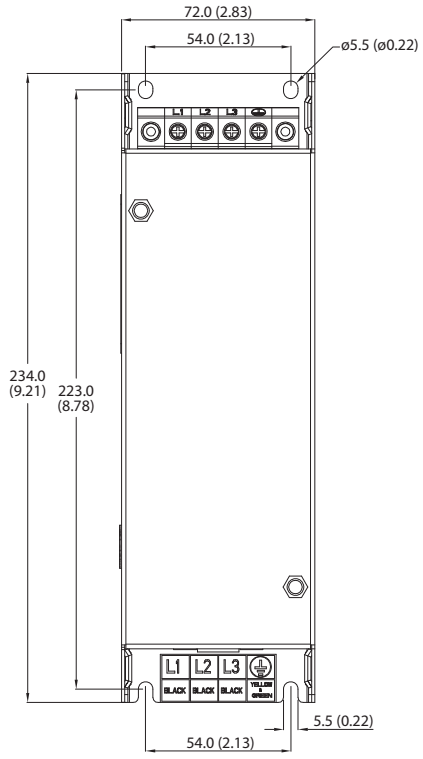


EMC Line Filter – Frame A

Dimensions are in millimeters and (inches)

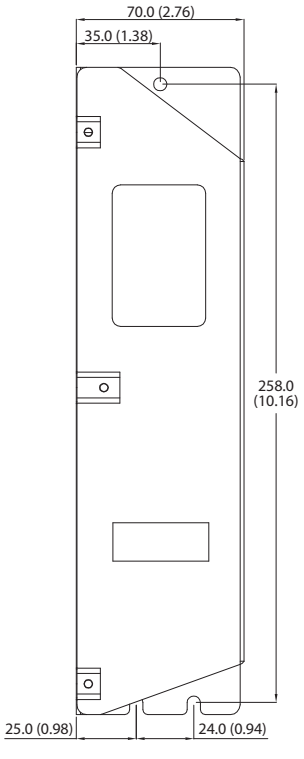


Filter can be mounted onto the back of the drive.

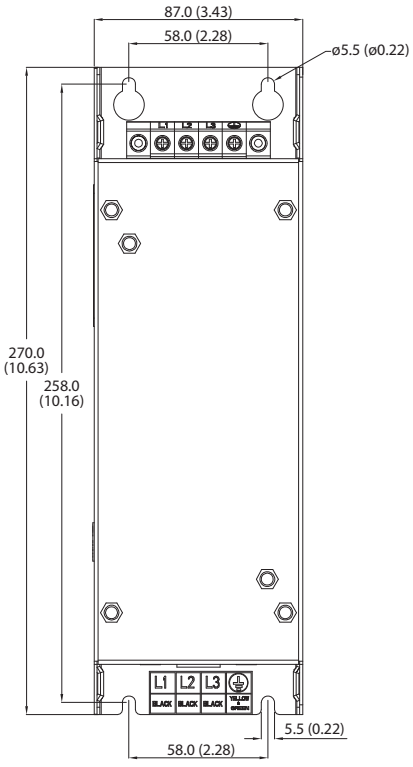


EMC Line Filter – Frame B

Dimensions are in millimeters and (inches)

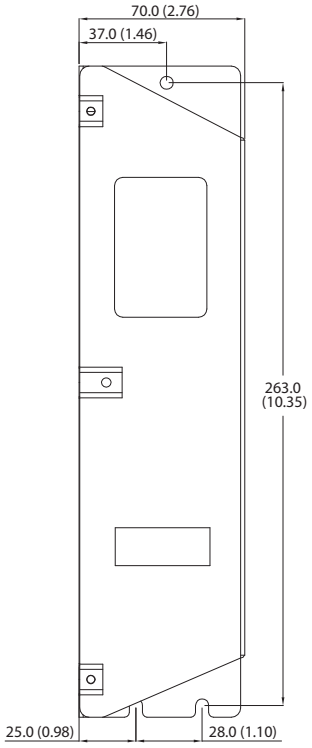


Filter can be mounted onto the back of the drive.

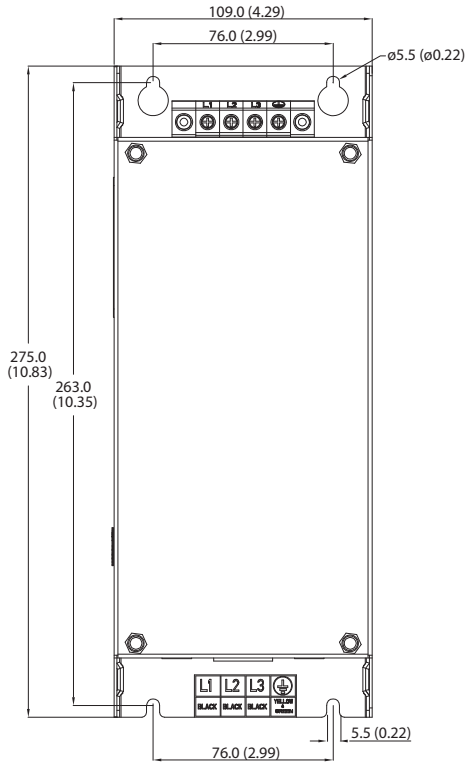


EMC Line Filter – Frame C

Dimensions are in millimeters and (inches)

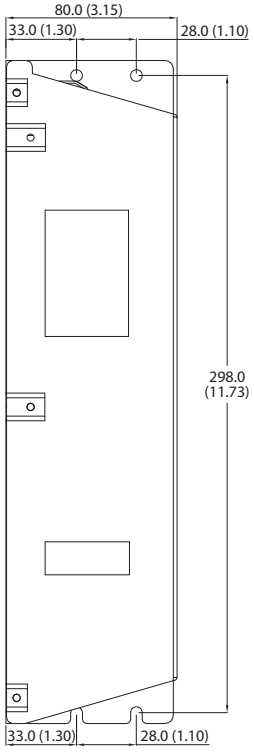


Filter can be mounted onto the back of the drive.

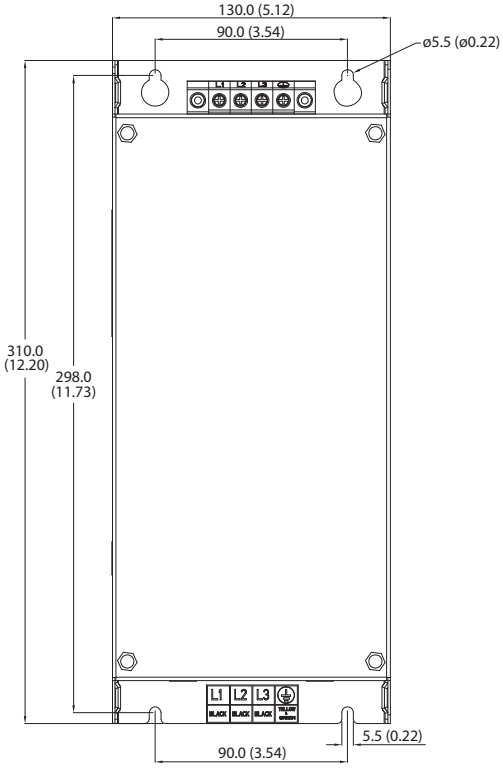


EMC Line Filter – Frame D

Dimensions are in millimeters and (inches)

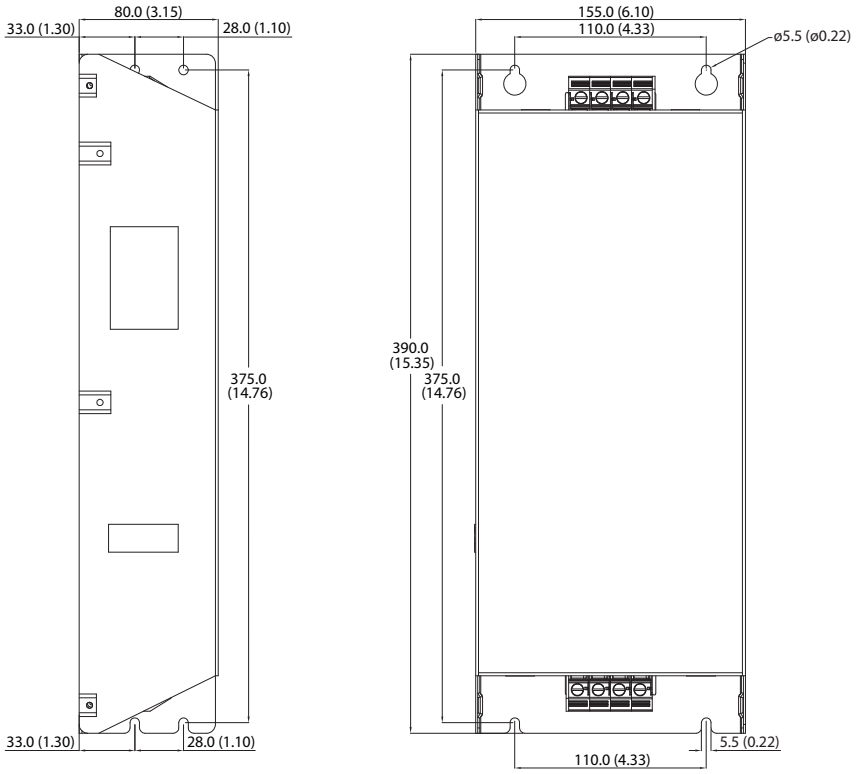


Filter can be mounted onto the back of the drive.



EMC Line Filter – Frame E

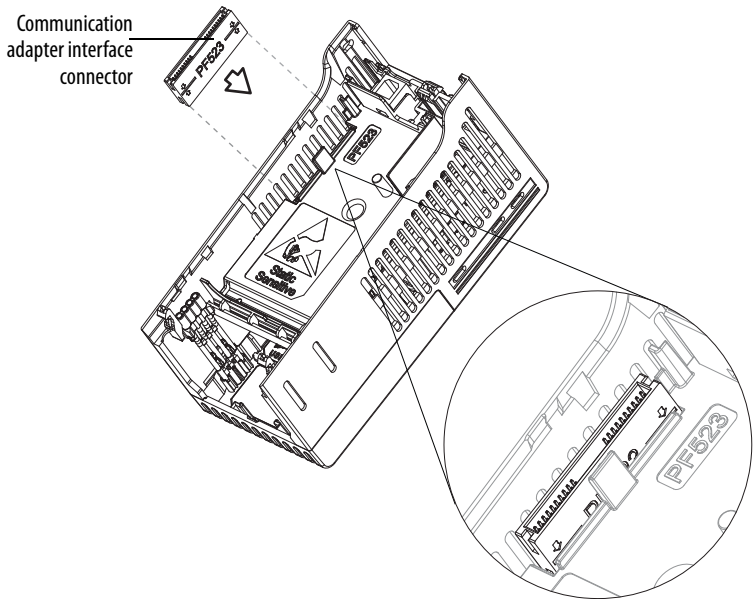
Dimensions are in millimeters and (inches)



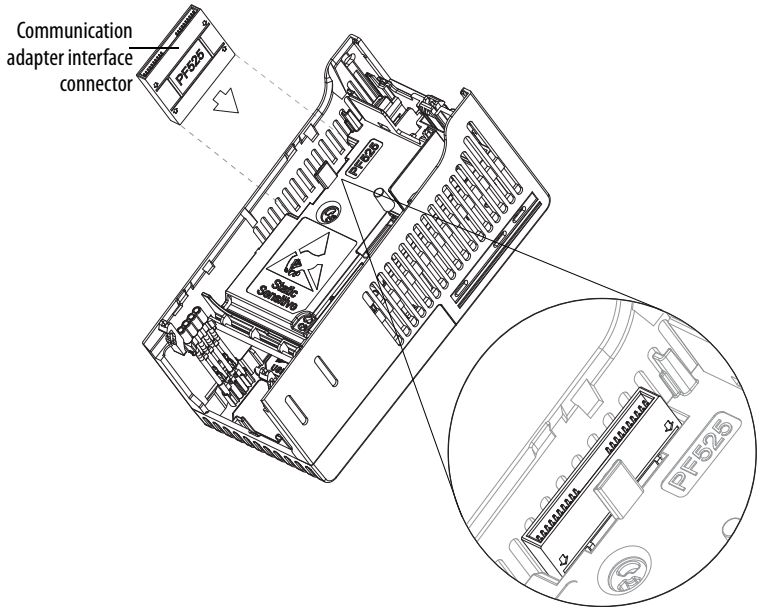
Optional Accessories and Kits Installing a Communication Adapter

1. Insert the communication adapter interface connector into the Control Module. Make sure the indicator line on the connector is aligned with the surface of the Control Module.

For PowerFlex 523

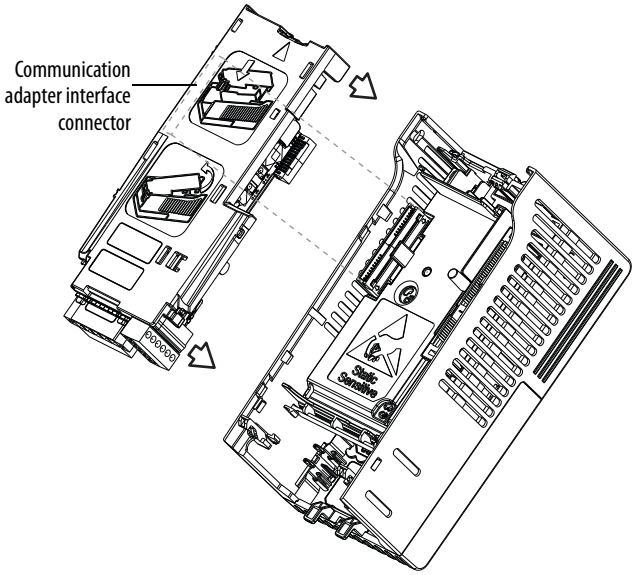


For PowerFlex 525



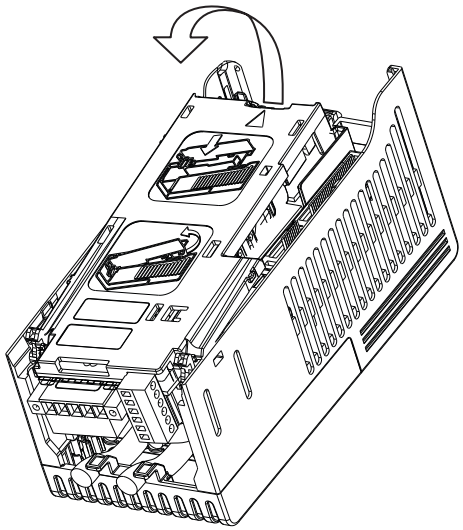
2. Align the connectors on the communication adapter to the communication adapter interface connector, then push the back cover down.

3. Press along the edges of the back cover until it snaps firmly into place.



Removing a Communication Adapter

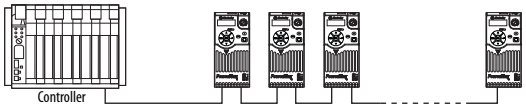
1. Insert a finger into the slot at the top of the back cover. Lift to separate the back cover from the Control Module.



RS485 (DSI) Protocol

PowerFlex 520-series drives support the RS485 (DSI) protocol to allow efficient operation with Rockwell Automation peripherals. In addition, some Modbus functions are supported to allow simple networking. PowerFlex 520-series drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

PowerFlex 520-Series Drive Network



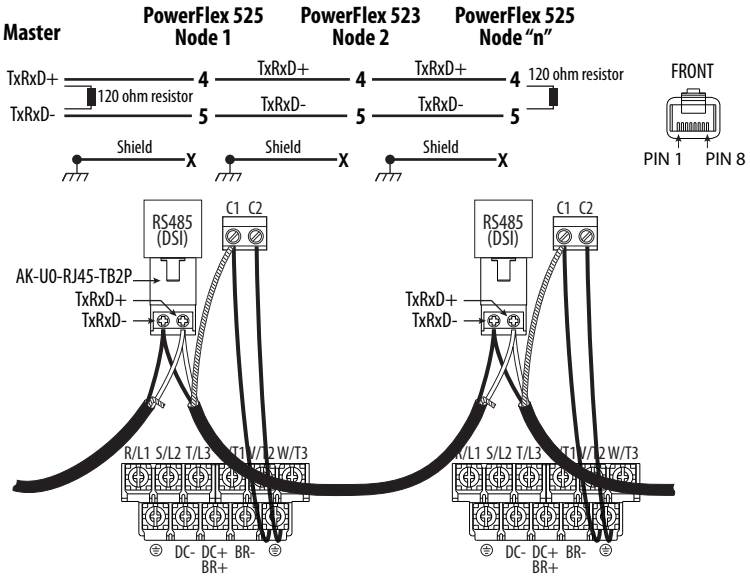
For information regarding EtherNet/IP or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

ATTENTION: Never attempt to connect a Power over Ethernet (PoE) cable to the RS485 port. Doing so may damage the circuitry.

Network Wiring Diagram Example



IMPORTANT The shield is connected at ONLY ONE end of each cable segment.

Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 520-series drive's RJ45 socket must not be connected because they contain power, etc. for other Rockwell Automation peripheral devices.

Wiring terminations on the master controller will vary depending on the master controller used and "TxRxD+" and "TxRxD-" are shown for illustration purposes only. Refer to the master controller's user manual for network terminations. Note that there is no standard for the "+" and "-" wires, and consequently Modbus device manufacturers interpret them differently. If you have problems with initially establishing communications, try swapping the two network wires at the master controller.

Standard RS485 wiring practices apply.

- Termination resistors need to be applied at each end of the network cable.
- RS485 repeaters may need to be used for long cable runs, or if greater than 32 nodes are needed on the network.
- Network wiring should be separated from power wires by at least 0.3 meters (1 foot).
- Network wiring should only cross power wires at a right angle.

I/O Terminal C1 (RJ45 Shield) on the PowerFlex 520-series drive must also be connected to PE ground (there are two PE terminals on the drive). See I/O Control Terminal Designations on page 38 and page 40 for more information.

I/O Terminal C2 (Comm Common) is internally tied to Network Common, and NOT to RJ45 Shield. Tying I/O Terminal C2 to PE ground may improve noise immunity in some applications.

Parameter Configuration

The following PowerFlex 520-series drive parameters are used to configure the drive to operate on a DSI network.

Configuring Parameters for DSI Network

Parameter	Details	Reference
P046 [Start Source 1]	Set to 3 "Serial/DSI" if Start is controlled from the network.	page 79
P047 [Speed Reference1]	Set to 3 "Serial/DSI" if the Speed Reference is controlled from the network.	page 80
C123 [RS485 Data Rate]	Sets the data rate for the RS485 (DSI) Port. All nodes on the network must be set to the same data rate.	page 94
C124 [RS485 Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	page 94
C125 [Comm Loss Action]	Selects the drive's response to communication problems.	page 94
C126 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements C125 [Comm Loss Action].	page 94
C127 [Comm Format]	Sets the transmission mode, data bits, parity and stop bits for the RS485 (DSI) Port. All nodes on the network must be set to the same setting.	page 95
C121 [Comm Write Mode]	Set to 0 "Save" when programming drive. Set to 1 "RAM only" to only write to volatile memory.	page 94

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 520-series drives supports some of the Modbus function codes.

Supported Modbus Function Codes

Modbus Function Code (Decimal)	Command
03	Read Holding Registers
06	Preset (Write) Single Register
16 (10 Hexadecimal)	Preset (Write) Multiple Registers

IMPORTANT Modbus devices can be 0-based (registers are numbered starting at 0) or 1-based (registers are numbered starting at 1). Depending on the Modbus Master used, the register addresses listed on the following pages may need to be offset by +1. For example, Logic Command may be register address 8192 for some master devices (e.g. ProSoft 3150-MCM SLC Modbus scanner) and 8193 for others (e.g. PanelViews).

Writing (06) Logic Command Data

The PowerFlex 520-series drive can be controlled through the network by sending Function Code 06 writes to register address 2000H (Logic Command). P046 [Start Source 1] must be set to 3 "Serial/DSI" in order to accept the commands. PowerFlex 523 drives support only Velocity bit definitions. PowerFlex 525 drives can use Parameter C122 [Cmd Stat Select] to select either Velocity or Position bit definitions.

TIP Powerup/Reset the drive after selecting an option for C122 [Cmd Stat Select] for the change to take effect.

Velocity Bit Definitions

Comm Logic Command – C122 = 0 "Velocity"		
Address (Decimal)	**Bit(s)**	**Description**
2000H (8192)	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5, 4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	1 = Force Keypad Control, 0 = Not Force Keypad Control
	7	1 = MOP Increment, 0 = Not Increment
	9, 8	00 = No Command
		01 = Accel Rate 1 Enable
		10 = Accel Rate 2 Enable
		11 = Hold Accel Rate Selected
	11, 10	00 = No Command
		01 = Decel Rate 1 Enable
		10 = Decel Rate 2 Enable
		11 = Hold Decel Rate Selected
	14, 13, 12	000 = No Command
		001 = Freq. Source = P047 [Speed Reference1]
		010 = Freq. Source = P049 [Speed Reference2]
		011 = Freq. Source = P051 [Speed Reference3]
		100 = A410 [Preset Freq 0]
		101 = A411 [Preset Freq 1]
		110 = A412 [Preset Freq 2]
		111 = A413 [Preset Freq 3]
	15	1 = MOP Decrement, 0 = Not Decrement

Position Bit Definitions

Comm Logic Command – C122 = 1 "Position"		
Address (Decimal)	**Bit(s)**	**Description**
2000H (8192)	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5, 4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	1 = Logic In 1
	7	1 = Logic In 2
	10, 9, 8	000 = Freq. and Position Step 0
		001 = Freq. and Position Step 1
		010 = Freq. and Position Step 2
		011 = Freq. and Position Step 3
		100 = Freq. and Position Step 4
		101 = Freq. and Position Step 5
		110 = Freq. and Position Step 6
		111 = Freq. and Position Step 7
	11	1 = Find Home
	12	1 = Hold Step
	13	1 = Pos Redefine
	14	1 = Sync Enable
	15	1 = Traverse Disable

Writing (06) Comm Frequency Command

The PowerFlex 520-series drive Comm Frequency Command can be controlled through the network by sending Function Code 06 writes to register address 2001H (Comm Frequency Command).

Comm Frequency Command

Reference	
Address (Decimal)	**Description**
2001H (8193)	Used by internal comm modules to control the reference of the drive. In units of 0.01 Hz.

Reading (03) Logic Status Data

The PowerFlex 520-series drive Logic Status data can be read through the network by sending Function Code 03 reads to register address 2100H (Logic Status). PowerFlex 523 drives support only Velocity bit definitions. PowerFlex 525 drives can use Parameter C122 [Cmd Stat Select] to select either Velocity or Position bit definitions.

Velocity Bit Definitions

Comm Logic Status – C122 = 0 "Velocity"		
Address (Decimal)	**Bit(s)**	**Description**
2100H (8448)	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	Not Used
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Main Freq Controlled by Active Comm
	10	1 = Operation Cmd Controlled by Active Comm
	11	1 = Parameters have been locked
	12	Digital Input 1 Status
	13	Digital Input 2 Status
	14	Digital Input 3 Status
	15	Digital Input 4 Status

Position Bit Definitions

Comm Logic Status – C122 = 1 "Position"		
Address (Decimal)	**Bit(s)**	**Description**
2100H (8448)	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	1 = Forward Travel Position, 0 = Reverse Travel Position
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = At Position, 0 = Not At Position
	10	1 = At Home, 0 = Not At Home
	11	1 = Drive Homed, 0 = Not Drive Homed
	12	1 = Sync Hold, 0 = Not Sync Hold
	13	1 = Sync Ramp, 0 = Not Sync Ramp
	14	1 =Traverse On, 0 = Traverse Off
	15	1 = Traverse Decel, 0 = Not Traverse Decel

Reading (03) Drive Error Codes

The PowerFlex 520-series Error Code data can be read through the network by sending Function Code 03 reads to register address 2101H (Drive Error Codes).

Drive Error Codes

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
2101H (8449)	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	9	Control Module Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	15	Load Loss
	21	Output Phase Loss
	29	Analog Input Loss
	33	Auto Restart Tries
	38	Phase U to Ground Short
	39	Phase V to Ground Short
	40	Phase W to Ground Short
	41	Phase UV Short
	42	Phase UW Short
	43	Phase VW Short
	48	Parameters Defaulted
	59	Safety Open
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	71	DSI Network Loss
	72	Option Card Network Loss
	73	Embedded EtherNet/IP Adapter Network Loss
	80	AutoTune Fail
	81	DSI Communication Loss
	82	Option Card Communication Loss
	83	Embedded EtherNet/IP Adapter Communication Loss
	91	Encoder Loss
	94	Function Loss
	100	Parameter Checksum Error
	101	External Storage
	105	Control Module Connect Error
	106	Incompatible Control-Power Module
	107	Unrecognized Control-Power Module
	109	Mismatched Control-Power Module
	110	Keypad Membrane
	111	Safety Hardware
	114	Microprocessor Failure
	122	I/O Board Fail

Drive Error Codes

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
2101H (8449)	125	Flash Update Required
	126	Non Recoverable Error
	127	DSI Flash Update Required

Reading (03) Drive Operational Values

The PowerFlex 520-series Drive Operational Values can be read through the network by sending Function Code 03 reads to register addresses 2102H...210AH.

Drive Operational Values

Reference	
Address (Decimal)	**Description**
2102H (8450)	Frequency Command (xxx.xx Hz)
2103H (8451)	Output Frequency (xxx.xx Hz)
2104H (8452)	Output Current (xxx.xx A)
2105H (8453)	DC-BUS Voltage (xxxV)
2106H (8454)	Output Voltage (xxx.xV)

Reading (03) and Writing (06) Drive Parameters

To access drive parameters, the Modbus register address equals the parameter number. For example, a decimal “1” is used to address Parameter b001 [Output Freq] and decimal “41” is used to address Parameter P041 [Accel Time 1].

Additional Information

See http://www.ab.com/drives/ for additional information.

Velocity StepLogic, Basic Logic and Timer/ Counter Functions

Four PowerFlex 520-series logic functions provide the capability to program simple logic functions without a separate controller.

- Velocity StepLogic™ Function (specific to PowerFlex 525 drives only)

  Steps through up to eight preset speeds based on programmed logic. Programmed logic can include conditions that need to be met from digital inputs programmed as "Logic In 1" and "Logic In 2" before stepping from one preset speed to the next. A timer is available for each of the eight steps and is used to program a time delay before stepping from one preset speed to the next. The status of a digital output can also be controlled based on the step being executed.
- Basic Logic Function (specific to PowerFlex 525 drives only)

  Up to two digital inputs can be programmed as "Logic In 1" and/or "Logic In 2". A digital output can be programmed to change state based on the condition of one or both inputs based on basic logic functions such as AND, OR, NOR. The basic logic functions can be used with or without StepLogic.
- Timer Function

  A digital input can be programmed for "Timer Start". A digital output can be programmed as a "Timer Out" with an output level programmed to the desired time. When the timer reaches the time programmed into the output level the output will change state. The timer can be reset with a digital input programmed as "Reset Timer".
- Counter Function

  A digital input can be programmed for "Counter In". A digital output can be programmed as "Counter Out" with an output level programmed to the desired number of counts. When the counter reaches the count programmed into the output level the output will change state. The counter can be reset with a digital input programmed as "Reset Counter".

TIP Use the Wizard in Connected Components Workbench to simplify setup instead of manually configuring the parameters.

Velocity StepLogic Using Timed Steps

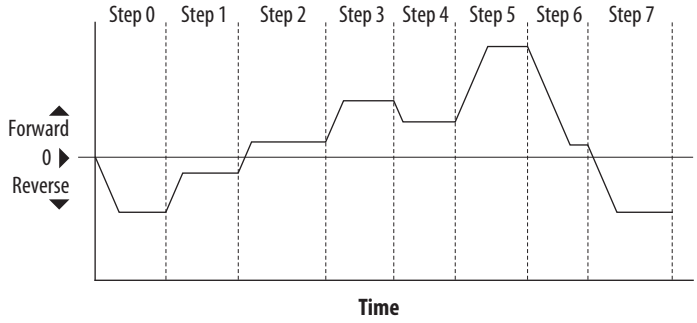
IMPORTANT This function is specific to PowerFlex 525 drives only.

To activate this function, set one of the three speed reference sources, parameter P047, P049 or P051[Speed Referencex] to 13 "Step Logic" and activate that speed reference source. Three parameters are used to configure the logic, speed reference and time for each step.

- Logic is defined using parameters L180...L187 [Stp Logic x].
- Preset Speeds are set with parameters A410...A417 [Preset Freq 0...7].
- Time of operation for each step is set with parameters L190...L197 [Stp Logic Time x].

The direction of motor rotation can be forward or reverse.

Using Timed Steps



Velocity StepLogic Sequence

- Sequence begins with a valid start command.
- A normal sequence begins with Step 0 and transition to the next step when the corresponding StepLogic time has expired.
- Step 7 is followed by Step 0
- Sequence repeats until a stop is issued or a fault condition occurs.

Velocity StepLogic Using Basic Logic Functions

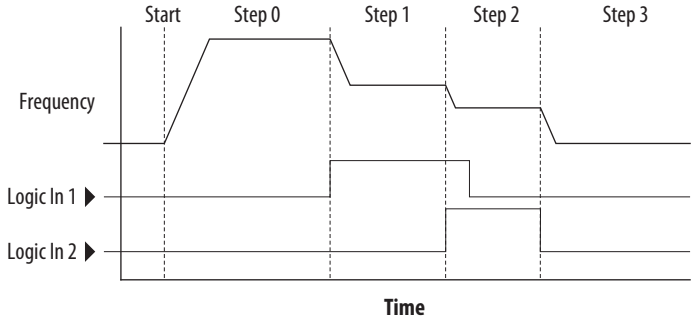
IMPORTANT This function is specific to PowerFlex 525 drives only.

Digital input and digital output parameters can be configured to use logic to transition to the next step. Logic In 1 and Logic In 2 are defined by programming parameters t062...t063, t065...t068 [DigIn TermBlk xx] to 24 "Logic In 1" or 25 "Logic In 2".

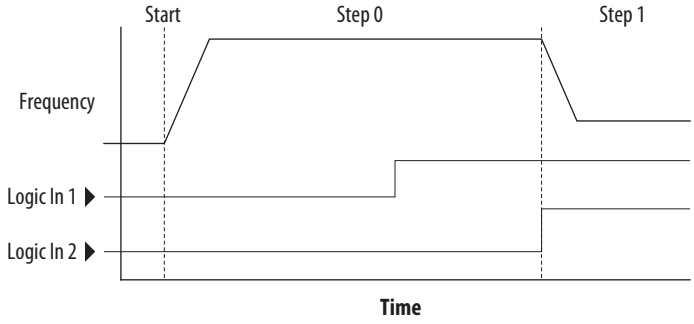
Example

- Run at Step 0.
- Transition to Step 1 when Logic In 1 is true.
  Logic senses the edge of Logic In 1 when it transitions from off to on. Logic In 1 is not required to remain "on".

- Transition to Step 2 when both Logic In 1 and Logic In 2 are true. The drive senses the level of both Logic In 1 and Logic In 2 and transitions to Step 2 when both are on.
- Transition to Step 3 when Logic In 2 returns to a false or off state. Inputs are not required to remain in the "on" condition except under the logic conditions used for the transition from Step 2 to Step 3.



The step time value and the basic logic may be used together to satisfy machine conditions. For instance, the step may need to run for a minimum time period and then use the basic logic to trigger a transition to the next step.



Timer Function

Digital inputs and outputs control the timer function and are configured with parameters t062...t063, t065...t068 [DigIn TermBlk xx] set to 19 "Timer Start" and 21 "Reset Timer".

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters t077 [Relay Out1 Level], t082[Relay Out2 Level], t070 [Opto Out1 Level] and t073 [Opto Out2 Level] are used to set the desired time in seconds.

Parameters t076 [Relay Out1 Sel], t081 [Relay Out2 Sel], t069 [Opto Out1 Sel] and t072 [Opto Out2 Sel] are set to 25 "Timer Out" and causes the output to change state when the preset level is reached.

Example

- Drive starts up and accelerates to 30 Hz.
- After 30 Hz has been maintained for 20 seconds, a 4-20 mA analog input becomes the reference signal for speed control.

- The timer function is used to select a preset speed with a 20 second run time that overrides the speed reference while the digital input is active.
- Parameters are set to the following options:
  - P047 [Speed Reference1] = 6 “4-20mA Input”
  - P049 [Speed Reference2] = 7 “Preset Freq”
  - t062 [DigIn TermBlk 02] = 1 “Speed Ref 2”
  - t063 [DigIn TermBlk 03] = 19 “Timer Start”
  - t076 [Relay Out1 Sel] = 25 “Timer Out”
  - t077 [Relay Out1 Level] = 20.0 Secs
  - A411 [Preset Freq 1] = 30.0 Hz
- The control terminal block is wired such that a start command will also trigger the timer start.
- The relay output is wired to I/O Terminal 02 (DigIn TermBlk 02) so that it forces the input on when the timer starts.
- After the timer is complete, the output is turned off releasing the preset speed command. The drive defaults to following the analog input reference as programmed.

Note that a “Reset Timer” input is not required for this example since the “Timer Start” input both clears and starts the timer.

Counter Function

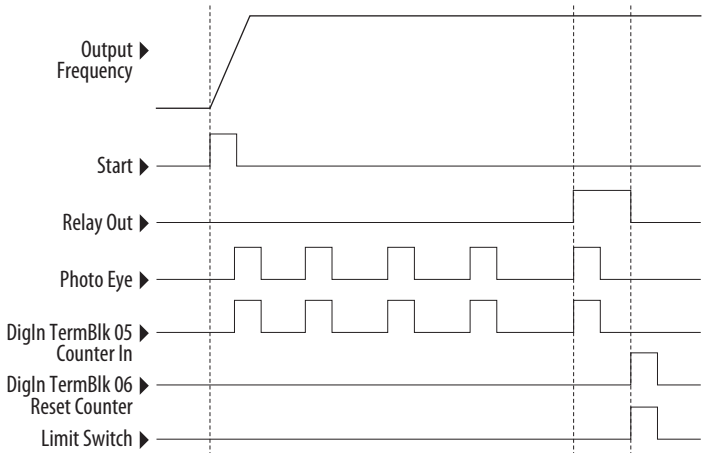
Digital inputs and outputs control the counter function and are configured with parameters t062...t063, t065...t068 [DigIn TermBlk xx] set to 20 “Counter In” and 22 “Reset Countr”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters t077 [Relay Out1 Level], t082[Relay Out2 Level], t070 [Opto Out1 Level] and t073 [Opto Out2 Level] are used to set the desired count value.

Parameters t076 [Relay Out1 Sel], t081 [Relay Out2 Sel], t069 [Opto Out1 Sel] and t072 [Opto Out2 Sel] are set to 26 “Counter Out” which causes the output to change state when the level is reached.

Example

- A photo eye is used to count packages on a conveyor line.
- An accumulator holds the packages until 5 are collected.
- A diverter arm redirects the group of 5 packages to a bundling area.
- The diverter arm returns to its original position and triggers a limit switch that resets the counter.
- Parameters are set to the following options:
  - t065 [DigIn TermBlk 05] = 20 “Counter In”
  - t066 [DigIn TermBlk 06] = 22 “Reset Countr”
  - t076 [Relay Out1 Sel] = 26 “Counter Out”
  - t077 [Relay Out1 Level] = 5.0 Counts



Velocity StepLogic Parameters

Code Descriptions for Parameters L180...L187

Digit 4	Digit 3	Digit 2	Digit 1
0	0	F	1

Digit 4 – Defines the action during the step currently executing

Setting	Accel/Decel Parameter Used	StepLogic Output State	Commanded Direction
0	1	Off	FWD
1	1	Off	REV
2	1	Off	No Output
3	1	On	FWD
4	1	On	REV
5	1	On	No Output
6	2	Off	FWD
7	2	Off	REV
8	2	Off	No Output
9	2	On	FWD
A	2	On	REV
b	2	On	No Output

Digit 3 – Defines what step to jump to or how to end program when the logic conditions specified in Digit 2 are met.

Setting	Logic
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F002)

Digit 2 – Defines what logic must be met to jump to a step other than the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if "Logic In 1" is active (logically true)	TRUE
3	Step if "Logic In 2" is active (logically true)	TRUE
4	Step if "Logic In 1" is not active (logically false)	FALSE
5	Step if "Logic In 2" is not active (logically false)	FALSE
6	Step if either "Logic In 1" or "Logic In 2" is active (logically true)	OR
7	Step if both "Logic In 1" and "Logic In 2" is active (logically true)	AND
8	Step if neither "Logic In 1" or "Logic In 2" is active (logically true)	NOR
9	Step if "Logic In 1" is active (logically true) and "Logic In 2" is not active (logically false)	XOR
A	Step if "Logic In2" is active (logically true) and "Logic In 1" is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and "Logic In 1" is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and "Logic In 2" is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and "Logic In 1" is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and "Logic In 2" is not active (logically false)	TIMED OR
F	Do not step OR no "jump to", so use Digit 0 logic	IGNORE

Digit 1 – Defines what logic must be met to jump to the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if "Logic In 1" is active (logically true)	TRUE
3	Step if "Logic In 2" is active (logically true)	TRUE
4	Step if "Logic In 1" is not active (logically false)	FALSE
5	Step if "Logic In 2" is not active (logically false)	FALSE
6	Step if either "Logic In 1" or "Logic In 2" is active (logically true)	OR
7	Step if both "Logic In 1" and "Logic In 2" is active (logically true)	AND
8	Step if neither "Logic In 1" or "Logic In 2" is active (logically true)	NOR
9	Step if "Logic In 1" is active (logically true) and "Logic In 2" is not active (logically false)	XOR
A	Step if "Logic In 2" is active (logically true) and "Logic In 1" is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and "Logic In 1" is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and "Logic In 2" is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and "Logic In 1" is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and "Logic In 2" is not active (logically false)	TIMED OR
F	Use logic programmed in Digit 1	IGNORE

Encoder/Pulse Train Usage and Position StepLogic Application

Encoder and Pulse Train Usage

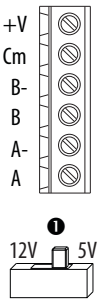
The PowerFlex 520-series drives include a pulse train input built into the terminal block. PowerFlex 525 drives also support an optional encoder card. The pulse train and encoder can be used for many of the same functions, but the pulse train supports up to 100 kHz at 24V, and uses the drive built-in terminal block. The encoder supports up to 250 kHz dual channel at 5, 12 or 24V and requires the optional encoder board to be installed. When A535 [Motor Fdbk Type] is set to a value other than zero, the drive is set to use an encoder or pulse train. The drive will use the encoder or pulse train in several ways depending on the settings of other parameters. The drive will use the encoder or pulse train as shown below (listed in order of priority):

1. If enabled by P047, P049, or P051 [Speed Referencex], the encoder or pulse train will be used directly as a commanded speed (normally used with a pulse train) or as a position reference (normally used with a quadrature encoder).
2. If not enabled by the Speed Reference parameters, the encoder or pulse train can be used with the PID function if enabled by A459 or A471 [PID x Ref Sel], or A460 or A472 [PID x Fdback Sel].
3. If not enabled by the Speed Reference or PID function parameters, the encoder or pulse train can be used with A535 [Motor Fdbk Type] for direct feedback and trim of the speed command. The normal slip compensation is not used in this case. Instead the drive will use the encoder or pulse train to determine actual output frequency and adjust the output frequency to match the command. Parameters A538 [Ki Speed Loop] and A539 [Kp Speed Loop] are used in this control loop. The primary benefit of this mode is increased speed accuracy when compared to open-loop slip compensation. It does not provide speed bandwidth improvement.

IMPORTANT The encoder usage, and position StepLogic application covered in this chapter is specific to PowerFlex 525 drives only.

Encoder Interface

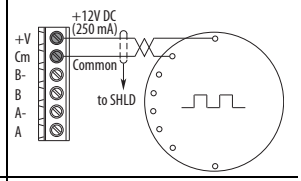
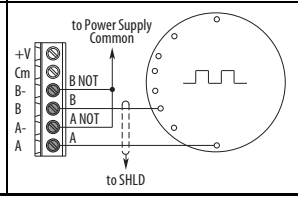
The incremental encoder option card can source 5 or 12 volt power and accept 5, 12 or 24 volt single ended or differential inputs. See Appendix B for ordering information.

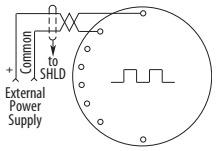
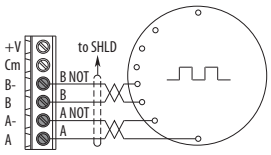


No.	Signal	Description
+V	5...12V Power(1)(2)	Internal power source 250 mA (isolated).
Cm	Power Return	
B-	Encoder B (NOT)	Quadrature B input.
B	Encoder B	
A-	Encoder A (NOT)	Single channel, pulse train or quadrature A input.
A	Encoder A	
❶	Output	DIP switch selects 12 or 5 volt power supplied at terminals "+V" and "Cm" for the encoder.

(1) When using 12V Encoder power, 24V I/O power, maximum output current at I/O Terminal 11 is 50 mA.
(2) If Encoder requires 24V power, it must be supplied by an external power source.

Encoder Wiring Examples

I/O	Connection Example
Encoder Power – Internal Drive Power Internal (drive) 12V DC, 250mA	
Encoder Signal – Single-Ended, Dual Channel	

I/O	Connection Example
Encoder Power – External Power Source	
Encoder Signal – Differential, Dual Channel	

Wiring Notes

The encoder option card can supply 5V or 12V power (250 mA maximum) for an encoder. Be sure the DIP switch is set properly for the encoder. In general, 12V will provide higher noise immunity.

The encoder can handle 5V, 12V, or 24V inputs, but the pulse train can handle only 24V inputs. The inputs will automatically adjust to the voltage applied and no additional drive adjustment is necessary. If a single-channel input is used, it must be wired between the A (signal) and A- (signal common) channels.

IMPORTANT A quadrature encoder provides rotor speed and direction. Therefore, the encoder must be wired such that the forward direction matches the motor forward direction. If the drive is reading encoder speed but the position regulator or other encoder function is not working properly, remove power to the drive, then do one of the following:

- Swap the A and A (NOT) encoder channels.
- Swap the B and B (NOT) encoder channels.
- Swap any two motor leads.

Drives will fault when an encoder is incorrectly wired and A535 [Motor Fdbk Type] is set to 5 "Quad Check".

Positioning Overview

The PowerFlex 525 drive includes a simple position regulator which can be used in a variety of position applications without the need for multiple limit switches or photo-eyes. This can be used as a stand-alone controller for simple applications (up to 8 positions) or in conjunction with a controller for more flexibility.

Please note that this is not intended to replace high end servo controllers or any application that needs high bandwidth or very high torque at low speeds.

Common Guidelines for All Applications

The position regulator can be configured for operation appropriate for a variety of applications. Certain parameters will need to be adjusted in all cases.

P047 [Speed Reference1] must be set to 16 "Positioning".

A535 [Motor Fdbk Type] must be set to the match the feedback device. Positioning mode must use A535 [Motor Fdbk Type] option 4.

A535 [Motor Fdbk Type] Options

0 "None" indicates no encoder is used. This can not be used for positioning.

1 "Pulse Train" is a single channel input, no direction, speed feedback only. This should not be used for positioning. The Single Channel selection is similar to a Pulse Train, but uses the standard encoder scaling parameters.

2 "Single Chan" is a single channel input, no direction, speed feedback only. This should not be used for positioning. Single channel uses the standard encoder scaling parameters.

3 "Single Check" is a single channel input with encoder signal loss detection. The drive will fault if it detects that the input pulses do not match the expected motor speed. This should not be used for positioning.

4 "Quadrature" is a dual channel encoder input with direction and speed from the encoder. This may be used for positioning control.

5 "Quad Check" is a dual channel encoder with encoder signal loss detection. The drive will fault if it detects that the encoder speed does not match the expected motor speed.

A544 [Reverse Disable] should be set to 0 "Rev Enabled" to allow bidirectional movement necessary for position control.

P039 [Torque Perf Mode] default setting is 1 "SVC". However, any mode can be used to improve the low speed torque for positioning applications. For best results, tune the application first. The autotune routine can be completed to further improve the drive-motor performance.

A550 [Bus Reg Enable] default setting is 1 "Enabled". If the deceleration time is too short, the drive may overshoot the desired position. For best results, a longer deceleration time may be necessary. A550 [Bus Reg Enable] can be disabled to provide precise stopping movements, but the deceleration time will need to be manually tuned so that it is long enough to avoid F005 "OverVoltage" faults.

A437 [DB Resistor Sel] default setting is 0 "Disabled". If improved deceleration performance is required a Dynamic Brake resistor can be used. If used, this parameter should be set to the appropriate setting for the resistor selected.

P035 [Motor NP Poles] must be set to match the number of motor poles on the motor driven by the PowerFlex 520-series drive.

A536 [Encoder PPR] must be set to match the number of pulses per revolution of the encoder used (i.e., 1024 PPR Encoder).

A559 [Counts Per Unit] sets the number of encoder counts that will be used to define one position unit. This allows the encoder positions to be defined in terms of units important to the application. For example, if 1cm of travel on a conveyor belt requires 0.75 turns of the motor, the motor encoder is 1024 PPR, and the Motor Feedback type is set to Quadrature, then this parameter would need to be set to (4 x 1024 x 0.75) = 3072 counts for one cm of travel. Then all other positions could be setup in units of "cm".

A564 [Encoder Pos Tol] indicates the desired position tolerance for the system. This will determine how close the drive must be to the commanded position before the drive will indicate "At Home" or "At Position" in units of raw encoder pulses. This has no effect on the actual positioning control of the motor.

Positioning Operation

Parameter A558 [Positioning Mode] must be set to properly match the desired operation of the positioning function.

A558 [Positioning Mode] Options

0 "Time Steps" uses Step Logic times. This mode ignores the Step Logic settings and moves through the steps (Step 0 to Step 7 and back to Step 0) based on the times programmed into L190...L197 [Stp Logic Time x]. This can be used when the desired position is based only on time. In addition, this mode only accepts absolute positions in a positive direction from "home". This option provides an easy way to implement a simple positioning program or to test the basic positioning setup. For additional flexibility one of the other settings should be used.

1 "Preset Input" directly commands movement to any step based on the status of the digital inputs programmed for "Preset Freq". This setting ignores the Step Logic Commands settings and instead the drive will move directly to whatever step is currently commanded by A410...A425 [Preset Freq x] and L200...L214 [Step Units x]. This is useful when an application

needs direct access to any position step based on discrete inputs. This mode moves in the forward direction from Home and is an absolute move.

IMPORTANT Advanced Step Logic options such as incremental move are not available in this mode.

2 "Step Logic" provides a highly flexible mode of operation. This can be used to move through the steps (Step 0 to Step 7 and back to Step 0) or can jump to a different step at any time based on time or the status of digital inputs or communication commands. In this mode the drive always starts at Step 0 of the Step Logic profile.

3 "Preset StpL" is identical to 2 "Step Logic" except the drive will use the current status of the Preset Inputs to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected.

4 "StpLogic-Lst" is identical to 2 "Step Logic" except the drive will use the step prior to its last stop command to determine which Step Logic step to begin. This only affects the initial step. After start, the drive will move through the steps in the same manner as if setting 2 was selected. This allows a process to be stopped and then restarted at the position where it stopped.

In all position modes, the following parameters will control the characteristics at each step:

L200, L202, L204, L206, L208, L210, L212 and L214 [Step Units x] are the number value to the left of the decimal (whole number) of the 8 positions desired for an application, beginning with Step 0 (L200) and continuing with each step until Step 7 (L214). For example, enter 2 into this parameter if you would like a commanded position of 2.77.

L201, L203, L205, L207, L209, L211, L213 and L215 [Step Units F x] are the number value to the right of the decimal (the portion less than 1) of the 8 positions desired for an application, beginning with Step 0 (L201) and continuing with each step until Step 7 (L215). For example, enter 0.77 into this parameter if you would like a commanded position of 2.77.

A410...A417 [Preset Freq x] are the parameters that define the maximum frequency the drive will run at during the corresponding step. For example, if [Preset Freq 2] is set to 40 Hz, the drive will accelerate to 40 Hz maximum when moving to Position 2.

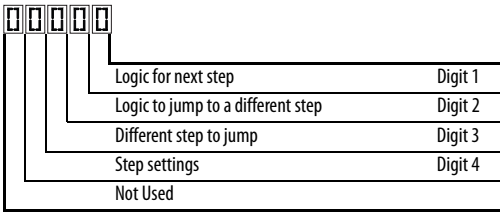
Frequency Source	Step Source	Position Source
A410 [Preset Freq 0]	L180 [Stp Logic 0]	L200 [Step Units 0]
A411 [Preset Freq 1]	L181 [Stp Logic 1]	L202 [Step Units 1]
A412 [Preset Freq 2]	L182 [Stp Logic 2]	L204 [Step Units 2]
A413 [Preset Freq 3]	L183 [Stp Logic 3]	L206 [Step Units 3]
A414 [Preset Freq 4]	L184 [Stp Logic 4]	L208 [Step Units 4]

Frequency Source	Step Source	Position Source
A415 [Preset Freq 5]	L185 [Stp Logic 5]	L210 [Step Units 5]
A416 [Preset Freq 6]	L186 [Stp Logic 6]	L212 [Step Units 6]
A417 [Preset Freq 7]	L187 [Stp Logic 7]	L214 [Step Units 7]

IMPORTANT The default value for A410 [Preset Freq 0] is 0.00 Hz. This value needs to be changed or the drive will not be able to move during Step 0.

L190...L197 [Stp Logic Time x] are the parameters that define the time the drive will remain in each corresponding step if that step is time-based. For example, if L192 [Stp Logic Time 2] is set to 5.0 seconds and that step is time-based, the drive will remain in Step 2 for 5.0 seconds. Note that this is the total time in that step, not the time at that position. Therefore, it will include the time needed to accelerate, run, and decelerate to that position.

L180...L187 [Stp Logic x] are the parameters that allow additional flexibility and control various aspects of each step when a positioning mode is selected that utilizes the Step Logic functions. Note that in Positioning mode these parameters have a different function than when used for normal velocity Step Logic. Each of the 4 digits controls one aspect of the each position step. The following is a listing of the available settings for each digit:



Velocity Control Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Positioning Settings (Digit 4)

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Direction From Home	Type of Command
0	Accel/Decel 1	Off	FWD	Absolute
1	Accel/Decel 1	Off	FWD	Incremental
2	Accel/Decel 1	Off	REV	Absolute
3	Accel/Decel 1	Off	REV	Incremental
4	Accel/Decel 1	On	FWD	Absolute
5	Accel/Decel 1	On	FWD	Incremental
6	Accel/Decel 1	On	REV	Absolute
7	Accel/Decel 1	On	REV	Incremental
8	Accel/Decel 2	Off	FWD	Absolute
9	Accel/Decel 2	Off	FWD	Incremental
A	Accel/Decel 2	Off	REV	Absolute
b	Accel/Decel 2	Off	REV	Incremental
C	Accel/Decel 2	On	FWD	Absolute
d	Accel/Decel 2	On	FWD	Incremental
E	Accel/Decel 2	On	REV	Absolute
F	Accel/Decel 2	On	REV	Incremental

Settings (Digit 3)

Setting	Description
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Settings (Digit 2 and 1)

Setting	Description
0	Skip Step (Jump Immediately)
1	Step Based on [Stp Logic Time x]
2	Step if “Logic In 1” is Active
3	Step if “Logic In 2” is Active
4	Step if “Logic In 1” is Not Active
5	Step if “Logic In 2” is Not Active
6	Step if either “Logic In 1” or “Logic In 2” is Active
7	Step if both “Logic In 1” and “Logic In 2” are Active
8	Step if neither “Logic In 1” nor “Logic In 2” is Active
9	Step if “Logic In 1” is Active and “Logic In 2” is Not Active
A	Step if “Logic In 2” is Active and “Logic In 1” is Not Active
b	Step after [Stp Logic Time x] and “Logic In 1” is Active
C	Step after [Stp Logic Time x] and “Logic In 2” is Active
d	Step after [Stp Logic Time x] and “Logic In 1” is Not Active
E	Step after [Stp Logic Time x] and “Logic In 2” is Not Active
F	Do Not Step/Ignore Digit 2 Settings

TIP Use the Wizard in Connected Components Workbench to simplify setup instead of manually configuring the parameters.

Note: Incremental move commands will cause the drive to move the amount specified based on the current position. Absolute commands are always with reference to “Home”.

A565 [Pos Reg Filter] provides a low pass filter at the input of the position regulator.

A566 [Pos Reg Gain] is a single adjustment for increasing or decreasing the responsiveness of the position regulator. For faster response, the filter should be reduced and/or the gain should be increased. For smoother response with less

overshoot, the filter should be increased and/or the gain should be reduced. In general, the gain will have a larger effect on most systems than the filter.

Homing Routine

This drive supports incremental encoders only. Therefore, when the drive powers up it will reset the current position to zero. If this is known to be correct the position routine can be started without further adjustment. However, in most applications the drive will need to be "homed" after each power-up and prior to starting the position routine.

This can be accomplished in one of the following two ways:

1. Manual Homing–Program the following drive parameters:

   t062, t063, t065...t068 [DigIn TermBlk xx] = 37 "Pos Redefine"

   Program one of the digital inputs to 37 "Pos Redefine". Then, move the system into the home position with a run command, a jog command, or by manually moving the system into the home position. Then, toggle the "Pos Redefine" input. This will set the drive to "Home" at its current position and d388 [Units Traveled H] and d389 [Units Traveled L] are set to zero. Alternately, the "Pos Redefine" bit in A560 [Enh Control Word] can be toggled instead of utilizing a digital input.

   IMPORTANT The "Pos Redefine" input or bit must be returned to inactive before starting the position routine. Otherwise the drive will continuously read a position of "0" (home) and the position routine will not function correctly.

2. Automatic Homing to Limit Switch–Program the following drive parameters:

   t062, t063, t065...t068 [DigIn TermBlk xx] = 35 "Find Home"
   Program one of the digital inputs to 35 "Find Home".

   t062, t063, t065...t068 [DigIn TermBlk xx] = 34 "Home Limit"
   Program one of the digital inputs to 34 "Home Limit". Normally, the "Home Limit" input would be wired to a proximity switch or photo-eye and will indicate the system is in the home position.

   A562 [Find Home Freq] sets the frequency the drive will use while it is moving to the home position during the automatic homing routine.

   A563 [Find Home Dir] sets the direction the drive will use while it is moving to the home position during the automatic homing routine.

To begin the automatic homing routine, activate the "Find Home" input and then initiate a valid start command. The drive will then ramp to the speed set in A562 [Find Home Freq] and in the direction set in A563 [Find Home Dir] until the digital input defined as "Home Limit" is activated. If the drive passes this

point too quickly it will then reverse direction at 1/10th A562 [Find Home Freq] to the point where the Home Limit switch reactivates. Approximately one second after the routine finds home the drive will stop. Alternately, the "Find Home Freq" and/or "Home Limit" bits in A560 [Enh Control Word] can be activated instead of utilizing a digital input. The inputs or bits should be returned to inactive after the routine is complete.

IMPORTANT After the position is reached the drive will stop. If the Find Home is removed before the homing is complete, the drive will begin running the position routine without the proper home. In this case Home will not be reset and the position will be in relation to the power up position.

Encoder and Position Feedback

d376 [Speed Feedback] indicates the measured speed feedback or the calculated speed feedback when no feedback device is selected. Parameter d376 [Speed Feedback] is the number value to the left of the decimal (whole number) and d377 [Speed Feedback F] is the value to the right of the decimal (the portion less than 1).

d378 [Encoder Speed] indicates the measured speed of the feedback device. This is useful if the encoder is not used for motor speed control. However, the encoder must be used for some purpose in order for d378 [Encoder Speed] to indicate a value. Parameter d378 [Encoder Speed] is the number value to the left of the decimal (whole number) and d379 [Encoder Speed F] is the number to the right of the decimal (the portion less than 1).

d388, d389 [Units Traveled x] indicate the current position of the system in terms of units away from Home. Parameter d388 [Units Traveled H] is the number value to the left of the decimal (whole number) and d389 [Units Traveled L] is the number to the right of the decimal (the portion less than 1).

d387 [Position Status] indicates the status of the positioning functions. The indication bits are:

Bit 0 "Dir Positive" indicates the current direction the drive has moved from Home.

Bit 1 "At Position" indicates whether the drive is at its commanded position. If the drive is within A564 [Encoder Pos Tol] of the commanded position, this bit will be active.

Bit 2 "At Home" indicates whether the drive is at Home. If the drive is within A564 [Encoder Pos Tol] of "Home", this bit will be active.

Bit 3 "Drive Homed" indicates whether the drive has been homed since power-up. This bit will be active once the drive has been homed either manually or automatically. It will remain active until the next power down.

Use Over Communications

If 8 steps are not adequate for the application or if dynamic program changes are required, many of the positioning functions can be controlled through an active communication network. The following parameters will allow this control.

C121 [Comm Write Mode]
Repeated writes to parameters over a communication network can cause damage to the drive EEPROM. This parameter allows the drive to accept parameter changes without writing to the EEPROM.

IMPORTANT Parameter values set prior to setting 1 "RAM only" are saved in RAM.

C122 [Cmd Stat Select]
Selects velocity-specific or position/fibers-specific Command and Status Word bit definitions for use over a communication network.

A560 [Enh Control Word]
This parameter allows many of the positioning functions to be completed through parameter control using an explicit message. This allows the operation over communications instead of with hardware inputs. The bits have the same functions as the digital input options of the same name. Options relating to positioning are:

Bit 0 "Home Limit" indicates the drive is at the home position.

Bit 1 "Find Home" causes the drive to find home at the next start command. Deactivate this bit after completing the homing routine.

Bit 2 "Hold Step" overrides other inputs and causes the drive to remain at its current step (running at zero speed once it reaches its position) until released.

Bit 3 "Pos Redefine" resets the home position to the current position of the machine. Deactivate this bit after completing the homing routine.

Bit 4 "Sync Enable" holds the existing frequency when A571 [Sync Time] is set to enable speed synchronization. When this bit is deactivated the drive will accelerate to the new commanded frequency based on A571 [Sync Time].

Bit 5 "Traverse Dis" disables the traverse function when this bit is active.

Bit 6 "Logic In 1" provides an identical function and is logically ORed with setting 24 "Logic In 1" for t062, t063, t065...t068 [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or position) using comms control without requiring actual digital input transitions.

Bit 7 "Logic In 2" provides an identical function and is logically ORed with setting 25 "Logic In 2" for t062, t063, t065...t068 [DigIn TermBlk xx]. It can be used to move through the Step Logic functions (speed or

position) using comms control without requiring actual digital input transitions.

L200...L214 [Step Units x]
All of the position steps can be written to while the drive is running. The changes will take place at the next move. For example, if step 0 is over-written while the drive is moving to step 0, the drive will move to the previous commanded position at step 0. The next time the drive is commanded to return to step 0 it will proceed to the new position. One possible use of this capability is when an application requires full control of the movement by a controller external to the drive. The Step Logic program might be written to jump from step 0 back to step 0 when Input 1 is active. The controller could write any desired position to step 0 and then toggle the input 1 bit of A560 [Enh Control Word] to cause the drive to move to the new position. This allows almost unlimited flexibility and can be used with absolute or incremental moves.

Setup Notes

The RA computer tool (Connected Components Workbench) can make setup of the positioning functions much easier. Refer to the latest versions for additional tools or wizards which can aid in the setup.

Notes:

PID Set Up

PID Loop

The PowerFlex 520-series drive features built-in PID (proportional, integral, derivative) control loops. The PID loop is used to maintain a process feedback (such as pressure, flow or tension) at a desired set point. The PID loop works by subtracting the PID feedback from a reference and generating an error value. The PID loop reacts to the error, based on the PID Gains, and outputs a frequency to try to reduce the error value to 0.

To enable the PID loop, P047, P049 or P051 [Speed Referencex] must be set to 11 "PID1 Output" or 12 "PID2 Output", and the corresponding speed reference activated.

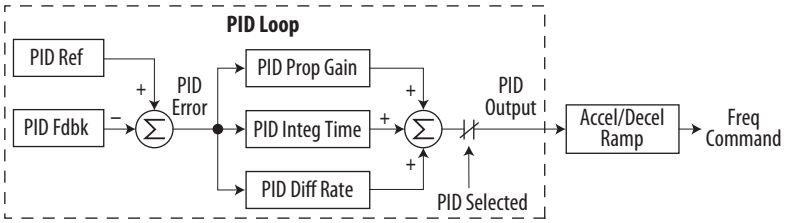
IMPORTANT PowerFlex 523 has one PID control loop.

PowerFlex 525 has two PID control loops, of which only one can be in use at any time.

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

Exclusive Control

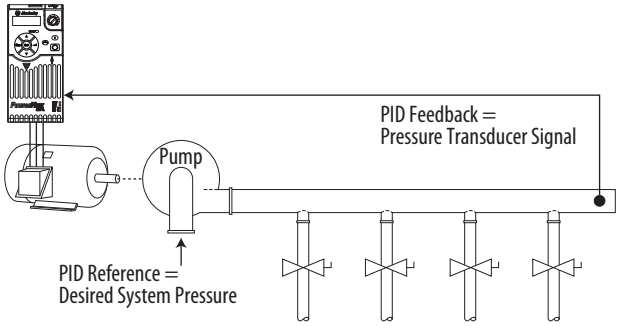
In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A458 or A470 [PID x Trim Sel] is set to option 0. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



Example

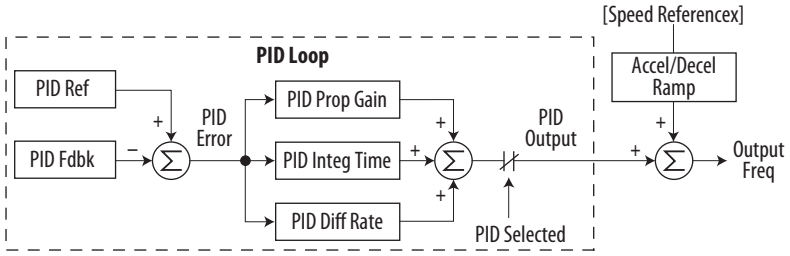
- In a pumping application, the PID Reference equals the Desired System Pressure set point.
- The Pressure Transducer signal provides PID Feedback to the drive. Fluctuations in actual system pressure, due to changes in flow, result in a PID Error value.
- The drive output frequency increases or decreases to vary motor shaft speed to correct for the PID Error value.

- The Desired System Pressure set point is maintained as valves in the system are opened and closed causing changes in flow.
- When the PID Control Loop is disabled, the Commanded Speed is the Ramped Speed Reference.



Trim Control

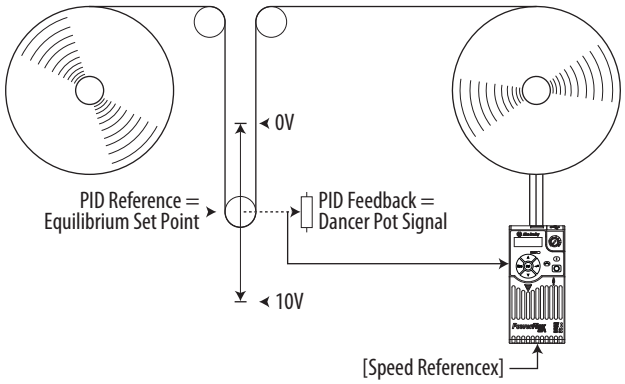
In Trim Control, the PID Output is added to the Speed Reference. In Trim mode, the output of the PID loop bypasses the accel/decel ramp as shown. Trim Control is used when A458 or A470 [PID x Trim Sel] is set to any option other than 0.



Example

- In a winder application, the PID Reference equals the Equilibrium set point.
- The Dancer Pot signal provides PID Feedback to the drive. Fluctuations in tension result in a PID Error value.
- The Master Speed Reference sets the wind/unwind speed.

- As tension increases or decreases during winding, the Speed Reference is trimmed to compensate. Tension is maintained near the Equilibrium set point.



PID Reference and Feedback

PID mode is enabled by setting P047, P049 or P051 [Speed Referencex] to 11 "PID1 Output" or 12 "PID2 Output", and activating the corresponding speed reference.

IMPORTANT PowerFlex 523 has one PID control loop.

PowerFlex 525 has two PID control loops, of which only one can be in use at any time.

If A459 or A471 [PID x Ref Sel] is not set to 0 "PID Setpoint", PID can still be disabled by select programmable digital input options (parameters t062, t063, t065...t068 [DigIn TermBlk xx]) such as "Purge".

A459, A471 [PID x Ref Sel] Options

Options	Description
0 "PID Setpoint"	A464 or A476 [PID x Setpoint] will be used to set the value of the PID Reference.
1 "Drive Pot"	The drive potentiometer will be used to set the value of the PID Reference.
2 "Keypad Freq"	The drive keypad will be used to set the value of the PID Reference.
2 "Serial/DSI"	The reference word from the Serial/DSI communication network becomes the PID Reference.
4 "Network Opt"	The reference word from a communication network option becomes the PID Reference.
5 "0-10V Input"	Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
6 "4-20mA Input"	Selects the 4-20 mA Input.
7 "Preset Freq"	A410...A425 [Preset Freq x] will be used as an input for the PID Reference.
8 "AnIgIn Multi"(1)	The product of the 0-10V and 4-20mA Inputs will be used as an input for the PID Reference.
9 "MOP Freq"	A427 [MOP Freq] will be used as an input for the PID Reference.
10 "Pulse Input"	Pulse train will be used as an input for the PID Reference.
11 "Step Logic"(1)	Step Logic will be used as an input for the PID Reference.
12 "Encoder"(1)	Encoder will be used as an input for the PID Reference.
13 "Ethernet/IP"(1)	The reference word from the Ethernet/IP communication network becomes the PID Reference.

(1) Setting is specific to PowerFlex 525 drives only.

A460 and A472 [PID x Fdback Sel] are used to select the source of the PID feedback.

A460, A472 [PID x Fdback Sel] Options

Options	Description
0 "0-10V Input"	Selects the 0-10V Input (default setting). Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
1 "4-20mA Input"	Selects the 4-20 mA Input.
2 "Serial/DSI"	Serial/DSI will be used as an input for the PID Feedback.
3 "Network Opt"	The reference word from a communication network option becomes the PID Reference.
4 "Pulse Input"	Pulse train will be used as an input for the PID Feedback.
5 "Encoder"(1)	Encoder will be used as an input for the PID Feedback.
6 "Ethernet/IP"(1)	Ethernet/IP will be used as an input for the PID Feedback.

(1) Setting is specific to PowerFlex 525 drives only.

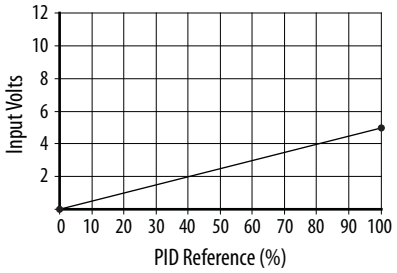
Analog PID Reference Signals

Parameters t091 [Anlg In 0-10V Lo] and t092 [Anlg In 0-10V Hi] are used to scale or invert an analog PID Reference or PID Feedback.

Scale Function

For a 0...5V signal, the following parameter settings are used so that a 0V signal = 0% PID Reference and a 5V signal = 100% PID Reference.

- t091 [Anlg In 0-10V Lo] = 0.0%
- t092 [Anlg In 0-10V Hi] = 50.0%
- A459 [PID 1 Ref Sel] = 5 "0-10V Input"

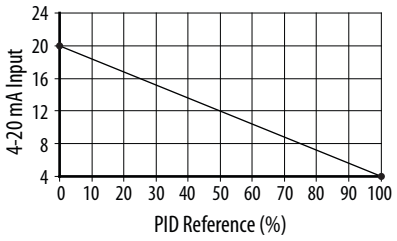


Invert Function

For a 4-20 mA signal, the following parameter settings are used so that a 20 mA signal = 0% PID Reference and a 4 mA signal = 100% PID Reference.

- t092 [Anlg In4-20mA Lo] = 100.0%
- t096 [Anlg In4-20mA Hi] = 0.0%

- A459 [PID 1 Ref Sel] = 6 “4-20mA Input”



PID Deadband

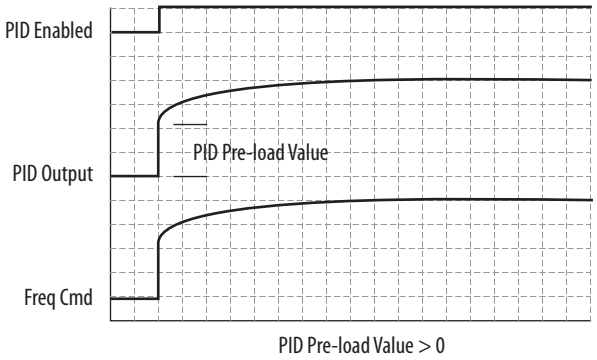
Parameters A465 and A477 [PID x Deadband] are used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- A465 [PID 1 Deadband] = 5.0%
- The PID Reference is 25.0%
- The PID Regulator will not act on a PID Error that falls between 20.0 and 30.0%

PID Preload

The value set in A466 or A478 [PID x Preload], in Hz, will be pre-loaded into the integral component of the PID at any start or enable. This will cause the drive’s frequency command to initially jump to that preload frequency, and the PID loop starts regulating from there.



PID Limits

A456 and A468 [PID x Trim Hi] and A457 and A469 [PID x Trim Lo] are used to limit the PID output and are only used in trim mode. [PID x Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID x Trim Lo] sets the reverse frequency limit for the PID output in trim mode. Note that when the

PID reaches the Hi or Lo limit, the PID regulator stops integrating so that windup does not occur.

PID Gains

The proportional, integral, and differential gains make up the PID regulator.

- A461 and A473 [PID x Prop Gain]
  The proportional gain (unitless) affects how the regulator reacts to the magnitude of the error. The proportional component of the PID regulator outputs a speed command proportional to the PID error. For example, a proportional gain of 1 would output 100% of max frequency when the PID error is 100% of the analog input range. A larger value for [PID x Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID x Prop Gain] to 0.00 disables the proportional component of the PID loop.
- A462 and A474 [PID x Integ Time]
  The integral gain (units of seconds) affects how the regulator reacts to error over time and is used to get rid of steady state error. For example, with an integral gain of 2 seconds, the output of the integral gain component would integrate up to 100% of max frequency when the PID error is 100% for 2 seconds. A larger value for [PID x Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID x Integ Time] to 0.0 disables the integral component of the PID loop.
- A463 and A475 [PID x Diff Rate]
  The Differential gain (units of 1/seconds) affects the rate of change of the PID output. The differential gain is multiplied by the difference between the previous error and current error. Thus, with a large error the D has a large effect and with a small error the D has less of an effect. This parameter is scaled so that when it is set to 1.00, the process response is 0.1% of P044 [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID x Diff Rate] makes the differential term have more of an effect and a small value makes it have less of an effect. In many applications, the D gain is not needed. Setting [PID x Diff Rate] to 0.00 (factory default) disables the differential component of the PID loop.

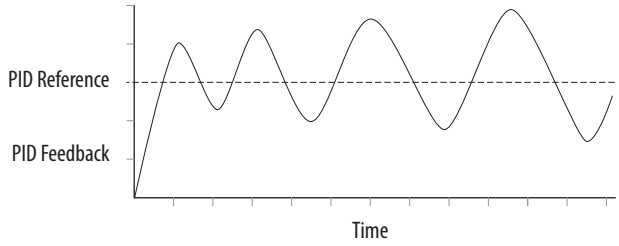
Guidelines for Adjusting the PID Gains

1. Adjust the proportional gain. During this step it may be desirable to disable the integral gain and differential gain by setting them to 0. After a step change in the PID Feedback:
   - If the response is too slow increase A461 or A473 [PID x Prop Gain].
   - If the response is too quick and/or unstable (see Unstable Response on page 217), decrease A461 or A473 [PID x Prop Gain].
   - Typically, A461 or A473 [PID x Prop Gain] is set to some value below the point where the PID begins to go unstable.

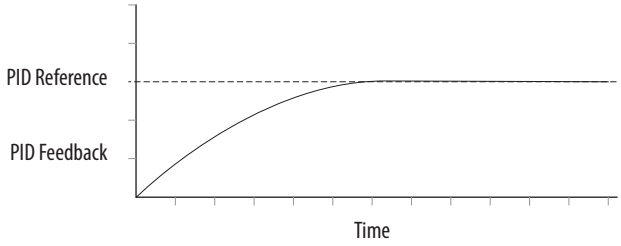
2. Adjust the integral gain (leave the proportional gain set as in Step 1). After a step change in the PID Feedback:
   - If the response is too slow (see Slow Response – Over Damped on page 217), or the PID Feedback does not become equal to the PID Reference, decrease A462 or A474 [PID x Integ Time].
   - If there is a lot of oscillation in the PID Feedback before settling out (see Oscillation – Under Damped on page 217), increase A462 or A474 [PID x Integ Time].
3. At this point, the differential gain may not be needed. However, if after determining the values for A461 or A473 [PID x Prop Gain] and A462 or A474 [PID x Integ Time]:
   - Response is still slow after a step change, increase A463 or A475 [PID x Diff Rate].
   - Response is still unstable, decrease A463 or A475 [PID x Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

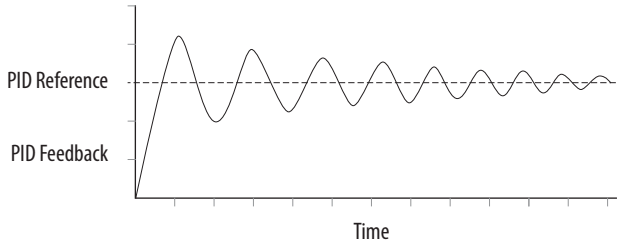
Unstable Response



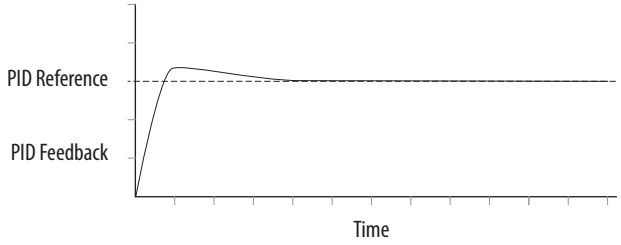
Slow Response – Over Damped



Oscillation – Under Damped



Good Response – Critically Damped



Safe-Torque-Off Function

The PowerFlex 525 Safe-Torque-Off function, when used with other safety components, helps provide protection according to EN ISO 13849 and EN62061 for safe-off and protection against restart. The PowerFlex 525 Safe-Torque-Off function is just one component in a safety control system. Components in the system must be chosen and applied appropriately to achieve the desired level of operator safeguarding.

For information on...	See page...
PowerFlex 525 Safe-Torque-Off Overview	219
EC Type Examination Certification	220
EMC Instructions	220
Using PowerFlex 525 Safe-Torque-Off	220
Enabling PowerFlex 525 Safe-Torque-Off	223
Wiring	223
Verify Operation	224
PowerFlex 525 Safe-Torque-Off Operation	223
Connection Examples	225
PowerFlex 525 Certification for Safe-Torque-Off	229

IMPORTANT The Safe-Torque-Off function covered in this chapter is specific to PowerFlex 525 drives only.

PowerFlex 525 Safe-Torque-Off Overview

The PowerFlex 525 Safe-Torque-Off function:

- Provides the Safe-Torque-Off (STO) function defined in EN IEC 61800-5-2.
- Blocks gate-firing signals from reaching the Insulated Gate Bipolar Transistor (IGBT) output devices of the drive. This prevents the IGBTs from switching in the sequence necessary to generate torque in the motor.
- Can be used in combination with other safety devices to fulfill the requirements of a system “safe torque off” function which satisfies Category 3 / PL (d) according to EN ISO 13849-1 and SIL CL2 according to EN/IEC 62061, IEC 61508, and EN/IEC 61800-5-2.

IMPORTANT The function is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety.

ATTENTION: Electric Shock Hazard. Verify that all sources of AC and DC power are de-energized and locked out or tagged out in accordance with the requirements of ANSI/NFPA 70E, Part II.

To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's User Manual for locations). The voltage must be zero.

In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

EC Type Examination Certification

TÜV Rheinland has certified the PowerFlex 525 Safe-Torque-Off function compliant with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC, and that it complies with the requirements of the relevant standards listed below:

- EN ISO 13849-1:2008 Safety of machinery – Safety related parts of control systems – Part 1: General principles for design.
  (PowerFlex 525 STO achieves Category 3 / PL(d))
- EN 61800-5-2:2007 Adjustable speed electrical power drive systems – Part 5-2 Safety requirements – Functional.
  (PowerFlex 525 STO achieves SIL CL 2)
- EN 62061:2005 Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
- IEC 61508 Part 1-7:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems – Parts 1-7.

TÜV also certifies that the PowerFlex 525 STO may be used in applications up to Category 3/ PL(d) according to EN ISO 13849-1 and SIL 2 according to EN 62061 / EN 61800-5-2 / IEC 61508.

The TÜV Rheinland certificate may be found at:
www.rockwellautomation.com/products/certification/.

EMC Instructions

PowerFlex 525 Safe-Torque-Off function requires CE Conformity as described on page 49.

Using PowerFlex 525 Safe-Torque-Off

The PowerFlex 525 Safe-Torque-Off function is intended to be part of the safety related control system of a machine. Before use, a risk assessment should be performed that compares the PowerFlex 525 Safe-Torque-Off function specifications and all foreseeable operational and environmental characteristics of the machine to which it is to be fitted.

A safety analysis of the machine section controlled by the drive is required to determine how often the safety function should be tested for proper operation during the life of the machine.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

ATTENTION: In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

ATTENTION: In the event of the failure of two output IGBTs in the drive, when the PowerFlex 525 Safe-Torque-Off has controlled the drive outputs to the off state, the drive may provide energy for up to 180° of rotation in a 2-pole motor before torque production in the motor ceases.

Safety Concept

The PowerFlex 525 Safe-Torque-Off function is suitable for use in safety applications up to and including Category 3 / PL(d) according to EN ISO 13849-1 and SIL 2 according to EN 62061 / EN 61800-5-2 / IEC 61508.

In addition, the PowerFlex 525 STO may be used together with other components in a safety application to achieve an overall Category 3 / PL(e) according to EN ISO 13849-1 and SIL 3 according to EN 62061 and IEC 61508. This is illustrated in Example 3 in this appendix.

Safety requirements are based on the standards current at the time of certification.

The PowerFlex 525 Safe-Torque-Off function is intended for use in safety-related applications where the de-energized state is considered to be the safe state. All of the examples in this manual are based on achieving de-energization as the safe state for typical Machine Safety and Emergency Shutdown (ESD) systems.

Important Safety Considerations

The system user is responsible for:

- the set-up, safety rating, and validation of any sensors or actuators connected to the system.
- completing a system-level risk assessment and reassessing the system any time a change is made.
- certification of the system to the desired safety performance level.
- project management and proof testing.
- programming the application software and the safety option configurations in accordance with the information in this manual.

- access control to the system, including password handling.
- analyzing all configuration settings and choosing the proper setting to achieve the required safety rating.

IMPORTANT When applying Functional Safety, restrict access to qualified, authorized personnel who are trained and experienced.



ATTENTION: When designing your system, consider how personnel will exit the machine if the door locks while they are in the machine. Additional safeguarding devices may be required for your specific application.

Functional Proof Test

The PFD and PFH values provided in the table below are contingent upon the Proof Test Interval (PTI). Before the end of the PTI specified in the table below, a proof test of the STO safety function must be performed in order for the specified PFD and PFH values to remain valid.

PFD and PFH Data

PFD and PFH calculations are based on the equations from Part 6 of EN 61508.

This table provides data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

PFD and PFH for 20-year Proof Test Interval

Attribute	Value
PFD	6.62E-05 (MTTF = 3593 years)
PFH_D	8.13E-10
SFF	83%
DC	62.5%
CAT	3
HFT	1 (1oo2)
PTI	20 YEARS
Hardware Type	Type A

Safety Reaction Time

The safety reaction time is the amount of time from a safety-related event as input to the system until the system is in the Safe State.

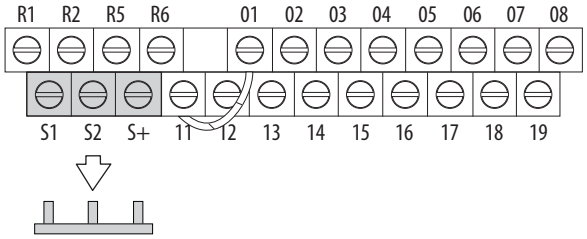
The safety reaction time from an input signal condition that triggers a safe stop, to the initiation of safe-torque-off, is 100 ms (maximum).

Enabling PowerFlex 525 Safe-Torque-Off

1. Remove all power to the drive.

> **ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's user manual for the location of the terminals). The voltage must be zero.

2. Loosen the screw of terminals Safety 1, Safety 2 and Safety +24V (S1, S2, S+) on the control I/O terminal block.
3. Remove the protective jumper.



4. Safe-Torque-Off function is now enabled and the terminals are ready to function as safety inputs.

Wiring

Important points to remember about wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control wires should be separated from power wires by at least 0.3 m (1 ft).

Recommended Wire

Type	Wire Type(1)	Description	Min. Insulation Rating
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equiv.)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	300V, 60 °C (140 °F)

(1) Recommendations are for 50 °C ambient temperature.
75 °C wire must be used for 60 °C ambient temperature.
90 °C wire must be used for 70 °C ambient temperature.

See I/O Wiring on page 35 for wiring recommendations and Control I/O Terminal Designations on page 40 for terminal descriptions.

If Safety Inputs S1 and S2 are powered by an external +24V source, apply it only in SELV system, PELV system or low voltage Class 2 circuit.

PowerFlex 525 Safe-Torque-Off Operation

The PowerFlex 525 Safe-Torque-Off function disables the drive's output IGBT's by breaking the link with the drive microcontroller. When used in combination with a safety input device, the system satisfies the requirements of EN ISO 13849 and EN62061 for safe-torque-off and helps protect against restart.

Under normal drive operation, both safety inputs (Safety 1 and Safety 2) are energized, and the drive is able to run. If either input is de-energized, the gate control circuit becomes disabled. To meet EN ISO 13849 operation, both safety channels must be de-energized. Refer to the following examples for more information.

IMPORTANT By itself, the Safe-Torque-Off function initiates a coast to stop action. Additional protective measures will need to be applied when an application requires a change to the stop action.

Verify Operation

Test the safety function for proper operation after the initial setup of the PowerFlex 525 Safe-Torque-Off function. Retest the safety function at the intervals determined by the safety analysis described on page 220.

Verify that both safety channels are functioning according to the table below.

Channel Operation and Verification

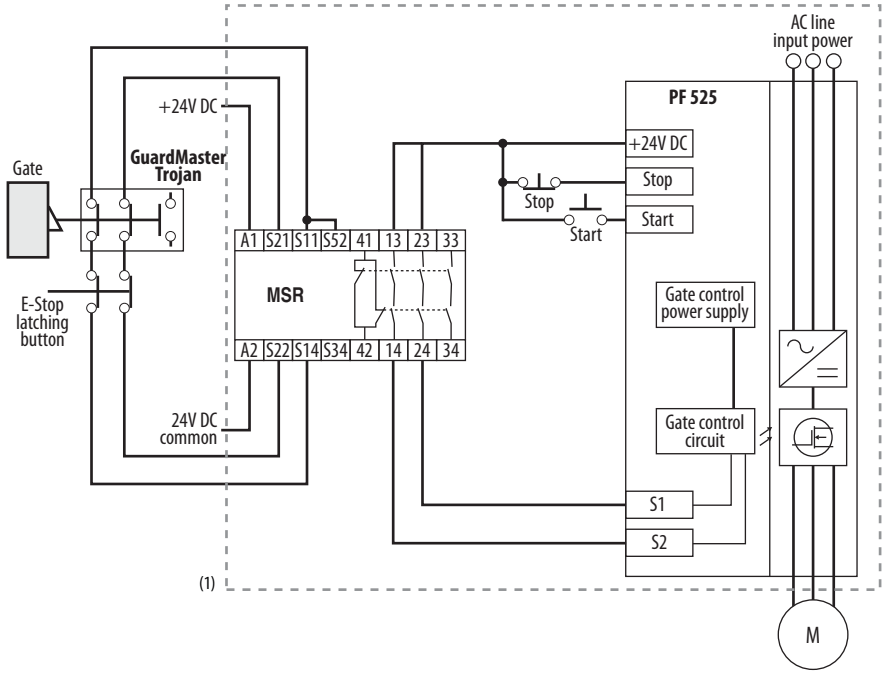
Safety Function Status	**Drive In Safe State**	**Drive In Safe State**	**Drive In Safe State**	**Drive Able To Run**
Drive Status	**Configured by t105 [Safety Open En]**	**Fault F111 (Safety Hardware)**	**Fault F111 (Safety Hardware)**	**Ready/Run**
		Safety Channel Operation		
Safety Input S1	No Power Applied	Power Applied	No Power Applied	Power Applied
Safety Input S2	No Power Applied	No Power Applied	Power Applied	Power Applied

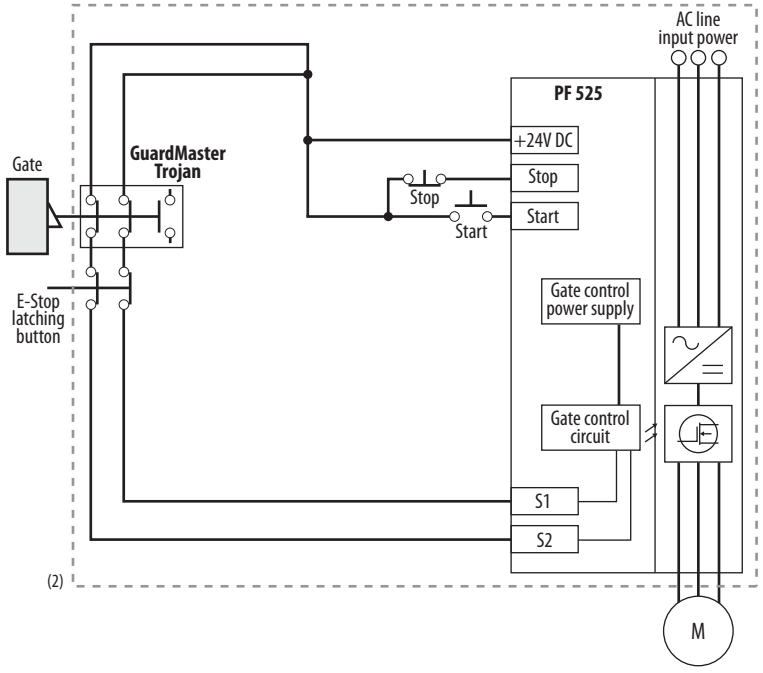
IMPORTANT If an external fault is present on the wiring or circuitry controlling the Safety 1 or Safety 2 inputs for a period of time, the Safe-Torque-Off function may not detect this condition. When the external fault condition is removed the Safe-Torque-Off function will allow an enable condition. Fault in the external wiring shall either be detected by external logic, or excluded (wiring must be protected by cable ducting or armoring), according to EN ISO 13849-2.

Connection Examples

Example 1 – Safe-Torque-Off Connection with Coast-to-Stop Action, SIL 2/PL d

Stop Category 0 – Coast

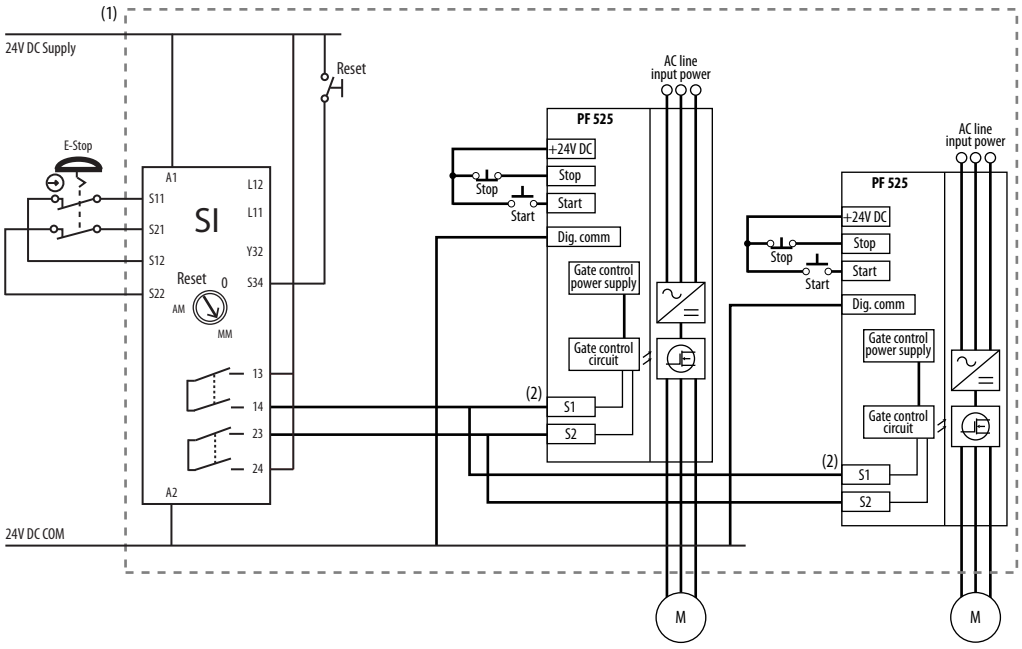




(1) Enclosure Recommended. Note: External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

(2) In some situations, a safety relay is not required if both the switch and PowerFlex 525 are installed in the same enclosure.

Stop Category 0 – Coast with Two PowerFlex 525 Drives



(1) Enclosure Recommended. Note: External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.
(2) Each safety input draws 6 mA from the supply.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S13-S14 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24) will cause the Safe-Torque-Off Enable circuit to trip and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

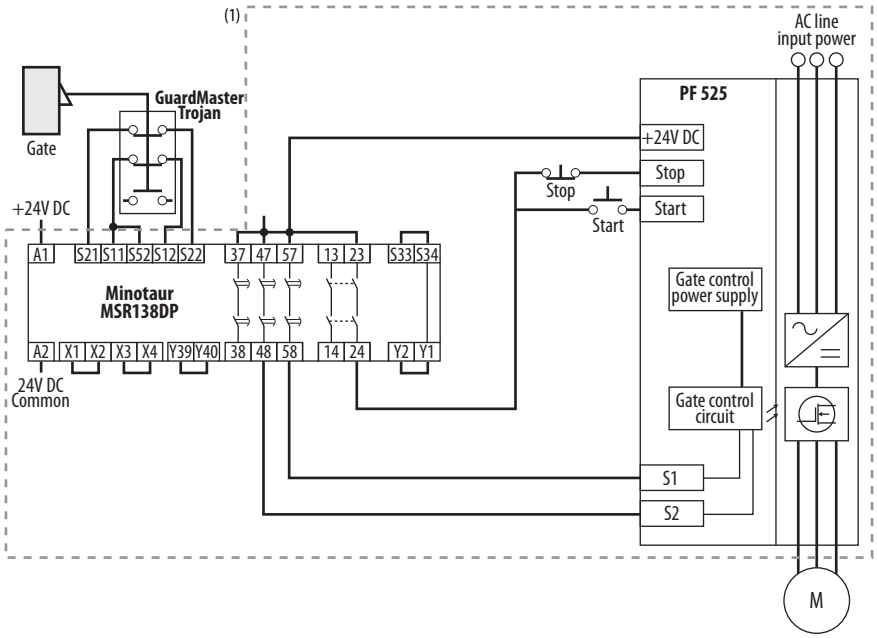
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

A single fault detected on the PowerFlex 525 safety enable redundant inputs will result in the lock-out of the drive and will not cause loss of the safety function.

Example 2 – Safe-Torque-Off Connection with Controlled Stop Action, SIL 2/PL d

Stop Category 1 – Controlled



(1) Enclosure Recommended. External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14) will issue a Stop command to the drive and cause a controlled deceleration. After the programmed delay, the timed output circuits (47-48 & 57-58) will cause the Safe-Torque-Off Enable circuit to trip. If the motor is rotating when the trip occurs, it will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

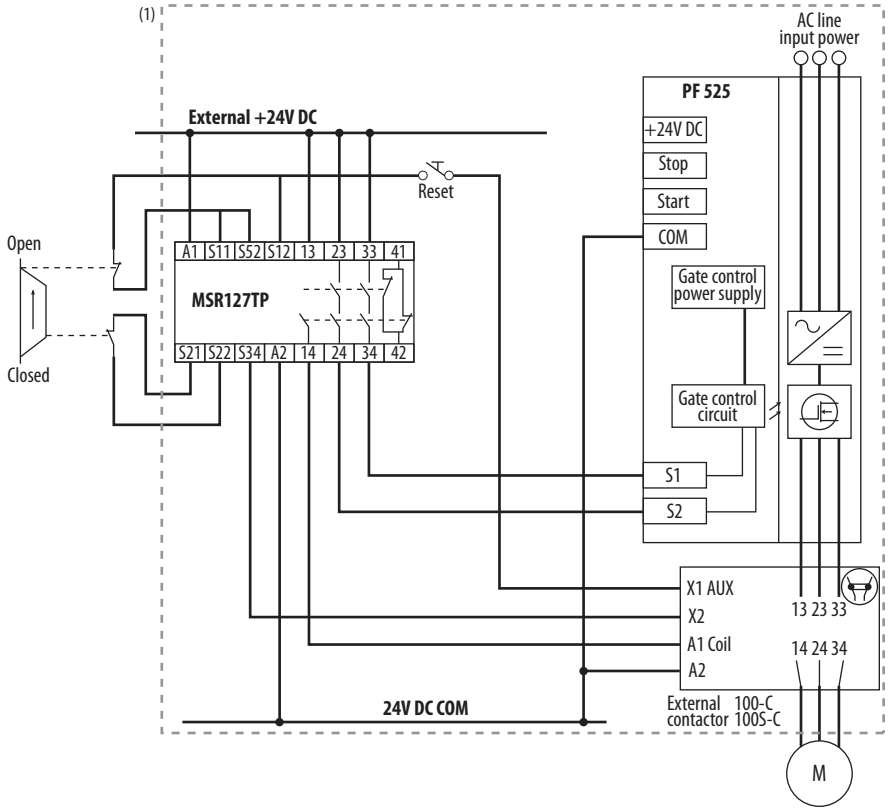
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

A single fault detected on the PowerFlex 525 safety enable redundant inputs will result in the lock-out of the drive and will not cause the loss of the safety function.

Example 3 – Safe-Torque-Off Connection with Coast-to-Stop Action Using External +24V supply, SIL 3/PL e

Stop Category 0 – Coast



(1) Enclosure Recommended. External wiring failure modes must be considered as described in EN ISO 13849-2. Enclosure or other measure to exclude these failure modes should be used.

Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

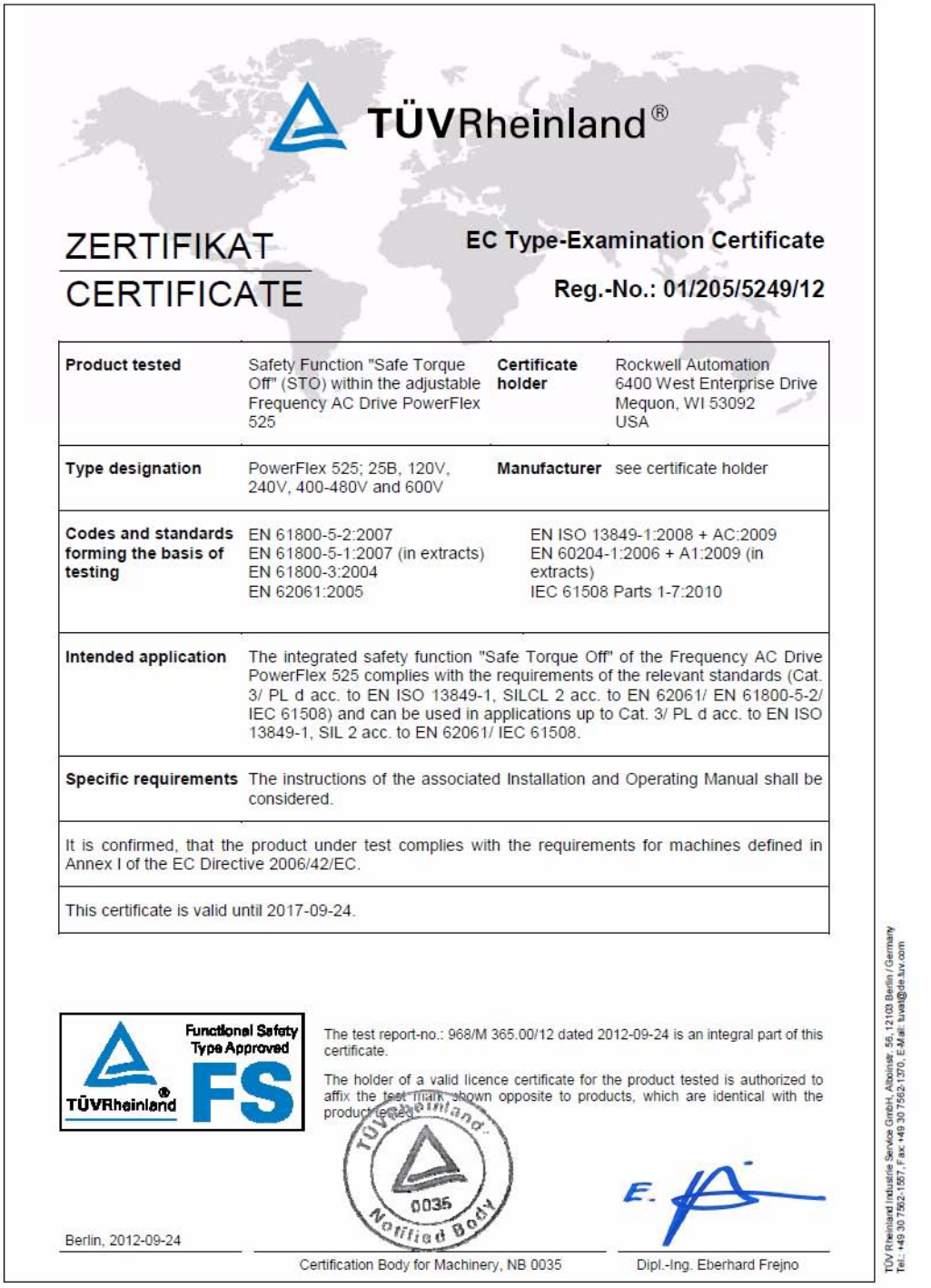
Operating Principle

This is a dual channel system with monitoring of the Safe-Torque-Off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24 & 33-34) will cause the output contact and Safe-Torque-Off Enable circuit to trip and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system at the next operation and will not cause loss of the safety function.

PowerFlex 525 Certification for Safe-Torque-Off



TÜVRheinland®

ZERTIFIKAT
CERTIFICATE

EC Type-Examination Certificate

Reg.-No.: 01/205/5249/12

Product tested	Safety Function "Safe Torque Off" (STO) within the adjustable Frequency AC Drive PowerFlex 525	**Certificate holder**	Rockwell Automation 6400 West Enterprise Drive Mequon, WI 53092 USA
Type designation	PowerFlex 525; 25B, 120V, 240V, 400-480V and 600V	**Manufacturer**	see certificate holder
Codes and standards forming the basis of testing	EN 61800-5-2:2007 EN 61800-5-1:2007 (in extracts) EN 61800-3:2004 EN 62061:2005		EN ISO 13849-1:2008 + AC:2009 EN 60204-1:2006 + A1:2009 (in extracts) IEC 61508 Parts 1-7:2010
Intended application	The integrated safety function "Safe Torque Off" of the Frequency AC Drive PowerFlex 525 complies with the requirements of the relevant standards (Cat. 3/ PL d acc. to EN ISO 13849-1, SILCL 2 acc. to EN 62061/ EN 61800-5-2/ IEC 61508) and can be used in applications up to Cat. 3/ PL d acc. to EN ISO 13849-1, SIL 2 acc. to EN 62061/ IEC 61508.		
Specific requirements	The instructions of the associated Installation and Operating Manual shall be considered.		
It is confirmed, that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.			
This certificate is valid until 2017-09-24.			

Functional Safety Type Approved
TÜVRheinland® FS

The test report-no.: 968/M 365.00/12 dated 2012-09-24 is an integral part of this certificate.

The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.

TÜVRheinland 0035 Notified Body

Berlin, 2012-09-24

Certification Body for Machinery, NB 0035

Dipl.-Ing. Eberhard Frejno

TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany
Tel.: +49 30 7562-1557, Fax: +49 30 7562-1370, E-Mail: tuvat@de.tuv.com

Notes:

EtherNet/IP

This section contains only basic information to setup an EtherNet/IP connection with your PowerFlex 520-series drive. For comprehensive information about EtherNet/IP (single and dual-port) and how to use it, see the following publications:

- PowerFlex 525 Embedded EtherNet/IP Adapter User Manual, publication 520COM-UM001.
- PowerFlex 25-COMM-E2P Dual-Port EtherNet/IP Adapter User Manual, publication 520COM-UM003.



ATTENTION: PowerFlex 523 drives support only the 25-COMM-E2P dual-port EtherNet/IP adapter. PowerFlex 525 drives support both the embedded EtherNet/IP adapter and the 25-COMM-E2P dual-port EtherNet/IP adapter.

Establishing A Connection With EtherNet/IP

There are three methods for configuring the Ethernet IP address:

- **BootP Server** – Use BootP if you prefer to control the IP addresses of devices using a server. The IP address, subnet mask, and gateway addresses will then be provided by the BootP server.
- **Adapter Parameters** – Use adapter parameters when you want more flexibility in setting up the IP address, or need to communicate outside the control network using a gateway. The IP address, subnet mask, and gateway addresses will then come from the adapter parameters you set.
- **DHCP** (**Dynamic Host Configuration Protocol**) (only with PowerFlex 25-COMM-E2P adapter) – Use DHCP when you want additional flexibility and ease-of-use compared to BOOTP in configuring the IP address, subnet mask, and gateway address for the adapter using a DHCP server.

IMPORTANT	If you are setting your network addresses manually using parameters, you must set the appropriate drive or 25-COMM-E2P adapter parameter value to 1 “Parameters”. See the respective EtherNet/IP adapter user manual for more information.

IMPORTANT	Regardless of the method used to set the adapter IP address, each node on the EtherNet/IP network must have a unique IP address. To change an IP address, you must set the new value and then remove and reapply power to (or reset) the adapter.

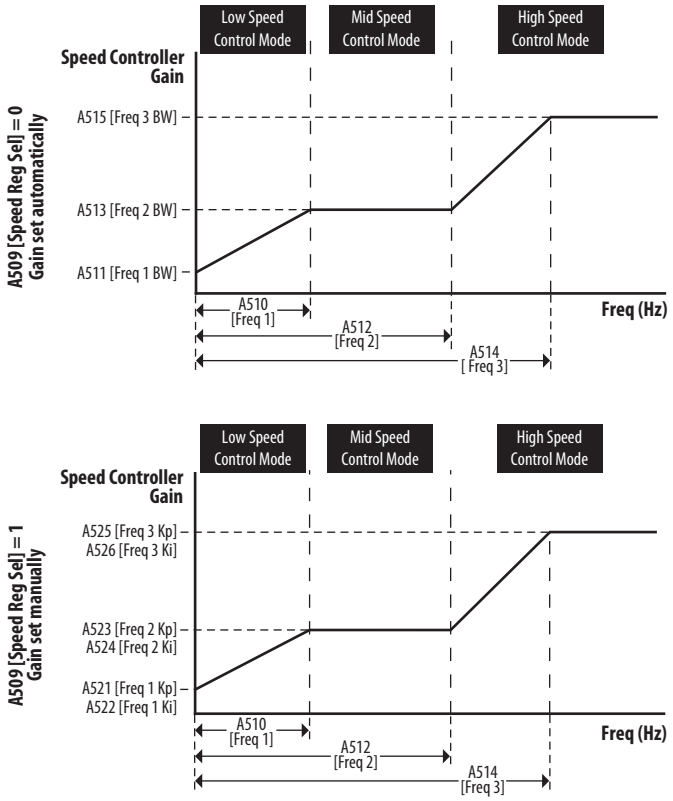
Notes:

Control Diagrams

This chapter contains various diagrams on the PowerFlex 520-series drive functions and behaviors.

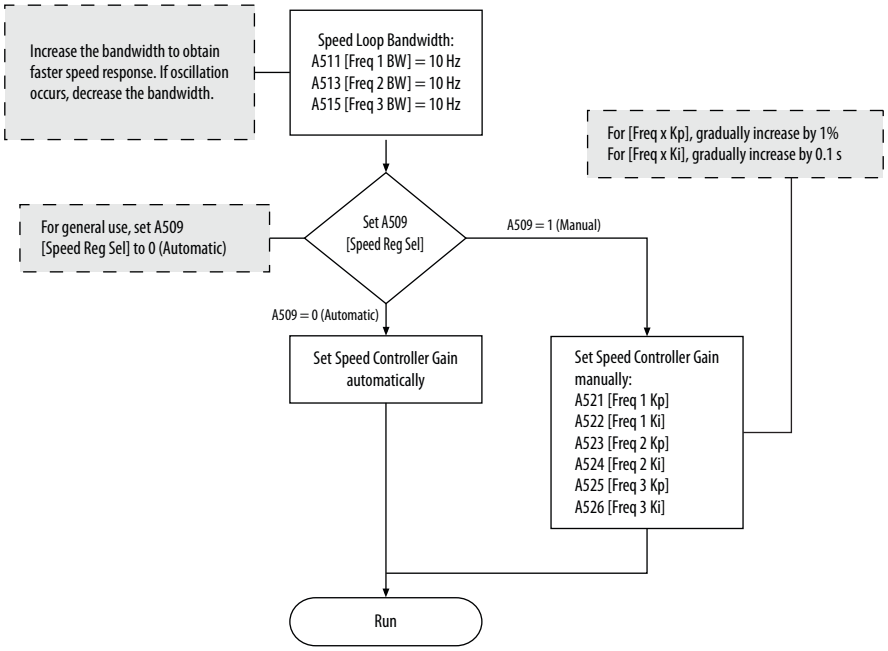
Induction Motor Tuning Diagrams

[Speed Reg Sel] Diagrams For Motor Tuning



Adjusting Speed Control Parameters

These settings show how to adjust the speed control for motor tuning.



Numerics

2-wire
inputs, **47**
3-wire
inputs, **47**

A

accel
override priority, **48**
selecting, **48**
accessing
control terminals, **30**
power terminals, **30**
applications
safety, **221**
auxiliary contact
drive, **33**, **35**

B

basic operation, **61**
drive, **56**, **61**, **148**
programming, **61**
safety, **224**

C

circuit breakers
inputs, **22**
ratings, **22**
common bus
drive, **35**
communications
positioning, **208**
configuring
RS485(DSI), **186**
control terminals
accessing, **30**
counter
programming, **193**, **196**

D

decel
override priority, **48**
selecting, **48**
derating
factor, **117**
temperature, **17**
digital inputs
selecting, **47**
start source, **47**
dimensions
mounting, **16**, **170**
disconnect
output, **33**
drive
auxiliary contact, **33**, **35**
basic operation, **56**, **61**, **148**
common bus, **35**
mount, **15**
programming, **57**, **60**
safety, **223**
drive damage
preventing, **19**
ungrounded distribution systems, **19**

E

encoder
programming, **199**
wiring, **200**
environment
storage, **18**
Ethernet
programming, **231**

F

fault monitoring
ground, **21**
fuses
rating, **22**

G

ground
fault monitoring, **21**
motor, **21**
RFI filter, **21**
safety, **21**
shielding, **21**

H

homing
automatic, **206**
manual, **206**
programming, **206**

I

inputs
2-wire, **47**
3-wire, **47**
circuit breakers, **22**
power, **20**

L

logic
basic, **193**, **194**
timed steps, **193**, **194**

M

Modbus
reading, **189**, **191**, **192**

writing, **187**, **189**, **192**
motor
ground, **21**
start, **33**
stop, **33**
mount
drive, **15**
mounting
dimensions, **16**, **170**

N

noise immunity
wiring, **36**, **186**

O

output
disconnect, **33**
override priority
accel, **48**
decel, **48**
speed reference, **46**
start source, **46**

P

parameters
AppView, **68**, **137**
CustomView, **138**
programming, **59**, **63**
PID
programming, **213**
positioning
communications, **208**
programming, **201**, **202**
power
inputs, **20**
power and control module
separating, **27**
power terminals
accessing, **30**
preventing
drive damage, **19**
programming, **61**
basic logic, **193**, **194**
counter, **193**, **196**
drive, **57**, **60**
encoder, **199**
Ethernet, **231**
homing, **206**
parameters, **59**, **63**
PID, **213**
positioning, **201**, **202**
pulse train, **199**
timed steps, **193**, **194**
timer, **193**, **195**
tools, **60**
pulse train
programming, **199**

R

rating
fuses, **22**
ratings
circuit breakers, **22**
reading
Modbus, **189**, **191**, **192**
recommended
wiring, **35**, **223**
reflected
wave protection, **33**
RFI filter
ground, **21**
RS485(DSI)
configuring, **186**

S

safety
applications, **221**
basic operation, **224**
drive, **223**
ground, **21**
testing, **222**
wiring, **223**
selecting
accel, **48**
decel, **48**
digital inputs, **47**
speed reference, **46**
start source, **46**
separating
power and control module, **27**
shielded
wiring, **32**
shielding
ground, **21**
speed reference
override priority, **46**
selecting, **46**
start
motor, **33**
start source
digital inputs, **47**
override priority, **46**
selecting, **46**
stop
motor, **33**
storage
environment, **18**

T

temperature
derating, **17**
wiring, **32**
testing
safety, **222**
timer

programming, **193**, **195**
tools
programming, **60**

U

unshielded
wiring, **32**

V

voltage reflections
wiring, **33**

W

wave protection
reflected, **33**
wiring
encoder, **200**
noise immunity, **36**, **186**
recommended, **35**, **223**
RS485 (DSI), **185**
safety, **223**
shielded, **32**
temperature, **32**
unshielded, **32**
voltage reflections, **33**
writing
Modbus, **187**, **189**, **192**

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

www.rockwellautomation.com

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APPENDIX V

American Sensor Technology

Precision Pressure Transducer / Transmitter

AST20HA



The AST20HA is a digitally compensated precision pressure transducer / pressure transmitter that offers high performance over temperature. Krystal Bond™ Technology alone offers excellent non-linearity and non-repeatability performance. When it is combined with the advanced electronics, the AST20HA steps into its own league of high performance pressure sensing at an affordable price.

Benefits

- Digital ASIC Compensation
- Superb Temperature Performance
- Real Time Thermal Compensation
- Real Time Linearity Correction
- Turndown Capability
- Pressures up to 45,000 PSI
- ABS (American Bureau of Shipping) Approved

Applications

- Aerospace
- Analytical Instruments
- Hydraulics
- Hydrogen (Consult factory for media compatibility)
- Labs / Metrology
- Medical
- Military
- Test Stands

Environmental Data

Temperature	
Operating	-40 to 85°C (-40 to 185°F)
Storage	-50 to 125°C (-58 to 257°F)
Thermal Limits	
Compensated Range	0-70°C (30 to 158°F)
TC Zero	<± 0.5% FS
TC Span	<± 0.5% FS
Other	
Shock	100G, 11 msec, 1/2 sine
Vibration	10G peak, 20 to 2000Hz
EMI/RFI Protection:	Yes
Rating:	IP-66

Performance @ 25°C (77°F)

Accuracy*	< ±0.1% BFSL (<±0.2% BFSL over 15,000 PSI)
Stability (1 year)	±0.1% FS, typical
Proof Pressure **	2X Rated Pressure, standard
Burst Pressure	5X or 50,000 PSI, whichever is less
Pressure Cycles	> 100 Million

** Accuracy includes non-linearity, hysteresis & non-repeatability **For higher proof pressures, contact factory*

Electrical Data

Output	**4-20mA**	**0-5V, 1-5V**	**0-10V, 1-10V**	**0.5-4.5V Ratiometric**
Excitation	10-28VDC	10-28VDC	15-30VDC	5VDC, Regulated
Current Consumption:	-	< 10mA	< 10mA	< 10mA
Sampling Rate	400Hz	400Hz	400Hz	400Hz
Output Noise:	< 1mV, RMS	< 1mV, RMS	< 1mV, RMS	< 1mV, RMS
Zero Offset	< ± 0.5% FS	< ± 0.5% FS	< ± 0.5% FS	< ± 0.5% FS
Span Tolerance	< ± 0.5% FS	< ± 0.5% FS	< ± 0.5% FS	< ± 0.5% FS
Output Load:	0-800 Ohms@10-28VDC	5k Ohms, min.	5k Ohms, min.	5k Ohms, min.
Reverse Polarity Protection	Yes	Yes	Yes	Yes

American Sensor Technologies · 450 Clark Dr., Mt. Olive, NJ 07828 · phone (973) 448-1901 · fax (973) 448-1905 · email: *info@astsensors.com*

Ordering Information*

AST20HA	A	05000	P	4	E	0	H	000

Series Type

Process Connection

A = 1/4" NPT Male
B = 1/8" NPT Male**
C = 1/4" BSPP Male
E = 9/16"-18 UNF Male [SAE6]
F = 7/16"-20 UNF Male [SAE4]**
P= 1/2" NPT Male***
W= F250C Female Autoclave****

** Not available under 50PSI (1/8" NPT Male not available in 316L)*
*** Pressures up to 15,000 PSI*
****Pressures from 10,000 to 45,000 PSI, not available in 316L*

Pressure Range
Insert 5-digit pressure code

Pressure Unit
B= Bar K= kg/cm^2 P= PSI

Outputs
1= 0.5-4.5V ratiometric
2= 0-5V(3 wire)
3= 1-5V
4= 4-20mA
5= 0-10V(3 wire)
G= 1-10V

Electrical *(for wiring information visit: http://www.astsensors.com/wiring.php)*
A= 2 ft.(0.6m)
B= 4 ft.(1.2m)
C= 6 ft.(1.8m)
D= 10 ft.(3.0m)
E= Mini DIN 43650C
I= DIN 43650A
R= 6- Pin Bendix
Y= M12x1

Wetted Material
0=17-4PH 1=316 L *(available up to 10,000 PSI)* 2= Inconel 718 *(consult factory on availability)*

Fail Condition
N= Not Specified H= Fail High L= Fail Low

Options (contact factory for additional options)
000= No Options

**Minimum order quantities may apply to certain configurations, please contact factory for more information.*

Pressure Ranges+

PSIG Measurement	Pressure Code
-14.7 to 25++	V0025++
0-25	00025
0-50	00050
0-100	00100
0-150	00150
0-200	00200
0-250	00250
0-500	00500
0-1,000	01000
0-2,500	02500
0-5,000	05000
0-7,500	07500
0-10,000	10000
0-15,000	15000
0-20,000	20000
0-30,000	30000
0-45,000	45000

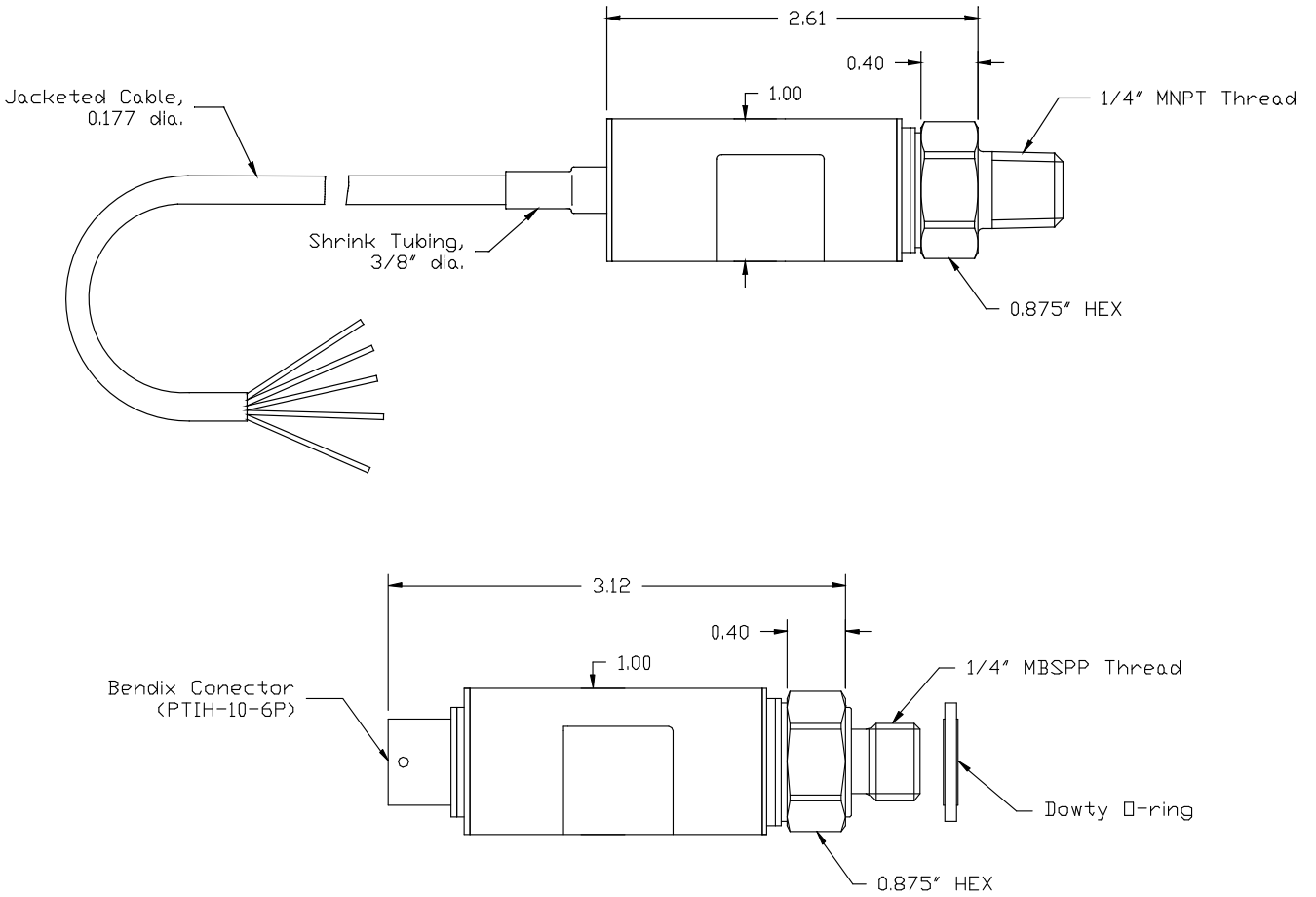
BARG Measurement	Pressure Code
-1 to 2++	V0002++
0-2	00002
0-5	00005
0-7	00007
0-10	00010
0-20	00020
0-35	00035
0-50	00050
0-100	00100
0-250	00250
0-350	00350
0-500	00500
0-700	00700
0-1,000	01000
0-1,400	01400
0-2,000	02000
0-3,000	03000

+All pressures between 0-25 PSI and 0-45,000 PSI available. ++Compound pressures up to -14.7 to 500 PSI available. Please consult factory.

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Precision Pressure Transducer / Transmitter

AST20HA



American Sensor Technologies · 450 Clark Dr., Mt. Olive, NJ 07828 · phone (973) 448-1901 · fax (973) 448-1905 · email: *info@astsensors.com*

www.astsensors.com

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MALABAR™ INTERNATIONAL
A TRONAIR COMPANY

APPENDIX VI

Beijer Electronics Touch Screen

QTERM®-A12 TERMINAL
HARDWARE MANUAL

BEIJER ELECTRONICS
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Salt Lake City, Utah 84115-2648
USA

Phone 801-466-8770
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M01-061-00 Rev 02

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Manual updated 6 September 2011.

FCC Compliance Information

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

Additionally, the QTERM-A12 may contain the following FCC module-certified components depending on product configuration: QOQWT12 or Q72WLC300GRS.

Notes

CONTENTS

CHAPTER 1. INTRODUCTION 1

CHAPTER 2. SAFETY SUMMARY 3

CHAPTER 3. APPLYING POWER 5
3.1 Connecting to Earth Ground 5
3.2 Primary Serial Port Connector for Power Input 6
3.3 Terminal Strip for Power Input 6
3.4 Optional Power-over-Ethernet Interface 7
3.5 Powering On the Terminal for the First Time 8

CHAPTER 4. HARDWARE DESCRIPTION AND ARCHITECTURE 9
4.1 User Interface 9
4.2 Processor 9
4.3 System and Application Memory 9
4.4 Serial Communications 10
4.5 Network 10
4.6 Speaker 10
4.7 Power Supply 11
4.8 Housing 11

CHAPTER 5. INSTALLATION 13
5.1 Cutting Out for Panel Mount 14
5.1.1 Standard Version Cutout 14
5.1.2 Modular Version Cutout 15
5.2 Installing the Terminal 16
5.2.1 Standard Version Installation 16
5.2.2 Modular Version Installation 17

CHAPTER 6. SPECIFICATIONS 19

CHAPTER 7. MECHANICAL 23
7.1 Layout and Dimensions 23
7.1.1 Standard Version 23
7.1.2 Modular Version 26
7.2 Connector Pinouts 28
7.2.1 Primary Serial Port 28
7.2.2 Secondary Serial Port 29
7.2.3 Terminal Strip for Power Input 29
7.2.4 Ethernet Port 30
7.2.5 USB 2.0 Ports 31

Notes

CHAPTER 1

INTRODUCTION

The QTERM®-A12 is a rugged graphic human-machine interface terminal for use in a wide range of commercial and industrial applications. It has been designed with a robust set of industrial-grade features and options.

- Windows® Embedded CE 6.0 operating system
- Support for application development with industry standard tools such as Microsoft® Visual Studio 2005 or 2008
- Marvell® PXA300 processor (ARMV5TE) with Intel XScale™ technology running at 624 MHz
- 4 Gbytes non-volatile storage (with support for larger capacities)
- 128 Mbytes of DDR SDRAM
- Two USB 2.0 full speed host ports with built-in support for standard USB keyboards, mice and memory devices
- 10/100Base-T wired Ethernet
- Two serial ports: one EIA-232/422/485 (software configurable) and one EIA-232 serial port
- Bright 307 mm (12.1") TFT color SVGA (800 x 600) display with 450 nit LED backlight
- Analog-resistive 5-wire touch screen for rugged applications
- Built-in speaker (behind panel)
- Terminal strip for power input (alternate power input on COM1 DB9)
- 10 to 32 VDC input voltage range
- Built-in protection from power transients and spikes, reverse voltage and overvoltage
- Optional Power-over-Ethernet (PoE) interface
- Wide operating temperature of -30 to 70 °C, storage temperature of -40 to 85 °C
- Tough industrial grade polymer housing

Notes

CHAPTER 2

SAFETY SUMMARY

The QTERM-A12 terminal is certified to operate at Temperature Code T6 in a Class I, Division 2, Group A, B, C and D hazardous environment. The terminal must be installed and operated as described in this document to meet this certification.

All safety related regulations, local codes and instructions that appear in this manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the QTERM-A12 to directly command motors, valves or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.

CAUTION



For Class I, Division 2 installations:
The USB ports are for operational maintenance only. Do not leave USB devices permanently connected unless the area is known to be non-hazardous.

CAUTION



For Class I, Division 2 installations:
Do not connect or separate any connection (power, Ethernet, USB, Com 1 or Com 2) unless area is known to be non-hazardous.

CAUTION



EXPLOSION HAZARD
Substitution of components may impair suitability for Class I, Division 2.



CAUTION: Risk of danger.
Read complete instructions prior to installation and operation of the terminal.



CAUTION: Risk of electric shock.

Notes

CHAPTER 3

APPLYING POWER

CAUTION



For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

Power is supplied to the QTERM-A12 terminal via the COM1 serial port connector or the 3-pin power terminal strip for input power, return and chassis ground. The QTERM-A12 may also be equipped with an optional Power-over-Ethernet (PoE) interface. When powered by the 3-pin power terminal strip or the COM1 serial port, the QTERM-A12 has a 10- to 32-volt DC input range and can be powered directly from a 12- or 24-volt DC power supply (the current will vary depending on the input voltage; see table below).

Power Consumption			
Terminal	**12 VDC**	**24 VDC**	**PoE (48 VDC)**
Standby[1]	1.3 W	1.6 W	3.0 W
Typical[2]	8.5 W	9.1 W	10.5 W
Estimated Maximum[3]	12.1 W	13.1 W	14.2 W

1. Standby power consumption is measured when the display has been powered down and the operating system has entered system idle mode.
2. Typical power consumption is measured when the display is at full brightness and a polygon drawing application is running.
3. Estimated maximum power consumption is measured with serial, USB and Ethernet communications active. In addition, several applications are running including video with full volume and two USB mass storage loads are being powered.

3.1 Connecting to Earth Ground

NOTE ☞ *The chassis ground connection of the QTERM-A12 is electrically connected to the exposed conductive parts of the QTERM-A12 for safety purposes. The chassis ground connection MUST be connected to an external protective earthing system.*

The QTERM-A12 has a chassis ground terminal and a chassis ground connection on the 3-pin power terminal strip on the back of the terminal. (See Figure 6 on page 24 and Figure 15 on page 29 for the location of the chassis ground terminal and the 3-pin power terminal strip.) The terminal should be connected to earth ground (protective earth). The chassis ground is not connected to signal common of the terminal. Maintaining isolation between earth ground and signal common is not required to operate the terminal; however, other equipment connected to the terminal may require isolation between signal common and earth ground. To maintain iso-

lation between signal common and earth ground, care must be taken when connections are made to the terminal. For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a serial cable or a USB cable may connect signal common and earth ground.

The serial cable shield or the USB shield may be connected to earth ground at the host. The serial cable or the USB shield, in turn, may also be connected to signal common.

3.2 Primary Serial Port Connector for Power Input

WARNING



Although the terminal includes protection circuitry to prevent power supply contention, power should not be connected to the 3-pin terminal strip or the RJ45 PoE interface while power is applied to the DB9 connector.

Power can be supplied to the terminal through pin 9 and ground return through pin 5 of the COM1 serial port connector.

3.3 Terminal Strip for Power Input

WARNING



Although the terminal includes protection circuitry to prevent power supply contention, power should not be connected to the DB9 connector or the RJ45 PoE interface while power is applied to the 3-pin terminal strip.

WARNING



QTERM-A12 power must come from an SELV (Safety Extra Low Voltage) power source and should have a current limit on its output of 5 Amperes. It must provide a minimum of 10 volts DC power and be limited to a maximum of 32 volts DC. Limiting may be inherent to the supply or may be provided by supplementary overcurrent devices. If the QTERM-A12 does not respond or exhibits abnormal behavior on power up, disconnect power and contact Beijer Electronics for technical support.

The 3-pin terminal strip is used to provide input voltage and ground to the terminal. The terminal strip provides a chassis ground connection. The chassis ground pin is isolated from the system ground of the terminal.

3.4 Optional Power-over-Ethernet Interface

WARNING



Although the terminal includes protection circuitry to prevent power supply contention, power should not be connected to the 3-pin terminal strip or the DB9 connector while power is applied to the RJ45 PoE interface.

The QTERM-A12 may be equipped with an optional Power-over-Ethernet (PoE) interface. This interface may be used to power the terminal by connecting a PoE equipped Power Sourcing Equipment (PSE) to the RJ45 connector on the rear of the terminal.

The QTERM-A12 PoE interface is functional with both IEEE 802.3af-2003 and 802.3at-2009 standards. If the terminal is connected to an IEEE 802.3af-2003 compliant network connection the terminal will operate as a Type 1 Class 4 PoE device in a low-power condition not exceeding 13 Watts average power consumption. The terminal will automatically disable both USB ports while operating as a Type 1 Powered Device (PD) to ensure that the total average power consumption remains lower than 13 Watts.

If the QTERM-A12 is connected to an IEEE 802.3at-2009 compliant network connection all included features will be operational. In this mode, the terminal will complete 2-event classification as specified by IEEE 802.3at-2009 and operate as a Type 2 Class 4 PoE Powered Device (PD).

The QTERM-A12 will also operate from a non-compliant (simple Power-over-Ethernet with no classification) PSE source if the source can supply up to 600 mA and maintain between 37.0 and 57.0 volts measured at the RJ45 connector on the terminal.

The QTERM-A12 will accept either Mode A or Mode B power connections as specified by IEEE 802.3at-2009. The following table provides pinout information for both of these modes. The polarity may be reversed in either mode.

NOTE ☞ *The chassis ground connection MUST be connected to an external protective earthing system. See section 3.1, "Connecting to Earth Ground" for more information.*

Port Pin Assignment		
Conductor	**Mode A**	**Mode B**
1	Tx+/V+	Tx+
2	Tx-/V+	Tx-
3	Rx+/V-	Rx+
4		V+
5		V+
6	Rx-/V-	Rx-
7		V-
8		V-

3.5 Powering On the Terminal for the First Time

When you connect power to the QTERM-A12 terminal, the operating system is automatically loaded. The QTERM-A12 takes 10 to 20 seconds to boot. During that time the backlight of the display will come on to indicate that the terminal is booting.

CHAPTER 4

HARDWARE DESCRIPTION AND ARCHITECTURE

4.1 User Interface

Display
The QTERM-A12 features a TFT color SVGA (800 x 600 pixels) LCD display that measures 308 mm (12.1") diagonally. The display backlight has a typical rating of 450 nit.

Touch Screen
A clear analog-resistive touch screen covers the entire display area for user input. The touch screen is a 5-wire architecture offering improved durability and touch endurance. The face of the touch screen has an anti-reflective (AR) coating and a hardness of 3H.

External Peripherals
Two full-speed USB ports are available on the back of the QTERM-A12. These ports can be used to add many other devices, such as a keyboard, mouse or additional mass storage. Adding USB peripherals that are not self-powered will increase the power consumption of the terminal.

CAUTION



For Class I, Division 2 installations:
The USB ports are for operational maintenance only. Do not leave USB devices permanently connected unless the area is known to be non-hazardous.

4.2 Processor

The processor in the QTERM-A12 is the Marvell PXA300 processor (ARMV5TE), incorporating Intel XScale technology running at 624 MHz.

4.3 System and Application Memory

DRAM
The QTERM-A12 includes 128 Mbytes of DDR SDRAM volatile memory with a maximum bandwidth of 520 Mbytes per second.

Flash
The QTERM-A12 uses an internal 4 Gbyte NAND flash device to hold the main Windows CE image and provide non-volatile storage for user applications and data.

4.4 Serial Communications

CAUTION



For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The QTERM-A12 has two serial ports, designated COM1 and COM2, that can communicate up to 3.6 MBaud. Refer to section 7.2, “Connector Pinouts” for serial port pinout data.

The COM1 serial port can be configured in software to your choice of EIA-232 with hardware flow control (supporting RX, TX, RTS and CTS), EIA-422 or EIA-485. COM2 is an EIA-232 port with hardware flow control. The serial ports are accessed through female DB9 connectors on the back of the unit.

The QTERM-A12 also has two powered (500 mA per port) full-speed USB host ports that are USB 2.0 compliant. The ports are accessed through USB type A connectors on the back of the unit. The connectors are right-angle facing the bottom of the unit to facilitate mounting in shallow panels.

4.5 Network

CAUTION



For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The QTERM-A12 has an internal 10/100Base-T wired Ethernet adapter for network communications. The network interface is accessed through a standard RJ45 socket located on the back of the unit.

4.6 Speaker

The QTERM-A12 includes an internally mounted speaker, providing the ability to play a variety of audio, including audible feedback, warnings, messages and media clips. The QTERM-A12 is also designed with software programmable volume control.

NOTE ☞ *The QTERM-A12 speaker is intentionally over-driven at full volume, and certain media files may sound distorted during playback. Some find that this gives better results after the unit has been mounted into a panel. Volume should be adjusted to give optimal results for the media files used in your application.*

4.7 Power Supply

CAUTION



For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The QTERM-A12 has a 10- to 32-volt DC input range and can be powered directly from a 12- or 24-volt DC power supply. The terminal includes circuitry to protect against normal variations such as transients and spikes (EN55024 compliant), as well as reverse voltage and overvoltage protection.

Power is applied through a 3-terminal strip with removable plug located on the back of the unit. The 3-terminal strip has a power connection, ground and chassis ground (isolated from the system). Alternatively, power may be applied through pin 9 of the COM1 DB9. In this case, pin 5 is the power ground return.

If equipped with optional Power-over-Ethernet (PoE) the QTERM-A12 will operate from power supplied over an Ethernet cable. For details about the PoE interface, refer to section 3.4, “Optional Power-over-Ethernet Interface”.

4.8 Housing

The QTERM-A12 housing is made of industrial grade polymer that is designed to withstand everyday use in industrial environments.

Refer to Chapter 5, “Installation” for instructions on installing the unit in a panel.

Notes

CHAPTER 5

INSTALLATION

A QTERM-A12 terminal uses a rugged chemical resistant polymer housing and mounting components. When properly installed in a NEMA-4X rated panel, the QTERM-A12 meets all NEMA-4X specifications including hose-down, icing and salt spray.

A QTERM-A12 terminal can be installed in either a landscape or portrait orientation. In addition, the terminal can be installed with or without a front bezel. The model with factory-installed front bezel is referred to as the standard version and the model without a front bezel is referred to as the modular version.

The standard version of the QTERM-A12 has a factory-installed front bezel. This bezel has molded-in studs that are used in combination with a terminal ring to mount the terminal to the panel.

The modular version of the QTERM-A12 does NOT have a factory-installed front bezel. The modular version of the terminal is ideal for installations that require a custom front bezel or no bezel at all. The modular version requires that the mounting studs be integral with the panel that the terminal will be mounted in.

Take the following steps to install the terminal:

- Decide whether to mount the terminal in portrait or landscape orientation. “Portrait” means that the longest dimension is vertical; “landscape” means that the longest dimension is horizontal.
- Cut a hole in the panel or drywall. See section 5.1, “Cutting Out for Panel Mount” for specifications.
- Install the QTERM-A12 terminal in the panel. See section 5.2, “Installing the Terminal” for instructions.
- Connect cables to the terminal. Verify that the thumb screws are tight or the locks snapped into place for each cable used.
- Apply DC power to the QTERM-A12 terminal. See Chapter 3, “Applying Power” for information.

5.1 Cutting Out for Panel Mount

5.1.1 Standard Version Cutout

The standard version cutout is to be used with QTERM-A12 models that have a factory-installed front bezel.

The standard QTERM-A12 terminal can be mounted in panels from 0.8 to 10 mm thick. No screw holes need to be drilled to install the terminal in the panel. Make a rectangular hole in the panel using the following dimensions.

Landscape		Portrait	
Horizontal:	302.5 ± 1 mm	Horizontal:	254.0 ± 1 mm
Vertical:	254.0 ± 1 mm	Vertical:	302.5 ± 1 mm

NOTE ☞ *See the "QTERM-A12 Cutout and Mounting Guide" insert that was included in the box with the QTERM-A12 for installation instructions. Printed on the back of the insert is a cutout template that can be used to trace the cutout area onto the housing panel.*

Figure 1 is a diagram of the landscape cutout. After the cutout is complete deburr any rough edges prior to mounting the terminal.

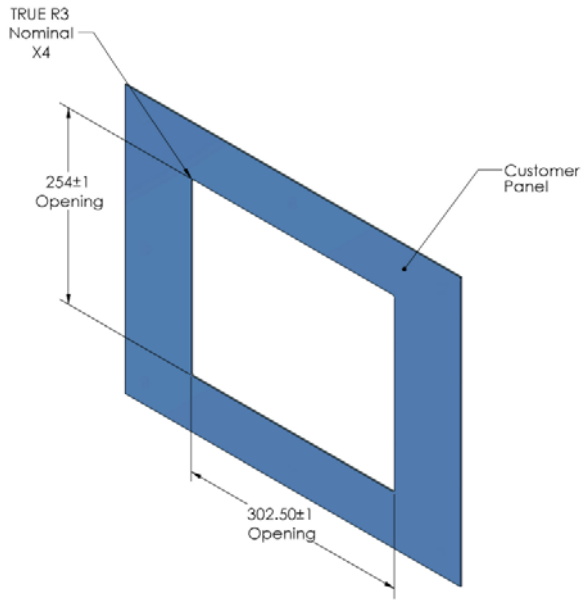


Figure 1
QTERM-A12 Landscape Cutout (units: mm)

5.1.2 Modular Version Cutout

The modular version cutout is to be used with QTERM-A12 models that DO NOT have factory-installed front bezels.

The modular version of the QTERM-A12 terminal can be mounted in panels with any thickness. In addition to making a cutout in the panel, the panel must be fitted with mounting studs. Make a rectangular hole in the panel using the following dimensions.

Landscape		Portrait	
Horizontal:	248.0 ± 1 mm	Horizontal:	187.0 ± 1 mm
Vertical:	187.0 ± 1 mm	Vertical:	248.0 ± 1 mm

NOTE ☞ *See the "QTERM-A12 Cutout and Mounting Guide" insert that was included in the box with the QTERM-A12 for installation instructions. Printed on the back of the insert is a cutout template that can be used to trace the cutout area onto the housing panel.*

Figure 2 is a diagram of the landscape cutout for the modular terminal. After the cutout is complete deburr any rough edges prior to mounting the terminal.

Install the recommended studs at the locations shown in Figure 2. The studs must be able to withstand a torque of 67.8 N cm (6 lbs in).

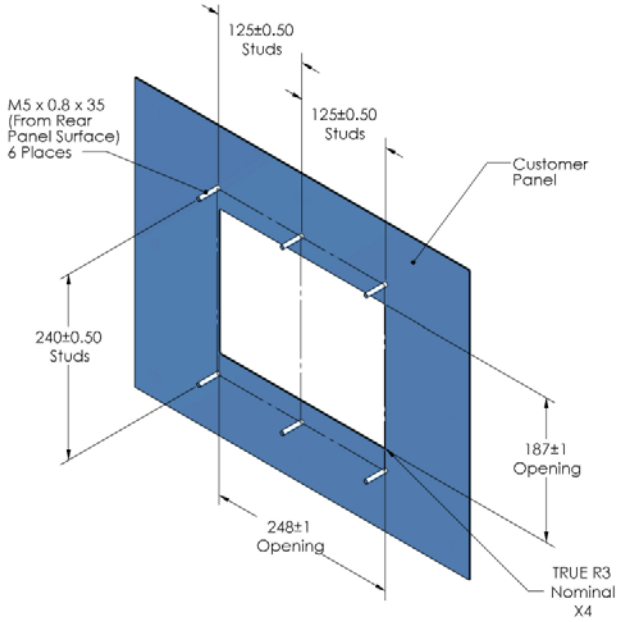


Figure 2
Modular QTERM-A12 Landscape Cutout (units: mm)

5.2 Installing the Terminal

WARNING



When mounting the QTERM-A12 terminal within a final enclosure, make sure you provide adequate ventilation: a minimum of 51 mm (2.0 inches) around the back, sides and bottom and 77 mm (3.0 inches) clearance above the top of the QTERM-A12 terminal.

CAUTION



This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D or non-hazardous locations only.

CAUTION



EXPLOSION HAZARD
Substitution of components may impair suitability for Class I, Division 2.

CAUTION



For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

NOTE ☞ *Use of an anti-static strap is recommended when performing installation and maintenance.*

5.2.1 Standard Version Installation

The standard version installation steps are to be used with QTERM-A12 models that have a factory-installed front bezel.

Take the following steps to install the standard terminal.

1. Verify that the panel surface around the cutout is clean and free of rough edges. A gasket built into the terminal seals against the panel surface. Dirt or imperfections on the panel may prevent a proper seal.

2. Place the terminal into the panel cutout and verify that the terminal is oriented correctly. The printed labels on the back panel may indicate the orientation. If not, you can determine which side should be at the top by the position of the serial port(s) on the back panel as follows:

   - Landscape
     When looking at the front of the unit, the back panel serial port(s) should be facing down.

- Portrait
  When looking at the front of the unit, the back panel serial port(s) should be facing left. Refer to Figure 3 for an example of a landscape installation.

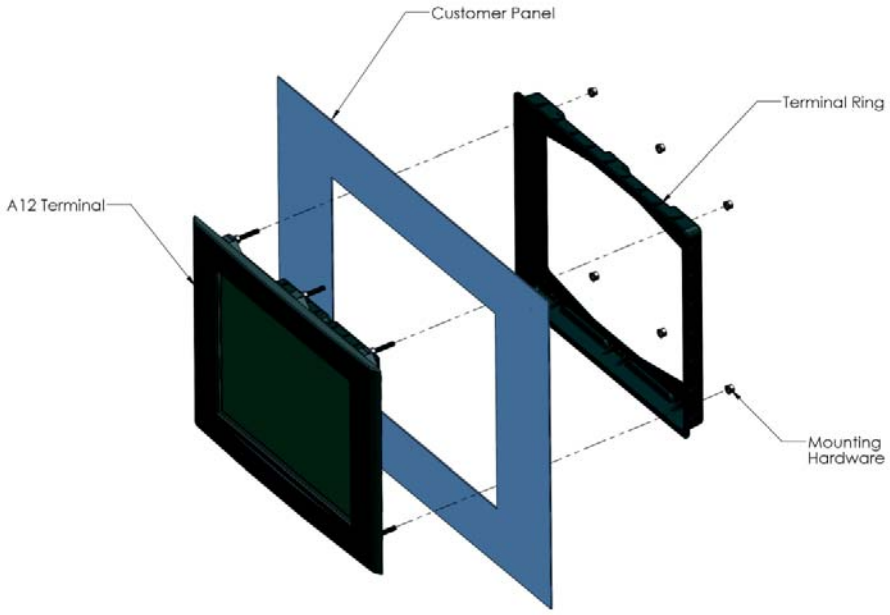


Figure 3
QTERM-A12 Mounting

3. On the back of the panel, align the terminal mounting ring holes with the mounting studs, and place the mounting ring against the back of the panel. Refer to Figure 3 for the location of the mounting studs.

4. Install nuts and washers (supplied with the terminal) onto each of the six mounting studs. Torque all nuts to 67.8 N cm (6 lbs in) to create a seal between the terminal gasket and the panel. Avoid overtightening the nuts.

5.2.2 Modular Version Installation

The modular version installation steps are to be used with QTERM-A12 models that DO NOT have a factory-installed front bezel.

Take the following steps to install the terminal.

1. Verify that the panel surface around the cutout is clean and free of rough edges. A gasket built into the terminal seals against the panel surface. Dirt or imperfections on the panel may prevent a proper seal.

2. Place the terminal over the panel cutout by aligning the terminal mounting holes with the mounting studs of the panel. Ensure that the orientation is correct. The printed labels on

the back panel may indicate the orientation. If not, you can determine which side should be at the top by the position of the serial port(s) on the back panel as follows:

- Landscape
  When looking at the front of the unit, the back panel serial port(s) should be facing down.
- Portrait
  When looking at the front of the unit, the back panel serial port(s) should be facing left. Refer to Figure 4 for an example of a landscape installation.

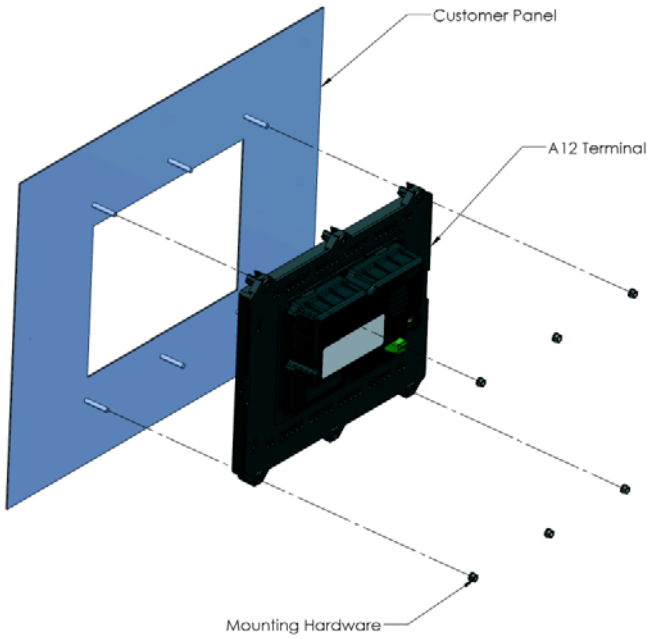


Figure 4
Modular QTERM-A12 Mounting

3. Install nuts and washers onto each of the six mounting studs. Torque all nuts to 67.8 N cm (6 lbs in) to create a seal between the terminal gasket and the panel. Avoid overtightening the nuts.

CHAPTER 6

SPECIFICATIONS

DISPLAY	
Color	TFT color SVGA LCD display 65,536 colors
Size	308 mm (12.1") diagonal 246 mm x 184.5 mm active area
Pixels	800 x 600 (SVGA)
Dot pitch	0.3075 x 0.3075 mm
Lighting	LED
	Brightness is software controllable
Backlight brightness	450 nits typical
Contrast ratio	700:1 (minimum)

TOUCH SCREEN
Analog-resistive operation
5-wire construction
Anti-glare surface treatment with 3H hardness

INTERFACE	
Primary serial port	User-configurable EIA-232, EIA-422 or EIA-485 interface with selectable 485 AC terminations and fail-safe network
Secondary serial port	EIA-232 serial port with hardware or software flow control
Ethernet	10/100Base-T wired Ethernet with optional PoE
USB host	Two USB 2.0 full-speed host ports
Power connector	3-pin, 5.0 mm pitch terminal strip. (Phoenix Contact MSTBVA 2,5/3-G – 1755529)

AUDIO	
Speaker	0.7 W 8 ohm speaker on back of unit

PHYSICAL	
STANDARD VERSION (WITH FACTORY-INSTALLED BEZEL)	
Dimensions	344.4 (W) x 267.0 (H) x 69.1 (D) mm
Mass	2.05 kg
MODULAR VERSION (WITHOUT FACTORY-INSTALLED BEZEL)	
Dimensions	298.9 (W) x 252.6 (H) x 62.8 (D) mm
Mass	1.72 kg

ENVIRONMENTAL	
Sealing	UL50 Type 4X Outdoor (pending), NEMA-4X, IP66 (front panel only)
Temperature	Operating: -30 to 70 °C Storage: -30 to 85 °C
Humidity	5 to 95%, non-condensing
Vibration	10 to 1500 Hz, 4 g RMS
Shock	40 g, 11 ms, common orthogonal axes
Electrical transient and noise	As specified in EN55024
ESD	8 kV contact 15 kV air on all surfaces

POWER	
Input voltage range	10 to 32 VDC
Typical power consumption	8.5 W (~700 mA @ 12 VDC)

OPTIONAL POWER-OVER-ETHERNET (PoE)	
Input voltage range	37 to 57 VDC
Typical power consumption	10.5 W

CPU	
ARM Architecture V5TE Marvell PXA300 with Intel XScale technology	
Speed	624 MHz
Cache	32 kbytes instruction cache, 32 kbytes data cache

MEMORY	
DDR SDRAM	128 Mbytes standard, 16 bit wide bus, 130 Mhz => 520 Mbytes/s transfer rate
Non-volatile storage	4 Gbytes standard

SOFTWARE	
Operating system	Microsoft Windows Embedded CE version 6.0 R3 Professional

CERTIFICATION
FCC Part 15, Class A
CE Certification EN-55022, EN-55024 and EN-60950
UL Listed by Und. Lab. Inc. To U.S. and Canadian safety standards, UL508 (pending)
Class I, Division 2, Group A, B, C and D hazardous locations, Temperature Code T6 (pending)
RoHS
UL50 Type 4X Outdoor (pending), NEMA-4X, IP66 (front panel only)

Notes

CHAPTER 7
MECHANICAL

7.1 Layout and Dimensions

7.1.1 Standard Version

The standard version of the QTERM-A12 is equipped with a factory-installed front bezel. The front bezel has molded-in studs that are used together with a terminal ring to mount the terminal to a panel.

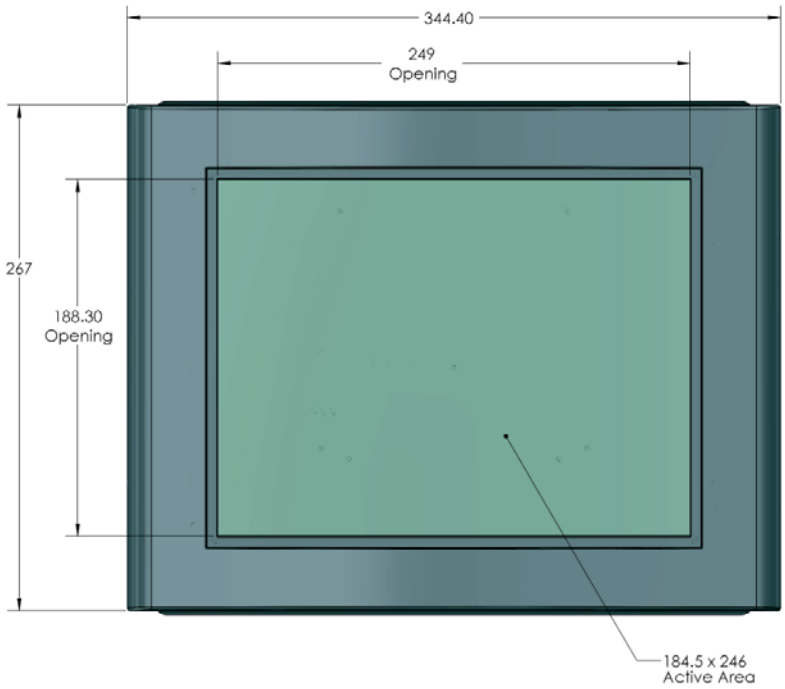


Figure 5
QTERM-A12 Front View (units: mm)

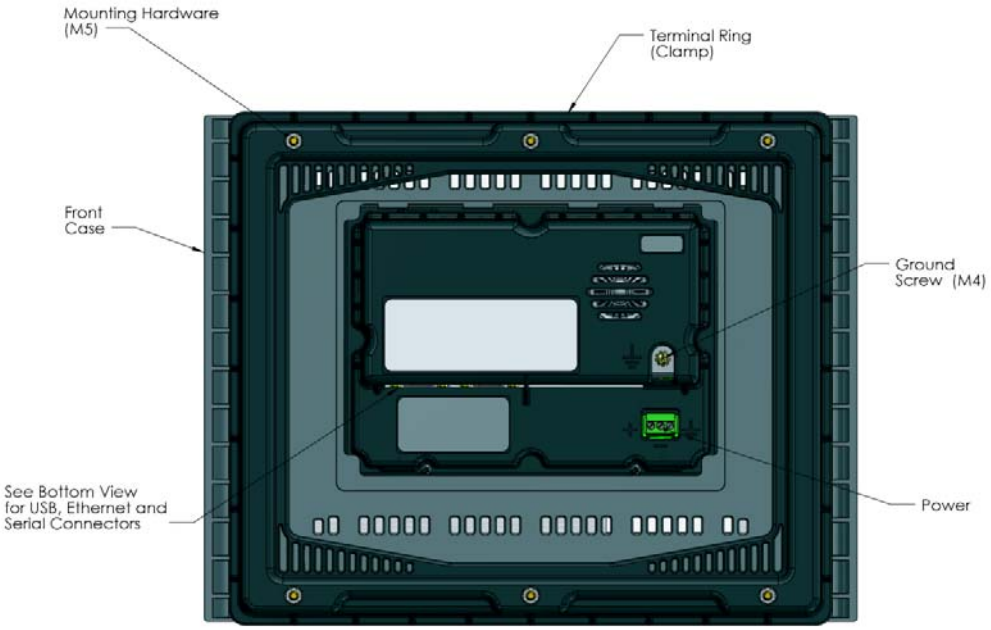


Figure 6
QTERM-A12 Back View (units: mm)

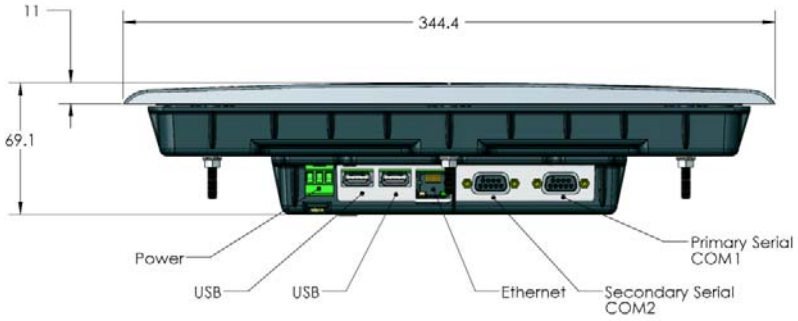


Figure 7
QTERM-A12 Bottom View (units: mm)

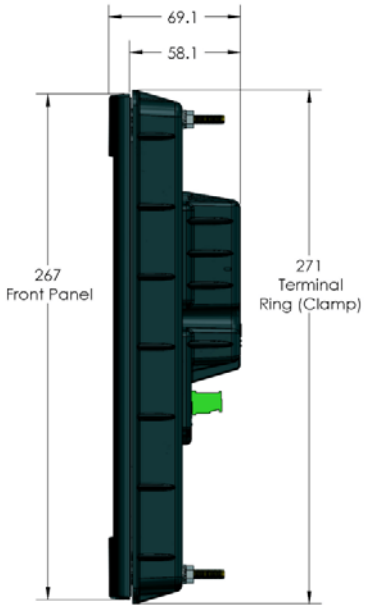


Figure 8
QTERM-A12 Side View (units: mm)

7.1.2 Modular Version

The modular version of the QTERM-A12 does NOT have a front bezel. Mounting studs must be integral to the panel where the QTERM-A12 will be mounted. The modular version allows installers to use their own custom bezel or to use the panel as the bezel.

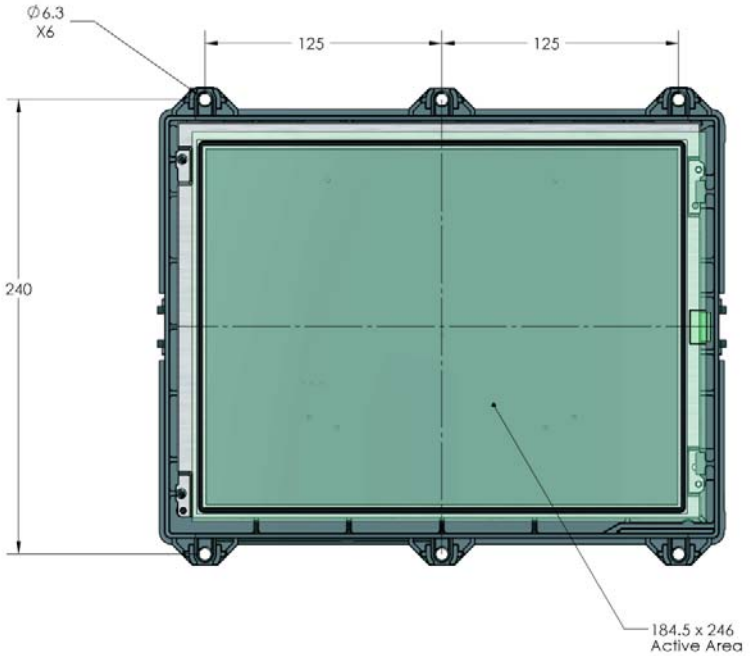


Figure 9
Modular QTERM-A12 Front View (units: mm)

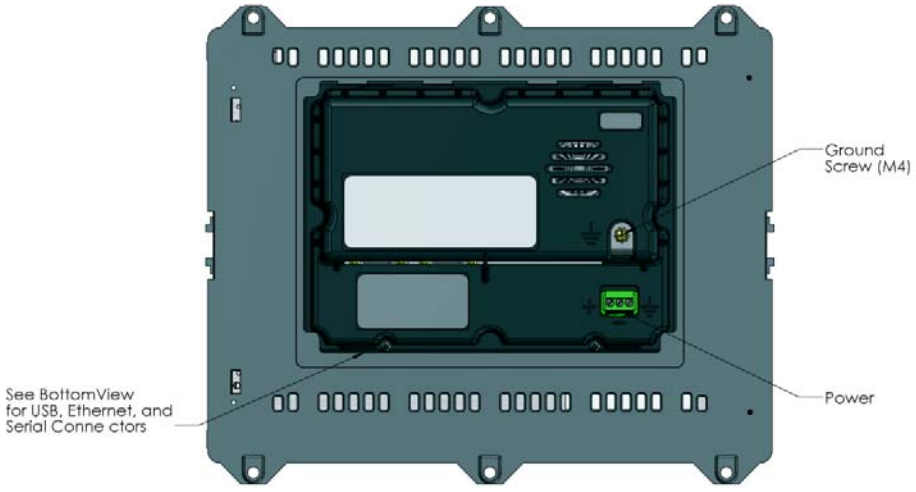


Figure 10
Modular QTERM-A12 Back View (units: mm)

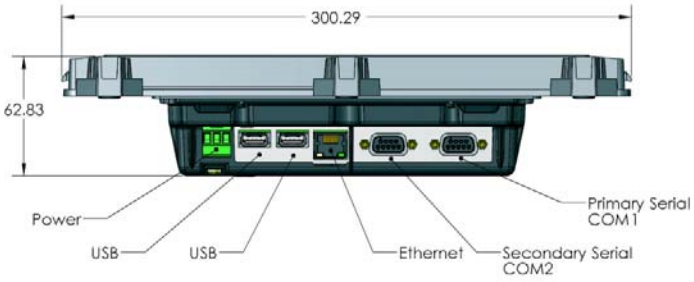


Figure 11
Modular QTERM-A12 Bottom View (units: mm)

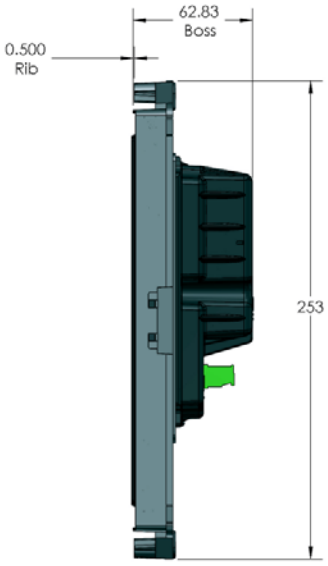


Figure 12
Modular QTERM-A12 Side View (units: mm)

7.2 Connector Pinouts

7.2.1 Primary Serial Port

CAUTION

For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The following table shows the pinouts for each type of serial interface on the primary serial port.

Pin	EIA-232	EIA-422	EIA-485
1	—	—	—
2	TX	TX-	RTX-
3	RX	RX+	—
4	—	—	—
5	Ground	Ground	Ground
6	—	—	—
7	CTS (in)	RX-	—
8	RTS (out)	TX+	RTX+
9	Power In	Power In	Power In

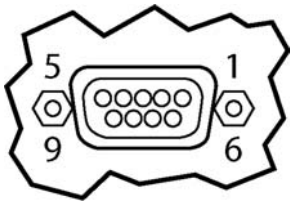


Figure 13
Female DB9 Connector

Power can be supplied to the terminal through pin 9 and ground return through pin 5 of the primary serial port connector.

WARNING

Although the terminal includes protection circuitry to prevent power supply contention, power should not be simultaneously connected to both the 3-pin terminal strip and the primary DB9 connectors.

WARNING

QTERM-A12 power must come from an SELV (Safety Extra Low Voltage) power source and should have a current limit on its output of 5 Amperes. It must provide a minimum of 10 volts DC power and be limited to a maximum of 32 volts DC. Limiting may be inherent to the supply or may be provided by supplementary overcurrent devices. If the QTERM-A12 does not respond or exhibits abnormal behavior on power up, disconnect power and contact Beijer Electronics for technical support.

7.2.2 Secondary Serial Port

CAUTION

For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The secondary serial port on the QTERM-A12 is configured as EIA-232 only with hardware or software handshaking. The pins are defined below.

Pinout Table	
1	—
2	TX
3	RX
4	—
5	Ground
6	—
7	CTS (in)
8	RTS (out)
9	—

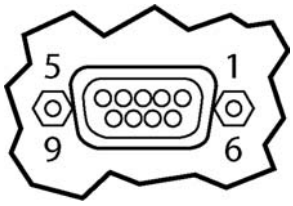


Figure 14
Female DB9 Connector

7.2.3 Terminal Strip for Power Input

CAUTION

For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The 3-pin terminal strip is used to provide input voltage and ground to the terminal. The terminal strip provides a chassis ground connection. The chassis ground pin is isolated from the system ground of the terminal.

Pin	Function
1	Power
2	Ground
3	Chassis GND

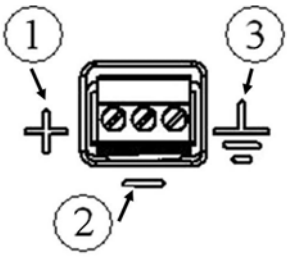


Figure 15
3-Pin Power Connector

7.2.4 Ethernet Port

CAUTION

For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The Ethernet port has a standard 10/100Base-T interface with an 8-pin (RJ-45) modular jack connector. The connector orientation and pinout table are shown below. For PoE pinout information please refer to section 3.4, “Optional Power-over-Ethernet Interface”.

Pinout Table	
1	TX+
2	TX-
3	RX+
4	—
5	—
6	RX-
7	—
8	—

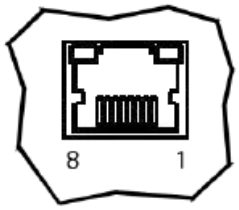


Figure 16
RJ-45 Connector

7.2.5 USB 2.0 Ports

CAUTION

For Class I, Division 2 installations:
The USB ports are for operational maintenance only. Do not leave USB devices permanently connected unless the area is known to be non-hazardous.

CAUTION

For Class I, Division 2 installations:
Do not connect or disconnect cables while power is applied unless the area is known to be non-hazardous.

The QTERM-A12 includes two USB 2.0 full-speed ports. The connector orientation and pinout table are shown below.

Pinout Table	
1	VCC (+5 VDC)
2	Data -
3	Data +
4	Ground

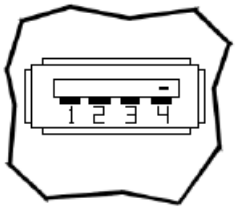


Figure 17
USB Connector

Notes

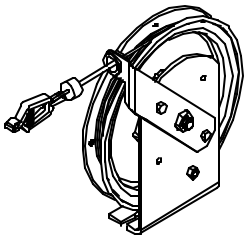
MALABAR™
INTERNATIONAL
A TRONAIR COMPANY

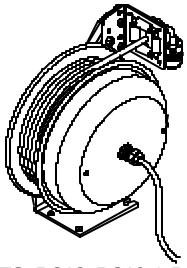
APPENDIX VII

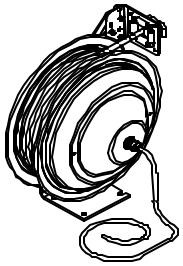
Cox Ground Reel

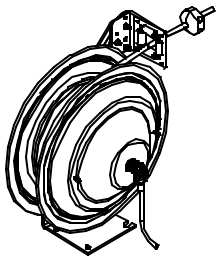
INSTALLATION AND MAINTENANCE MANUAL

SPRING RETRACTABLE CORD AND CABLE REELS:
SERIES: SD, PC13, PC17, PC19, PC24, P-WC
(ADD "EZ" PREFIX FOR EZ-COIL™ MODELS IN EACH SERIES)


SERIES: SD


SERIES: PC13, PC19 & PC24


SERIES: PC17


SERIES: P-WC

READ THESE INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE, OR MAINTAIN THIS PRODUCT. ONLY QUALIFIED PERSONNEL SHOULD UNDERTAKE THE INSTALLATION AND COMMISSIONING OF THIS PRODUCT. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE.

▪ PERSONAL SAFETY

1.) Ensure reel has been properly installed before connecting supply line. Note: Reel should NOT be installed above 15 feet maximum from the floor.
2.) Before connecting reel to power supply be certain source is compatible with specifications of the reel.
3.) If reel was purchased without cable, thoroughly review the "Cable Installation" instructions to properly install cable.
4.) Perform "Operational Check" per instructions to ensure reel is operating properly. NEVER use a spring retractable reel that is not performing as intended.
5.) Inspect for frayed, worn, or lacerated cables prior to using reel.
6.) Always pull on cord/cable itself. Never pull on the attachment.

▪ MOUNTING OF REEL

1.) Reel is supplied with guide arm in standard positions depending on model.
   a.) Guide arm may be adjusted to desired location as shown in figure 1.0. Refer to figure 2.0 for Series SD models.
   b.) Pull out cable until reel latches.
   c.) Remove bolts holding guide arm to support base.
   d.) Reposition guide arm and securely fasten bolts.
2.) To mount reel to a solid structure you will need 7/16" M12 bolts, washers, and nuts. Masonry bolts may be used depending on mounting application. Mounting hardware is NOT provided. Mounting patterns will vary depending on model.
3.) Loosely fit two pieces of mounting hardware to ceiling/floor/or wall so that reel can be slid into position. Fit reel. Install two pieces of hardware in other end of reel. Securely fasten all bolts and nuts.

▪ OPERATIONAL CHECK

1.) Check reel for correct operation by slowly pulling out cable. A clicking noise will be heard after each half revolution of the drum.
2.) **LATCH** the reel. Pull out the cable and allow it to slightly retract after the first, second or third "click" is heard.
3.) **UNLATCH** the reel. Slowly pull the cable until the clicking noise stops, and then allow the cable to retract. The hose stopper should rest against the roller hose guide.

CAUTION: DO NOT ALLOW CABLE TO RETRACT WITHOUT RESTRAINING RECOIL SPEED. NEVER LET GO OF THE CABLE WHEN REWINDING. NOTE: EZ-COIL™ MODELS ARE DESIGNED TO RETRACT AT A SLOW CONTROLLED SPEED.

4.) Apply power to reel. Periodically check cable for improper wear.
5.) Reels are shipped with approximately three pre-wraps of tension. This is adequate for most applications. However, if your application requires more or less tension, see "Spring Tension Adjustment" instructions.
6.) Lubrication is NOT required.

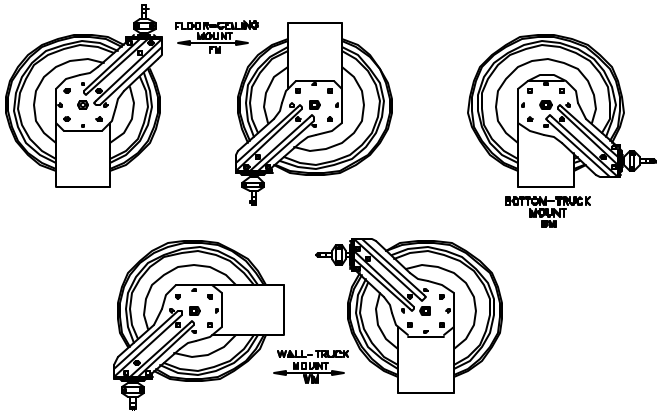


Fig. 1.0

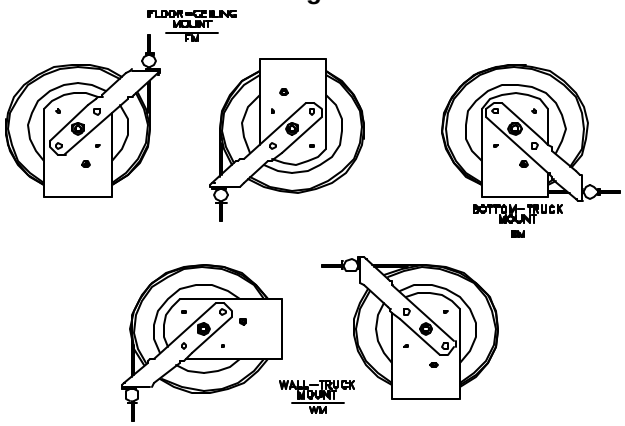


Fig. 2.0

▪ SPRING TENSION ADJUSTMENT

1.) Remove power from reel prior to making spring adjustments.
2.) Pull out approximately 6 feet (2m) of cable and latch the drum.
3.) Add or subtract one wrap of cable as desired to acquire the proper tension on the reel.

NOTE: Spring tension adjustment is accomplished by adding wraps of cable around the drum (to increase tension) or subtracting wraps of cable (to decrease tension).

CAUTION: Improper tensioning of spring or adding too many pre-wraps may cause damage to spring mechanism. Only authorized personnel should make adjustments.

4.) Unlatch drum and check for proper tension.
5.) Connect power source.

- **SPRING CANISTER REPLACEMENT (SD Series)**

1.) Pull out approximately 3 feet (1m) of cable and latch the reel.
2.) Release all spring tension by removing five wraps of cable from reel.
3.) Carefully unlatch the reel and **firmly hold the drum**. Allow the drum to **slowly** unwind until it stops.
4.) Remove two nuts from spring cartridge. (See figure 3.0)
5.) Pull spring cartridge off center axle shaft.
6.) Reverse above procedure to re-assemble.
7.) Re-tension the reel by turning the drum three complete turns and latching in place. Follow "Spring Tension Adjustment" procedure.

- **SPRING CANISTER REPLACEMENT (P-WC Series)**

1.) Pull out approximately 3 feet (1m) of cable and latch the reel.
2.) Release all spring tension by removing five wraps of cable from reel.
3.) Carefully unlatch the reel and **firmly hold the drum**. Allow the drum to **slowly** unwind until it stops.
4.) Remove input cable from reel. Remove cover. (See figure 4.0)
5.) Remove two spring canister mounting nuts from opposite side of drum assembly.
6.) Pull spring canister off drum shaft.
7.) Reverse above procedure to re-assemble.
8.) Re-tension the reel by turning the drum three complete turns and latching in place. Follow "Spring Tension Adjustment" procedure.

- **SPRING CANISTER REPLACEMENT (PC Series)**

1.) Pull out approximately 3 feet (1m) of cable and latch the reel.
2.) Release all spring tension by removing five wraps of cable from reel.
3.) Carefully unlatch the reel and **firmly hold the drum**. Allow the drum to **slowly** unwind until it stops.
4.) Remove the input strain relief cap. Remove two acorn nuts to take off cover.
5.) Refer to figures 5.0 or 6.0, depending on PC model, to become familiar with components before performing the following steps.
6.) Disconnect wires at wire nuts. Remove inlet port from the main axle. (This step applies to PC13, PC19 & PC24 models only).
7.) Remove two coupling nuts located on the electrical mounting plate. Allow the electrical assembly to swing out of the way.
8.) Remove two spring canister mounting nuts from opposite side of drum assembly.
9.) Pull spring canister off drum shaft.
10.) Reverse above procedure to re-assemble.
11.) Re-tension the reel by turning the drum three complete turns and latching in place. Follow "Spring Tension Adjustment" procedure.

CAUTION: Disconnect from power source prior to making any repairs or adjustments to the reel.

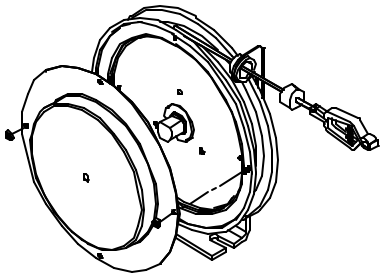


Fig 3.0 (SD Reel)

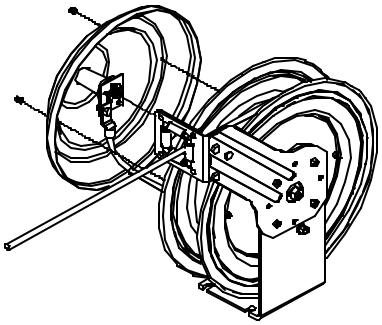


Fig 4.0 (P-WC Reel)

- **SLIP RING BRUSH REPLACEMENT (P-WC Series)**

1.) Disconnect power source.
2.) Remove input cable from reel. Remove cover. See figure 4.0
3.) Remove brush retaining nut to access worn brushes.
4.) Replace with new copper brushes.
5.) Reverse above procedure to re-assemble reel.

- **SLIP RING BRUSH REPLACEMENT (PC Series)**

1.) Disconnect power source.
2.) Remove input strain relief cap. Remove cover. See Figures 5.0 or 6.0 depending on model.
3.) Disconnect brush from wire and remove spring finger (PC13, PC19 & PC24 models only).
4.) Remove brush retaining bolt and remove brush (PC17 model only).
5.) Reverse above procedure to re-assemble.

INSTALLATION / REPLACMENT OF CABLE (SD AND P-WC SERIES)

Installation of Cable

1. Securely stabilize the reel.
2. Wind the Reel Drum clockwise (facing the Spring Cartridge 1) until the spring is tight.
3. **Use Extreme Caution!** Back off approximately two turns and lock the Reel Drum from rotating.
4. Insert the fitted end of the cable through the cable Guide Arm and through the cut-out in the Drum.
5. The cable fitting should now be on the inside of the Drum connect cable to the existing bolt.
6. **CAREFULLY** release the Locking Ratchet and **SLOWLY** allow the cable to retract onto the Reel.

Note: Final Spring Tension Adjustment is accomplished by adding wraps of Cable around the Drum (to increase tension) or subtracting wraps of Cable (to decrease tension).

Replacement of Cable

1. Securely stabilize the Reel
2. Pull out all the Cable and lock the Reel in that position.

Caution: Make sure Reel is securely locked and will not rotate back.

3. Carefully disconnect Cable from inside of Reel and remove old Cable.
4. Remove Cable Stopper from old cable and fit these parts to the new Cable in the same position.
5. Feed new Cable fitted end through the Guide Arms and through the cut-out slot on the Drum.
6. The fitting should now be on the inside of the Drum to allow you to reconnect the cable to the reel.
7. **CAREFULLY** release the Locking Ratchet and **SLOWLY** allow the hose to retract onto the Reel.

Note: Final Spring Tension Adjustment is accomplished by adding the wraps of Hose around the Drum (to increase tension) or subtracting wraps of Hose (to decrease tension).

Instructions for Replacement of Lead-in or Output Cable on PC Reels

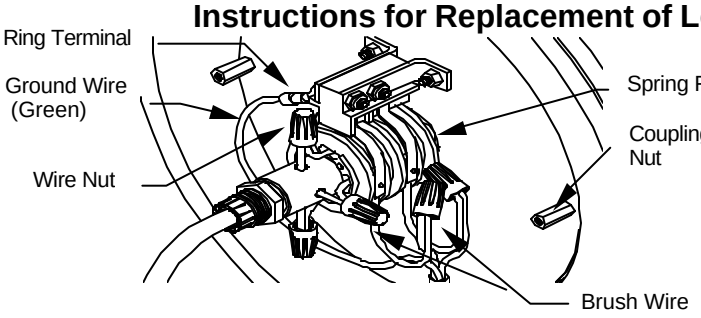


Fig 5.0 (PC13, PC19 & PC24 Models)

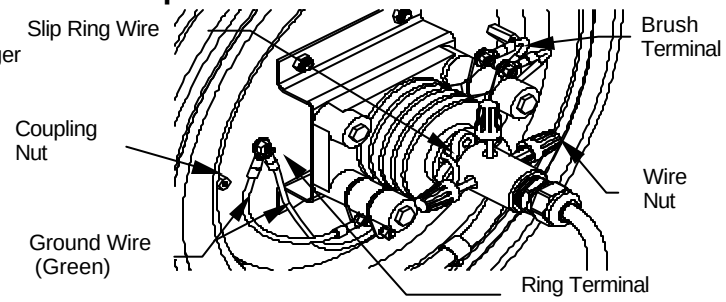


Fig 6.0 (PC17 Model)

Replacement of Output Cable

1. Disconnect power source.
2. Wind the Reel Drum clockwise (facing the cover) until the Spring is tight.
3. **Use Extreme Caution!** Back off approximately two turns and lock the Reel Drum from rotating.
4. Remove Input Strain Relief Cap. Remove Cover.
5. Disconnect existing Output Cable Wires from Brushes & Ground, remove Cable Clamps/Strain Relief bushing and remove Cable from Reel.
   Note: Be sure to note which wire goes to which Brush.
6. Insert the bare wire end of the Cable through the Four Roller Guide Arm and through the cut-out in the side of the Drum Flange.
7. The bare wire end should now be on the outside of the Drum. Secure the Cable using the Cable Clamps/Strain Relief Bushing allowing approximately 10" of Cable through second Clamp/Bushing.
8. Attach Ring Terminal to the Green Wire on the Output Cable and secure to Stud Post. Connect other wires, by color, to their respective Brush. *(Wire path must begin and end with the same color.)*
9. Install Cover and replace input strain relief cap.
10. **CAREFULLY** release the Locking Ratchet and **SLOWLY allow the Cable to retract onto the Reel.**

Note: Final Spring Tension Adjustment is accomplished by adding wraps of Cable around the Drum (to increase tension) or **subtracting wraps of Cable (to decrease tension).**

Replacement of Lead-In Cable

1. Disconnect power source.
2. Remove Input Strain Relief Cap. Remove Cover.
3. Disconnect existing Lead-in Cable Wires from Slip Rings and remove Lead-in Cable. **Note: Be sure to note which wire goes to which Slip Ring.**
4. Strip insulation from Cable approximately 2" from Cable end, exposing the individual wires.
5. Thread Cable through Strain Relief Cap, Strain Relief, Cover and Inlet Port, respectively. Thread each wire through the holes provided in the Inlet Port.
6. Connect wires to Slip Rings using Wire Nuts. *(Wire path must begin and end with the same color.)*
7. Install Cover and secure in place.
8. Replace Input Strain Relief Cap.

Instructions For Installation of Input & Output Cable On PCL "Less Cable" Models

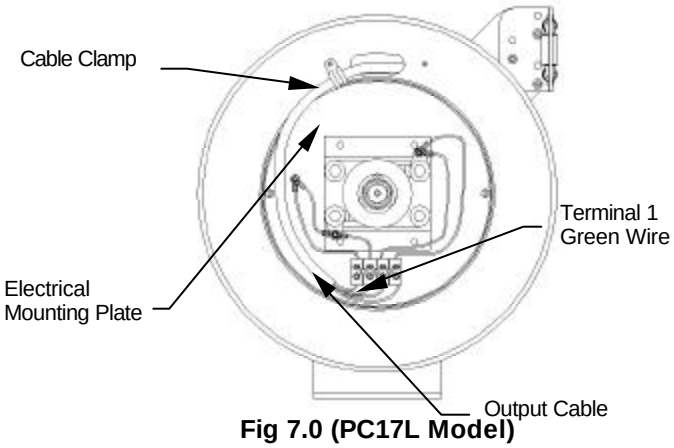


Fig 7.0 (PC17L Model)

Installation of Output Cable

1. Remove Input Strain Relief Cap. Remove Cover.
2. Wind the Reel Drum clockwise (facing the cover) until the Spring is tight.
3. **Use Extreme Caution!** Back off approximately two turns and lock the Reel Drum from rotating with the terminal block in the down position.
4. Insert the bare wire end of the cable through the four roller guide arm and through the cut-out in the side of the drum flange.
5. The bare wire end should now be on the outside of the Drum. Secure the Cable using the Cable Clamps allowing approximately 10" of Cable through second Clamp.
6. Insert the bare wire ends of the output cable into the bottom side of the terminal strip. Connect wires to ground and Brush Terminals, by color, their respective Brush. Connect the green ground wire to terminal 1 on left *(Wire path must begin and end with the same color).* Connect the b wire to terminal 2, the white to terminal 3 and the red (if used) to termina

Installation of Lead-In Cable

Note: Slip ring is pre-wired to terminal block at factory.

1. Remove Input Strain Relief Cap. Remove Cover.
2. Strip insulation from new Cable approximately 2" from Cable end, exposing the individual wires.
3. Thread Cable through Strain Relief Cap, Strain Relief, Cover and Inlet Port, respectively. Thread each wire through the holes provided in the Inlet Port.
4. Connect lead-in wires to slip rings wires using Wire Nuts. *(Wire path mus begin and end with the same color.)* Connect the green wire to lead 1,th black to lead 2, the white to lead 3 and the red (if used) to lead 4.
5. Use a meter to verify that the wires of each circuit are the same color o the input and output cables.
6. Install Cover and secure in place. Replace strain relief.
7. **CAREFULLY** release the Locking Ratchet and **SLOWLY** allow the Cable to retract onto the Reel.

TROUBLE SHOOTING GUIDE

TROUBLE	CAUSE	REMEDY
CABLE WILL NOT FULLY RETRACT	a) Outlet attachment is too heavy. b) Spring is fatigued. c) Field installed cable is too long.	a) Add spring tension. See "Spring Tension Adjustment". b) Add spring tension. See "Spring Tension Adjustment". Replace Spring Canister if required. c) Call local Distributor for correct specified cable length.
CABLE WILL NOT RETRACT AT ALL	Spring has lost all tension or has possibly broken.	a) Reinstall Spring Tension b) Replace Spring Canister. See "Spring Canister Replacement".
REEL WILL NOT LATCH	a) Incorrect operation. b) Dog spring or locking cam is broken or worn.	a) Reel latches on first, second, third or fourth "click". After forth "click" it automatically rewinds. b) Replace dog spring or locking cam.
NO ELECTRICAL POWER AT OUTPUT END OF CABLE.	a) Wires are severed. b) Wires have become disconnected. c) Slip ring / brushes are worn	a) Replace entire cable. See instructions. b) Check all connections ensuring they are properly wired. c) Replace slip ring / brushes. See instructions.
BREAKER OR FUSE REPEATEDLY BLOWN.	a) Application does not conform to the electrical rating of the reel. b) Wires are broken or shorted. c) Field installed cable was not wired properly.	a) Check electrical rating on reel label. Do not attempt to use a reel that is not rated properly for the application. b) Check wiring path on reel to determine if wires are broken or shorted. Correct problem. See instructions for wiring. c) Review wiring. See instructions to correct problem.
CABLE REEL IS NOT PROVIDING ADEQUATE GROUND (SD REELS)	a) Cable or reel has become damaged or worn. b) Cable or reel was not installed properly.	a) Review ground path and correct problem. Use meter to inspect. b) Review installation procedure and correct problem. Note: Do not use reels until a proper ground is provided.
REEL RETRACTS TOO FAST (EZ-COIL MODELS ONLY)	a) Reel is improperly tensioned. b) EZ-Coil unit is defective.	a) Decrease spring tension. See “Spring Tension Adjustment”. b) Replace EZ-Coil unit. Note: When weather is extremely hot, reel will operate slightly faster than under normal conditions. This function is normal.
CABLE LOCKS UP WHEN FULLY EXTENDED	Cable clamp is in the incorrect position.	Relocate cable clamp to optional location.

WARNING:

Use extreme caution when operating or servicing electrical cable reels. Personal injury or death can occur even under low voltage! Only qualified service technicians should troubleshoot and repair these products.

Observe all applicable NEC, OSHA, and local codes when operating or installing these products.

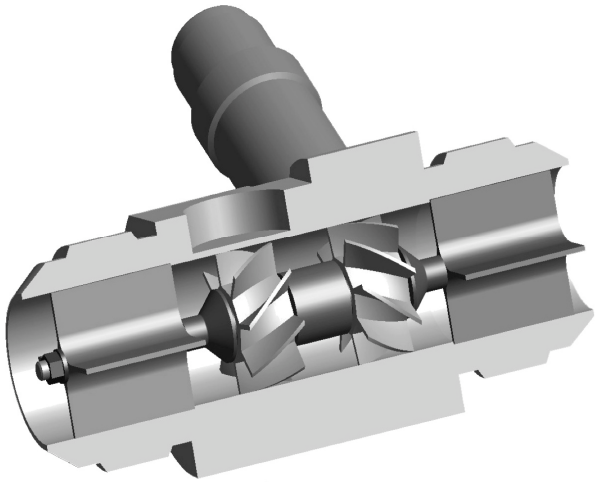
MALABAR™
INTERNATIONAL
A TRONAIR COMPANY

APPENDIX VIII

Exact Flow
Dual Rotor Turbine Flow Meter

15555 North 79th Place
Scottsdale, AZ 85260
Main Office: 480-948-3789
www.exactflow.com

Turbine Flow Meter
Installation and Operation Manual



This IOM applies to the following Exact Flow Turbine Flow Meters series:

EFM SR, EFM DR, EFM ER, DX, DL

EXPM-0002-09-A
www.exactflow.com
www.flow-dynamics.com

Flow Dynamics Inc.
15555 N 79th Place
Scottsdale, AZ, 85260

TABLE OF CONTENTS

MANUFACTURER'S NOTICE 1

LIMITED WARRANTY POLICY 2

1) INTRODUCTION 3

1.1) PRINCIPLE OF OPERATION 3

1.2) MATERIAL SELECTION AND CONSTRUCTION 4

1.3) FLUID CONSIDERATIONS 6

2) GENERAL INSTALLATION PROCEDURE 6

2.1) SINGLE ROTOR TURBINE METER INSTALLATION 6

2.2) DUAL ROTOR TURBINE METER INSTALLATION 7

2.3) VALVES & PIPING 7

2.4) CALIBRATION 8

3) PREVENTATIVE MAINTENANCE 9

3.1) BEARING REPLACEMENT 10

4) TROUBLESHOOTING 10

4.1) RECOMMENDED SPARE AND REPLACEMENT PARTS 12

APPENDIX A – ADDITIONAL INFORMATION 13

MANUFACTURER'S NOTICE

Exact Flow makes no warranty of any kind with regard to this written material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

This manual has been provided as an aid in installing, connecting, calibrating, operating, and servicing this unit. Every precaution for accuracy has been taken in the preparation of this manual; however, Exact Flow neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with information contained in this manual.

Exact Flow policy is to provide a user manual for each item supplied. Therefore, it is recommended that all applicable user manuals be examined prior to attempting to install or otherwise connect a number of related subsystems.

During installation, care must be taken to perform the correct interconnecting wiring. Failure to follow correct interconnection diagrams may result in damage to the system and/or one of the components.

Please review the complete model number of each item to be connected and locate the appropriate manual(s) and/or drawing(s). Identify all model numbers exactly before making any connections. A number of options and accessories may be added to the main instrument, which is not shown on the basic user wiring. Consult the appropriate option or accessory user manual before connecting it to the system. In many cases, a system wiring drawing is available and may be requested from Exact Flow.

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Exact Flow policy is to make improvements when technology becomes available. This affords our customers the cutting edge in technology and engineering for the highest quality solutions possible. For this reason, information contained in this document is subject to change without notice.

This warranty is expressly in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose. Exact Flow shall not be liable for any loss or damage resulting, directly or indirectly, from the use or loss of use of the goods. Without limiting the generality of the foregoing, this exclusion from liability embraces the purchaser's expenses for downtime or for making up downtime, damages for which the purchaser may be liable to other persons, damages to property, and injury to, or death of, any persons. Exact Flow neither assumes nor authorizes any person to assume any other liability in connection with the sale or use of Exact Flow's goods, and there are no oral agreements or warranties collateral to or affecting the agreement. Purchaser's sole and exclusive remedy is the repair and/or replacement of nonconforming goods as provided in the preceding paragraphs. Exact Flow shall not be liable for any other damages whatsoever including indirect, incidental, or consequential damages.

Flow Dynamics Inc.
15555 N 79th Place
Scottsdale, AZ, 85260

LIMITED WARRANTY POLICY

Exact Flow warrants the EFM SR/EFM DR/EFM ER/DX/DL series of turbine flow meters to be free from defects in material and workmanship under normal use and service, only if such goods have been properly selected for the service intended, properly installed and properly operated and maintained as described in the turbine flow meter manual. Reference: "turbine flow meter manual" for specific details. This warranty shall extend for a period of one (1) years from the date of shipment to the original purchaser. This warranty is extended only to the original purchaser ("Purchaser"). Purchaser's sole and exclusive remedy is the repair and/or replacement of nonconforming goods as provided in the following paragraphs.

In the event Purchaser believes the Exact Flow product is defective, the product must be returned to Exact Flow, transportation prepaid by Purchaser, within the appropriate warranty period relative to the product. If Exact Flow inspection determines that the workmanship or materials are defective and the required maintenance has been performed and, has been properly installed and operated, the product will be either repaired or replaced, at Exact Flow sole determination, free of additional charge, and the goods will be returned, transportation paid by Exact Flow, using a transportation method selected by Exact Flow.

Prior to returning the product to Exact Flow, Purchaser must obtain a Returned Material Authorization (RMA) Number from Exact Flow's Customer Service Department within 30 days after discovery of a purported breach of warranty, but not later than the warranty period; otherwise, such claims shall be deemed waived. See the Return Requests/inquiries Section of this manual.

If Exact Flow's inspection reveals the Exact Flow product to be free of defects in material and workmanship or such inspection reveals the goods were improperly used, improperly installed, and/or improperly selected for service intended, Exact Flow will notify the purchaser in writing and will deliver the goods back to Purchaser upon receipt of Purchaser's written instructions and agreement to pay the cost of transportation. If Purchaser does not respond within thirty (30) days after notice from Exact Flow, the goods will be disposed of in Exact Flow's discretion.

Exact Flow does not warrant the product to meet the requirements of any safety code of any state, municipality, or other jurisdiction, and Purchaser assumes all risk and liability whatsoever resulting from the use thereof, whether used alone or in combination with other machines or apparatus.

This warranty shall not apply to any Exact Flow product or parts thereof, which have been repaired outside Exact Flow's factory or altered in any way, or have been subject to misuse, negligence, or accident, or have not been operated in accordance with Exact Flow's printed instructions or have been operated under conditions more severe than, or otherwise exceeding, those set forth in the specifications.

FOR **NON-WARRANTY** REPAIRS OR **CALIBRATIONS**, consult Exact Flow for current repair/calibration charges. Have the following information available BEFORE contacting Exact Flow:

1. P.O. number to cover the COST of the repair/calibration,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

1) INTRODUCTION

Thank you for your purchase of an Exact Flow Turbine Flow meter to fulfill your flow measurement requirements. These meters have been designed and manufactured to the highest quality standards to provide you with the best possible performance for your flow measurement requirements. This manual is intended as an installation and operation guide. Please consult the factory or our website if you have any questions or concerns regarding any of the equipment or installation.

1.1) PRINCIPLE OF OPERATION

The turbine meter is a volumetric type measuring device with only one moving part, the rotor or impellor. The rotor is turned by the impingement of the metered fluid on the rotor blades as the fluid travels through the flow meter. As fluid velocity increases through the meter, the rotor rotation speed increases. Therefore, the flow rate is proportional to the speed of the rotor or the frequency of the rotor blades passing the external pickoff. The pickoff located directly over the rotor senses each individual rotor blade passing. This produces a sine wave signal which is sent to electronic signal conditioners or flow computers. The performance of any turbine flow meter is affected by three forces which can cause the output signal to become non-linear: bearing friction, viscous drag, and magnetic drag (from magnetic type pickoffs). Bearing friction is minimized by using exceptionally high quality ball bearings. Viscous drag, which is a function of the metered fluid, cannot be eliminated. Magnetic drag can be eliminated by the use of a modulated carrier (RF) pickoff. Bearing friction and viscous drag are accounted for by calibrating the flow meter on a primary standard positive displacement liquid flow meter calibrator.

The above principles of operation apply to all turbine type flow meters. The patented dual rotor design eliminates many of the problems associated with traditional single rotor designs. The hydraulic coupling of the two rotors reduces the fall-off of the meter's output frequency at low flow rates extending the usable range. Additionally, swirl at the meter inlet, which causes a significant inaccuracy in a single rotor meter, is largely canceled by summing the counter-rotating rotor signals. When using flow straighteners, diagnostic checking of the frequency ratio between the two rotors can be used to determine the bearing health and changes in the accuracy of the flow meter. The dual rotor allows for a much larger turn down ratios, improved UVC measurement range, exceptional repeatability and reduces the need for flow straightening prior to entering and exiting the flow meter.

1.2) MATERIAL SELECTION AND CONSTRUCTION

Stainless steel is the standard material choice for Exact Flow turbine flow meters. Specific grades are utilized for components based upon their performance requirements. Specialized material choices are also available based on media compatibility and manufacturing cost. Please consult Exact Flow Sales for questions regarding unique applications and recommended material selections.

The Exact Flow rotor was designed with minimal mass to allow for rapid response time to variation in flow rate. This affords excellent performance in transient or pulsating flow conditions. The Exact Flow rotor utilizes dual ball bearings to eliminate rotor wobble which improves meter performance and offers extended bearing life. The bearings are typically the only maintenance item in a turbine flow meter and must be periodically replaced. Bearing wear is inherent in flow meter usage and is increased with fluid contamination. Bearing life is inversely proportional to the square of the bearing speed. For example, if the flow meter is used at 40% of the maximum flow rate, the bearings will wear at approximately 16% of the maximum rate.

To prolong the life of a flow meter, it is recommended to select a size that allows continuous operation at less than the maximum flow rate.

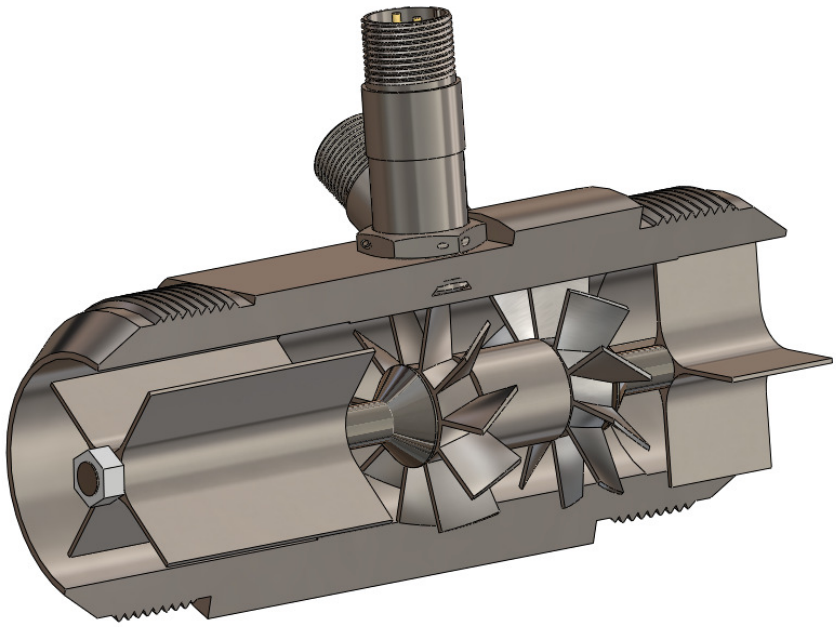


Figure 1 –Exact Flow Meter Section View

The Exact Flow design utilizes a tie-bolt concept where the rotor(s) are suspended in the housing on common stem. The stem is threaded into the downstream flow straightener except for on the -4 and -6 sizes where it is captured on both ends with a nut. Stem nuts are held in place with high temperature locking compound. The Exact Flow turbine flow meter does not contain snap rings or retaining rings which can be dislodged by shock or vibration.

The flow meter pickoff (also called pickup) senses the motion of the rotor and produces a sine wave signal to be amplified by electronic signal conditioners. There are two main types of pickoff: magnetic and modulated carrier.

A magnetic pickoff has an internal magnet generating a field through which the ferromagnetic rotor blade passes. When this occurs, the field is disrupted and a sine wave is produced on the pickoff output. As the frequency and amplitude of the signal is directly proportional to the rotational speed of the rotor, each blade passing by the pickoff is counted as a 'pulse'. These pulses are utilized for flow measurement calculations. A preamplifier is not typically required for this type of pickoff unless mandated by the data collection system requirements. Magnetic pickoffs have two limitations. The first is the drag imparted upon the rotor by the magnet. This is most evident at low flow rates and has a greater magnitude of effect on smaller size meters. The second is that each magnetic pickoff has a specific signature and cannot be replaced without recalibrating the flow meter.

A modulated carrier frequency pickoff (also known as RF) is an active coil which produces a high frequency signal. The passing of each rotor blade modulates this signal, thereby creating a sine wave. Through filtering, shaping, and amplifying, each pulse can be isolated and utilized for flow measurement calculations. A signal conditioner or flow computer is required. The benefit of using an RF pickoff is that there is no magnetic drag involved and thus very wide flow ranges can be attained. RF pickoffs are not signature specific and can be field replaced without the need for recalibration.

The DX & DL series of flow meters utilize an RF pickoff that is not field replaceable. The low profile design of these meters requires a specialized potted pickoff that must be returned to Exact Flow if it requires service or replacement. This type of embedded pickoff is vibration resistant and minimizes the size of the flow meter envelop.

WARNING: Do not remove the pickoff while the meter is under pressure! The metal diaphragm separating the pickoff from the fluid stream may be deformed causing permanent damage!

1.3) FLUID CONSIDERATIONS

Turbine flow meters have miniature ball bearings upon which the rotor turns. These bearings have extremely precise tolerances and are sensitive to contamination. It is recommended that 10 micron filtration be installed upstream of the flow meter and routinely serviced as part of the preventative maintenance schedule for the metering installation. A strainer should be located ahead of the flow straightener or flow meter if flow straighteners are not used.

2) GENERAL INSTALLATION PROCEDURE

Upon receipt of the turbine flow meter a visual inspection should be performed checking for any indications of damage, which may have occurred during shipment. Inspect all packing material carefully to prevent the loss of meter parts or auxiliary components, which may have been packed with the shipment. Refer to the packing list/invoice for a detailed list of items included in the shipment.

The meter housing is marked by a flow direction arrow. The meter must be installed in the piping in the correct orientation to ensure the most accurate and reliable operation. Care must be taken in the proper selection of the mating fittings and the size, type of material, and pressure rating dictated by the process piping system and the flow meter maximum pressure rating. The correct gaskets and bolts per the applicable code must be utilized. When it is expected that flow will be intermittent, the meter should not be mounted at a low point in the piping system. Solids which settle or congeal in the meter will affect meter bearing performance. In order to achieve optimum electrical signal output from the flow meter, due consideration must be given to its isolation from ambient electrical interference such as nearby motors, transformers, and solenoids.

2.1) SINGLE ROTOR TURBINE METER INSTALLATION

As stated in the Principle of Operation, the fluid moving through the flow meter engages the rotor. If swirl is present in the fluid ahead of the meter it can change the effective angle of engagement and, therefore, cause a deviation from the supplied calibration (performed under controlled flow conditions). Single rotor turbine meters require flow straighteners having a minimum straight run of pipe approximately 10 pipe diameters ahead of the inlet and 5 pipe diameters following the outlet. Proper installation of the flow meter minimizes the negative effects of fluid swirl.

2.2) DUAL ROTOR TURBINE METER INSTALLATION

Exact Flow's patented approach uses two closely coupled rotors, turning in opposite directions. The flow exiting from the first rotor greatly affects the inlet incidence angle on the rear rotor. The two rotors now become hydraulically coupled. Swirl conditions on the first rotor will have an opposite effect on the second rotor. This means that if the front rotor slows down, due to swirl effect, the rear rotor will speed up by the same percentage. The inverse is also true. If the front rotor speeds up, the rear rotor will slow down. The sum (or average) of the two rotors is constant, regardless of swirl effects on rotor RPM. Therefore, flow straighteners are not required in most applications, making it possible to install the flow meter in tight spaces where the added length of piping cannot be tolerated.

2.3) VALVES & PIPING

Blocking or isolation valves and a bypass loop should be installed at each end of the flow meter in order to perform preventative maintenance without shutting down the system completely. If installation conditions will not permit a bypass loop, a 'dummy' flow meter housing or spool should be purchased to replace the flow meter during maintenance and periodic recalibration.

Thermowells for temperature sensing should be installed down stream of the flow meter.

WARNING: It is important that all flow lines be purged of foreign objects and debris prior to installing a flow meter to avoid bearing contamination or rotor damage. Do not purge lines with the flow meter installed or irreparable damage is highly likely to occur.

It is critical to avoid over-spinning the meter (operating at greater than the maximum flow rate). Always select a meter sized appropriately for your application. Entrained vapor or gaseous state product in the metered fluid piping can also cause the rotor to over-spin resulting in bearing damage. Necessary precautions must be made by the end user to address these two situations.

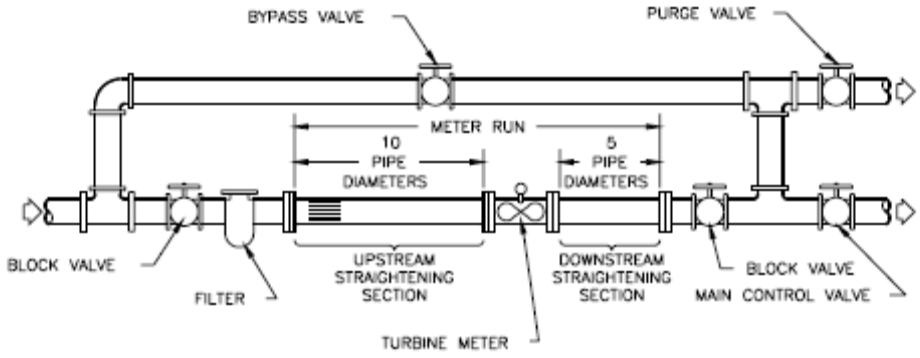


Figure 2 – Recommended Flow Meter Installation

Flow meters with threaded end fittings (NPT or AN) should not be over tightened when installed into the flow line. This can deform the end fitting of the flow meter resulting in sealing issues and problems in performing routine maintenance. Stainless steel is relatively soft and can be damaged if not handled with care. Liquid pipe thread sealant is recommended for pipe thread applications as Teflon tape often is pulled into the flow stream, thereby contaminating the rotor bearings. Copper crush washers are recommended for use in AN style fittings to protect the sealing surface but are not mandatory to attain a seal.

Flow straighteners can be manufactured with stainless steel B-nuts. The flow meter housing is typically manufactured from stainless steel. It is imperative that anti-seize be utilized in this case to prevent galling and permanent, irreparable damage to both items.

In order to obtain accurate flow measurement, sufficient downstream pressure is required to prevent flashing and/or cavitation. The minimum downstream pressure is calculated using the following equation:

$Pressure_{Minimum}$ = (Fluid Vapor Pressure x 1.25) + (Pressure Drop x 2)

Downstream pressure should be adjusted using a control valve located downstream of the metering assembly.

2.4) CALIBRATION

Flow meter calibrations should always be performed on a primary standard calibrator. Turbine flow meters are a viscosity sensitive device and should always be calibrated for the specific application viscosity range using the correct calibration fluid.

A flow measurement application with a variable viscosity should always utilize a Universal Viscosity Curve (UVC) flow meter calibration. The UVC uses data from two or more different viscosity calibrations to provide a blended data curve across the application viscosity range. This UVC data, including fluid properties, are then programmed into a flow computer. The flow computer can then compensate for the viscosity shift due to temperature changes encountered and provide an accurate linearized output.

CAUTION: It is important for the calibration of the flow meter to match the application fluid conditions in order for accuracy, uncertainty, and repeatability metrics to be achieved.

All original calibrations of Exact Flow meters are performed by Flow Dynamics; a NVLAP accredited calibration lab certified to ISO 17025 & ANSI Z540. It is highly recommended that the flow meter be returned to Flow Dynamics for subsequent recalibrations in order to maintain performance standards. This will also eliminate any bias between calibration labs that might appear as a calibration shift.

Flow Dynamics is a major, independent, primary standard flow calibration laboratory, supplying both manufacturers and end users with dependable calibration results. Throughout global metrology industry, they are recognized as the calibration-lab-of-choice for customers demanding high-accuracy flow meter calibrations traceable to the most rigorous international standards.

Flow Dynamics is also the world's largest manufacturer of full-featured flow meter calibration equipment, offering a proven line of liquid positive displacement calibrators ranging from 10 GPM to 400 GPM.

Flow Dynamics is dedicated to the science of metrology, and has earned the trust of both government agencies and leading industrial manufacturers. We understand there is no substitute for accuracy and traceability when it comes to ensuring the performance of critical flow measurement equipment.

3) PREVENTATIVE MAINTENANCE

Bearings are the only wear item a turbine flow meter. The bearings should be periodically replaced due to normal, in-service wear. Failure to periodically service the bearings will result in inaccurate readings. Generally, replacing the bearing will return the meter to its original calibration, however, new bearings can be defective and rotor blade wear will also shift the calibration. Therefore, turbine flow meters should never be returned to service after a bearing change until they have been calibrated using a primary standard flow meter calibrator.

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15555 N 79th Place
Scottsdale, AZ, 85260

3.1) BEARING REPLACEMENT

It is highly recommended to have bearing replacement performed by the factory. Bearing changes are technically simple but can become very costly and time-consuming if performed incorrectly. Additionally, bearing changes mandate recalibration in order to maintain accuracy due to variances in bearing performance. By returning the meter to the factory, you guarantee receiving the fastest, most economical service combined with the correct and current calibration for your application.

Simple visual inspection is the only other preventative maintenance to be performed. Periodically inspect the flow meter housing for signs of damage, wear, or fatigue failure (stress cracking, specifically on flanged series). Leaks from fluid connections are important to catch in order to maintain accuracy and to prevent contamination of the environment. It is important to regard the flow meter as both pipe work and instrumentation when defining the preventative maintenance schedule.

The signal output system should be periodically checked while inspecting for environmental deterioration. Allowing the connectors and cabling to degrade can adversely affect the quality of the output signal, which may cause data acquisition system issues.

The frequency of inspection and maintenance is application specific. As the environment and application get harsher/dirtier, the frequency of inspection should be increased. Additionally, the criticality of the flow measurement should be considered including the ramifications of potentially incorrect indications.

4) TROUBLESHOOTING

The typical failure mode for a turbine flow meter is failure to provide an output indication of flow. Troubleshooting this condition can be divided in to two major sections: mechanical and electrical.

Mechanical items to check when there is a failure to indicate condition are:

- Is there flow present to the instrument?

  Confirm all isolation and/or bypass valves are in the correct orientation to provide a moving fluid stream to the unit. Spectacle blinds and other blocking devices must be removed in order to allow fluid to enter the meter and turn the rotor. Flange gaskets can also slip out of place during installation and block the flow stream.

- Is there foreign material blocking the rotor?

Debris or solids allowed to enter the flow meter can easily stop the rotation of the rotor. Purging of lines for construction debris should be performed with the instrument removed from the line. Remove the meter and remove all foreign bodies. Typical debris is Teflon thread tape, flux, rags and slug from the bottom of tanks. Anytime upstream pipe maintenance is preformed, there is a potential of bearing contamination or blockage.

- Has the internal assembly been damaged?

  Allowing solids to enter the meter or shocking the system with extreme pressurization variations can damage the internals assembly such that the rotor will no longer rotate. Remove the meter and gently blow air through the meter and verify if the rotor can freely move. Do not use high pressure air or further damage can result. If the rotor does not rotate freely under minimal input, contact the factory for repair.

Electrical items to check when there is a failure to indicate condition are:

- Is the pickoff or flow computer connected?

  The pickoff or flow computer must be connected to the data acquisition system in order for signal to be received. Often, a break is encountered in the cable run rather than at the connector.

- Is there power being supplied to the pickoff or flow computer?

  Several models of pickoff and all flow computers require supply power in order to operate. Please consult the applicable wiring diagram for your model and verify that supply voltage is present on the correct conductors at the correct pins.

- Has the electrical installation been done correctly?

  Many factors affect the electrical installation including power and signal cable proximity, shielding from adjacent electrical noise sources, proper grounding, amplifier gain settings, length of cabling runs, impedance matching of pickoff and amplifier or readout, shielding from excessive heat sources, and more. Each installation is unique and may require several iterations of troubleshooting to correct electrical issues. Exact Flow can assist in solving any issues that may arise, please contact Technical Support.

4.1) RECOMMENDED SPARE AND REPLACEMENT PARTS

Due to the calibrated nature of this instrument, it is not beneficial to maintain a stock of spare or replacement parts. If the application is critical and must not be offline for maintenance or periodic recalibration, it is highly recommended to stock a spare calibrated flow meter assembly.

APPENDIX A – ADDITIONAL INFORMATION

Figure A.1 - Single Rotor Exploded View (EFM SR series)

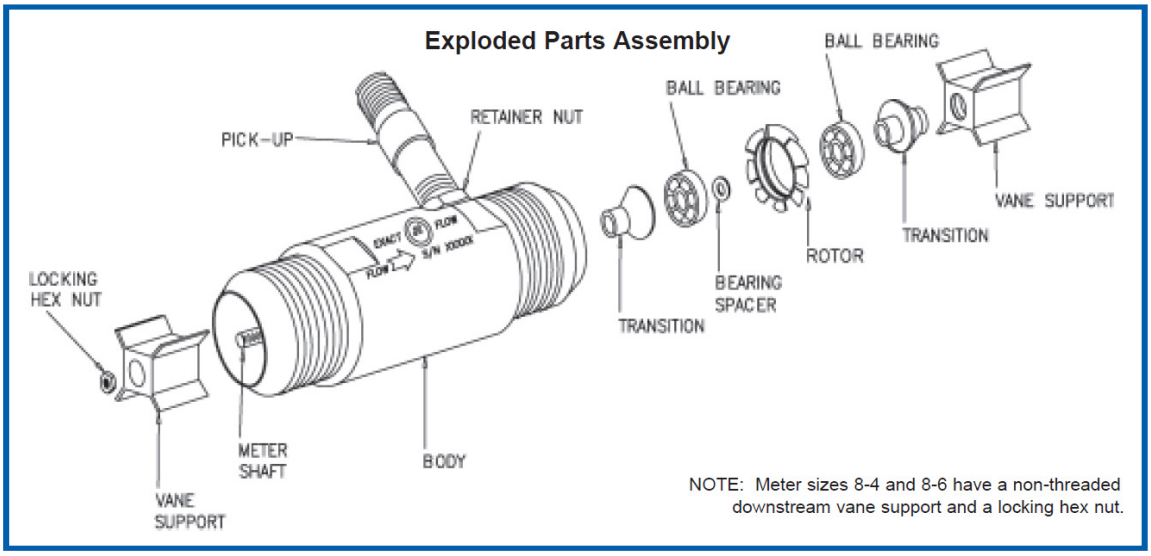


Figure A.2 – Dual Rotor Exploded View (DX, DL, EFM DR and ER series)

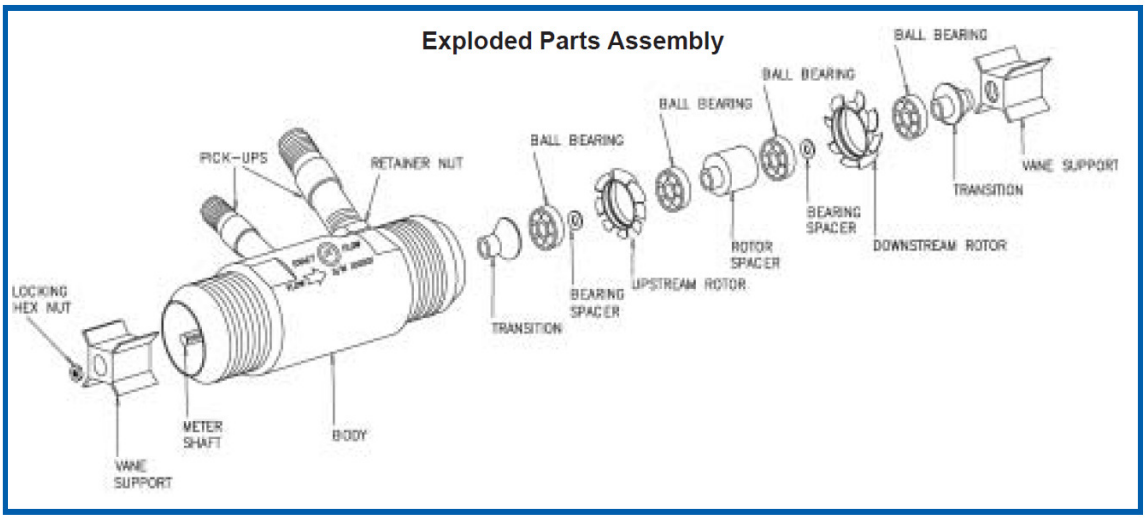


Figure A.3 – EFM Single Rotor Specifications

Single Rotor Housing Dimensions Inches [mm]						
Model #	A (AN / NPT)	A (RFF)	B (AN)	B (RFF)	C (Flats)	D
EFM8-4	2.45 [62]	-	2.16 [55]	-	1.00 [25]	1.12 [28]
EFM8-6	2.45 [62]	-	2.18 [55]	-	1.00 [25]	1.12 [28]
EFM8	2.45 [62]	-	2.20 [56]	-	1.00 [25]	1.12 [28]
EFM10	2.72 [69]	-	2.25 [57]	-	1.13 [29]	1.25 [32]
EFM12	3.25 [83]	-	2.30 [58]	-	1.38 [35]	1.50 [38]
EFM16	3.56 [91]	5.50 [140]	2.42 [61]	2.70 [69]	1.50 [38]	1.63 [41]
EFM20	4.06 [103]	6.00 [152]	2.54 [64]	2.81 [71]	1.72 [44]	1.88 [48]
EFM24	4.59 [117]	6.00 [152]	2.66 [67]	2.93 [74]	2.00 [51]	2.25 [57]
EFM32	6.06 [154]	6.50 [165]	2.89 [73]	3.17 [81]	2.50 [63]	2.75 [70]
EFM40	-	7.00 [178]	-	3.55 [90]	-	2.88 [73]
EFM48	-	10.0 [254]	-	3.81 [98]	-	3.50 [89]
EFM64	-	12.0 [305]	-	4.31 [109]	-	4.50 [114]

Single Rotor Model Specifications							
Model #	Connection Size	Flow Range @ 1 cstk, S.G.=1		D P @ Max Flow, 1 cstk	Typical K-Factor	Recommended Filtration	Weight AN without Pickoff
		GPM	LPM	PSI	PPG	Mesh (Microns)	Lbs
EFM8-4	1/4" NPT / 1/2" AN	0.15 - 3.0	0.57 - 11	10	30000	1250 10	0.38
EFM8-6	3/8" NPT / 1/2" AN	0.30 - 6.0	1.14 - 23	10	15000	1250 10	0.38
EFM8	1/2"	0.40 - 10	1.51 - 38	10	9480	1250 10	0.38
EFM10	1/2"	0.53 - 16	2.01 - 61	10	6000	1250 10	0.49
EFM12	3/4"	1.0 - 30	3.79 - 114	10	3640	1250 10	0.76
EFM16	1"	2.2 - 65	8.33 - 246	10	1680	1250 10	1.1
EFM20	1.25"	3.2 - 95	12.1 - 360	10	1149	1250 10	1.7
EFM24	1.5"	5.2 - 155	19.7 - 587	10	705	1250 10	2.7
EFM32	2"	10 - 310	37.9 - 1173	10	242	1250 10	5.0
EFM40	2.5" RFF	12 - 500	45.0 - 1893	10	132	1250 10	-
EFM48	3" RFF	20 - 800	76.0 - 3028	10	45	1250 10	-
EFM64	4" RFF	38 - 1500	144 - 5678	10	20	1250 10	-

Figure A.4 – EFM Dual Rotor Specifications

Dimensions Inches [mm]							
Model #	A (NPT)	A (AN)	A (RFF)	B (AN & RFF)	B(RFF)	C (Flats)	D
EFM8-4	2.45 [62]	2.75 [70]	-	2.15 [55]	-	1.00 [25]	1.12 [28]
EFM8-6	2.45 [62]	2.75 [70]	-	2.17 [55]	-	1.00 [25]	1.12 [28]
EFM8	2.45 [62]	2.75 [70]	-	2.20 [56]	-	1.00 [25]	1.12 [28]
EFM10	2.72 [69]	2.72 [69]	-	2.25 [57]	-	1.13 [29]	1.25 [32]
EFM12	3.25 [82]	3.25 [82]	-	2.30 [58]	-	1.38 [35]	1.50 [38]
EFM16	3.56 [90]	3.56 [90]	5.50 [139]	2.42 [61]	2.70 [69]	1.50 [38]	1.63 [41]
EFM20	4.06 [103]	4.06 [103]	6.00 [152]	2.54 [64]	2.81 [71]	1.72 [44]	1.88 [48]
EFM24	4.59 [116]	4.59 [116]	6.00 [152]	2.66 [67]	2.93 [74]	2.00 [51]	2.25 [57]
EFM32	6.06 [154]	6.06 [154]	6.50 [165]	2.89 [73]	3.17 [81]	2.50 [63]	2.75 [2.88]
EFM40	-	-	7.00 [178]	-	3.55 [90]	-	2.88 [73]
EFM48	-	-	10.0 [254]	-	3.81 [98]	-	3.50 [89]
EFM64	-	-	12.0 [305]	-	4.31 [109]	-	4.50 [114]

Model #	Connection Size	Flow Range @ 1 cstk, S.G.=1		D P @ Max Flow, 1 cstk	Typical K Factor, PPG		Recommended Filtration	Weight NPT		RF Flange	
		GPM	LPM	Psi	Rotor A	Rotor B	Mesh (Microns)	Lb	Kg	Lb	Kg
EFM8-4	1/4" NPT 1/2" AN	0.015 - 3.0	0.06 - 11	14	30000	33000	1250 10	1.0	.45	-	-
EFM8-6	3/8" NPT 1/2" AN	0.025 - 6.0	0.09 - 23	14	15000	16500	1250 10	1.0	.45	-	-
EFM8	1/2"	0.030 - 10	0.11 - 38	14	9480	10440	1250 10	1.0	.45	-	-
EFM10	1/2" NPT 5/8" AN	0.035 - 16	0.13 - 61	14	6000	6375	1250 10	1.1	.50	-	-
EFM12	3/4"	0.05 - 30	0.19 - 114	14	3640	4000	1250 10	1.4	.63	-	-
EFM16	1"	0.08 - 65	0.30 - 246	14	1680	1845	1250 10	1.5	.68	6.4	2.9
EFM20	1.25"	0.15 - 95	0.57 - 360	14	1149	1263	1250 10	1.7	.78	8.3	3.8
EFM24	1.5"	0.25 - 155	0.94 - 587	14	705	774	1250 10	2.0	.91	10.2	4.6
EFM32	2"	0.39 - 310	1.48 - 1173	14	242	266	1250 10	2.5	1.1	15.7	7.1
EFM40	2.5" RFF	1.0 - 500	3.78 - 1893	14	132	145	1250 10	-	-	21.5	9.8
EFM48	3" RFF	2.0 - 800	7.57 - 3028	14	45	50	1250 10	-	-	27.9	12.7
EFM64	4" RFF	5.0 - 1500	18.9 - 5678	14	20	22	1250 10	-	-	42.3	19.2

Figure A.5 – EFM Series Meter Dimension Layout

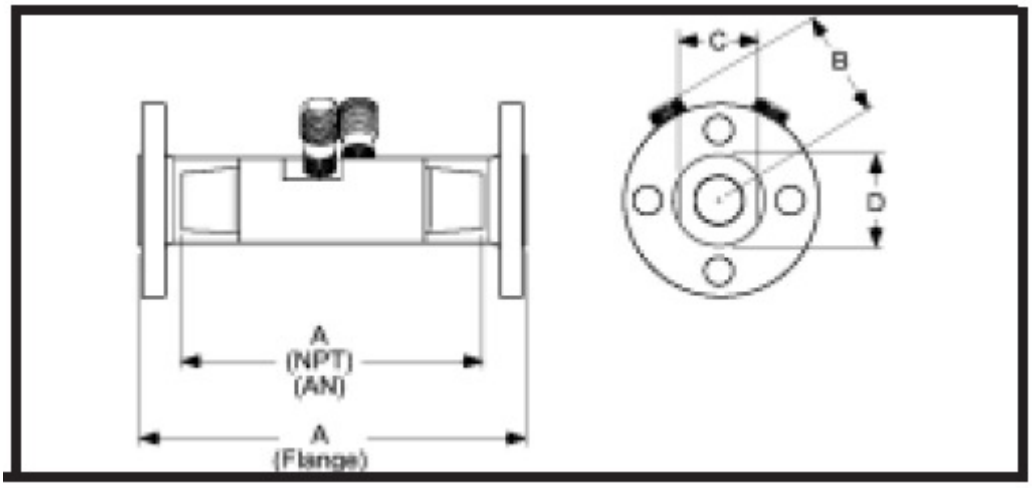


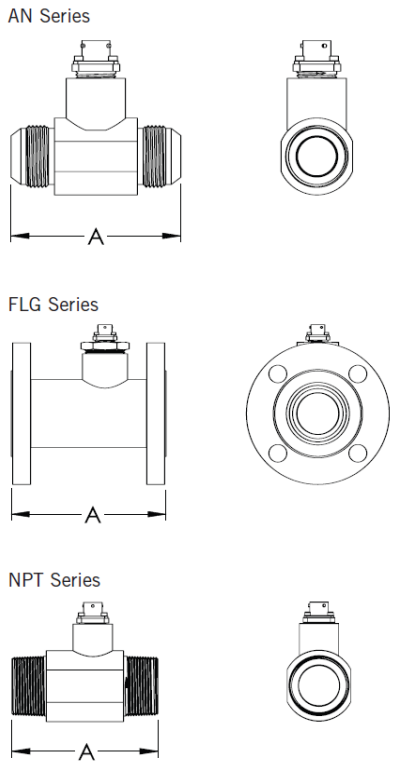
Figure A.6 – DX/DL Meter Specifications

Model #	End Fitting	Flow Ranges @ 1 cStk, S.G. = 1		Turn-down range 1 cStk	UVC Turn-down range	Typical K Factor Pulses/Gallon	
		GPM	LPM	Ratio	Ratio	Rotor "A"	Rotor "B"
DX/DL8-4	1/4" NPT / 1/2" AN	0.025 – 3.0	0.095 – 11.4	120:1	30:1	30000	33000
DX/DL8-6	3/8" NPT / 1/2" AN	0.035 – 6.0	0.132 – 22.7	171:1	35:1	15000	16500
DX/DL-08	1/2"	0.040 – 10	0.132 – 37.8	286:1	40:1	9480	10440
DX/DL-10	3/4" NPT / 5/8" AN	0.045 – 16	0.170 – 60.5	355:1	45:1	6000	6375
DX/DL-12	3/4"	0.08 – 30	0.189 – 113.5	375:1	50:1	3640	4000
DX/DL-16	1"	0.15 – 65	0.378 – 246	433:1	60:1	1680	1846
DX/DL-20	1 1/4"	0.25 – 95	0.946 – 359.6	380:1	60:1	1149	1263
DX/DL-24	1 1/2"	0.35 – 155	1.324 – 586.7	443:1	60:1	705	774
DX/DL-32	2"	0.60 – 310	1.70 – 1173.4	517:1	60:1	242	266
DX/DL-40	2 1/2"	1.0 – 500	3.78 – 1892.7	500:1	60:1	132	145
DX/DL-48	3"	2.0 – 800	7.57 – 3028	400:1	60:1	45	50
DX/DL-64	4"	5 – 1,500	18.9 – 5678	300:1	60:1	20	22

Figure A.7 – DX/DL Meter Series Dimensions

Model #	Size	"A" FLANGE	"A" AN/NPT
DX/DL8-4	1/4" NPT / 1/2" AN		2.75 (70)
DX/DL8-6	3/8" NPT / 1/2" AN		2.75 (70)
DX/DL-08	1/2"		2.75 (70)
DX/DL-10	5/8"		2.92 (74)
DX/DL-12	3/4"		3.25 (83)
DX/DL-16	1"	5.50 (140)	3.56 (91)
DX/DL-20	1 1/4"	6.00 (152)	4.06 (103)
DX/DL-24	1 1/2"	6.00 (152)	4.59 (117)
DX/DL-32	2"	6.50 (165)	6.06 (154)
DX/DL-40	2 1/2"	7.00 (178)	N/A
DX/DL-48	3"	10.0 (254)	N/A
DX/DL-64	4"	12.0 (305)	N/A

Figure A.8 – DX/DL Meter Series Dimension Layout



Revision History			
Revision	**Revised by**	**Changes**	**Release Date**
A	Regan Morrison	Initial Release	01/29/2010

-END OF INSTALLATION AND OPERATION MANUAL-

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APPENDIX IX

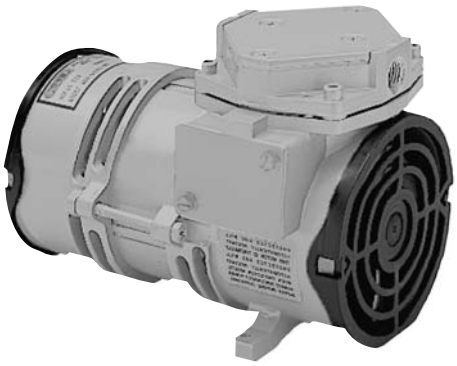
Gast Vacuum Pump

OIL-LESS DIAPHRAGM VACUUM PUMPS & COMPRESSORS

OPERATION & MAINTENANCE MANUAL



Model DOA Shown



Model MOA Shown



Model DAA Shown

Thank you for purchasing this Gast product. It is manufactured to the highest standards using quality materials. Please follow all recommended maintenance, operational and safety instructions and you will receive years of trouble free service.

WARNING

PLEASE READ THIS MANUAL COMPLETELY BEFORE INSTALLING AND USING THIS PRODUCT. SAVE THIS MANUAL FOR FUTURE REFERENCE AND KEEP IN THE VICINITY OF THE PRODUCT.

Product Use Criteria:

- Pump only clean, dry air.
- Operate at 40ºF - 104ºF (4.4ºC - 40ºC).
- Protect unit from dirt & moisture.
- Do not pump flammable or explosive gases or use in an atmosphere that contains such gases.
- Protect all surrounding items from exhaust air. This exhaust air can become very hot.
- Corrosive gases and particulate material will damage unit. Water vapor, oil-based contaminants or other liquids must be filtered out.
- Consult your Gast Distributor/Representative before using at high altitudes.

GAST® A Unit of IDEX Corporation

ISO 9001 & 14001 CERTIFIED

www.gastmfg.com

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Your safety and the safety of others is extremely important.

We have provided many important safety messages in this manual and on your product. Always read and obey all safety messages.

This is the safety alert symbol. This symbol alerts you to hazards that can kill or hurt you and others. The safety alert symbol and the words "DANGER" and "WARNING" will precede all safety messages. These words mean:

DANGER

You will be killed or seriously injured if you don't follow instructions.

WARNING

You can be killed or seriously injured if you don't follow instructions.

All safety messages will identify the hazard, tell you how to reduce the chance of injury, and tell you what can happen if the safety instructions are not followed.

INSTALLATION

WARNING



Electrical Shock Hazard

Disconnect electrical power at the circuit breaker or fuse box before installing this product.

Install this product where it will not come into contact with water or other liquids.

Install this product where it will be weather protected.

Electrically ground this product.

Failure to follow these instructions can result in death, fire or electrical shock.

Correct installation is your responsibility. Make sure you have the proper installation conditions and that installation clearances do not block air flow.

Blocking air flow over the product in any way can cause the product to overheat.

Mounting
This product can be installed in any orientation. Mounting the product to a stable, rigid operating surface and using shock mounts will reduce noise and vibration.

Plumbing
Remove plugs from the IN and OUT ports. Connect with pipe and fittings that are the same size or larger than the product's threaded ports. Be sure to connect the intake and exhaust plumbing to the correct inlet and outlet ports.

Accessories
Filters and mufflers are supplied with some models. These should be checked periodically and replaced when necessary. Please consult your Gast Distributor/Representative for additional filter recommendations.

Install relief valves and gauges at inlet or outlet, or both, to monitor performance. Check valves may be required to prevent back streaming through the pump.

Motor Control
It is your responsibility to contact a qualified electrician and assure that the electrical installation is adequate and in conformance with all national and local codes and ordinances. The metal capacitor shell must be grounded.

Determine the correct overload setting required to protect the motor (see motor starter manufacturer's recommendations). Select fuses, motor protective switches or thermal protective switches to provide protection. Fuses act as short circuit protection for the motor, not as protection against overload. Incoming line fuses must be able to withstand the motor's starting current. Motor starters with thermal magnetic overload or circuit breakers protect motor from overload or reduced voltage conditions.

The wiring diagram supplied with the product provides required electrical information. Check that power source is correct to properly operate the dual-voltage motors.

OPERATION

WARNING

Injury Hazard

Install proper safety guards as needed.

Product surfaces become very hot during operation, allow product surfaces to cool before handling.

Air stream from product may contain solid or liquid material that can result in eye or skin damage, wear proper eye protection.

Failure to follow these instructions can result in burns, eye injury or other serious injury.

It is your responsibility to operate this product at recommended pressures or vacuum duties and room ambient temperatures.

Start Up
If motor fails to start or slows down significantly under load, shut off and disconnect from power supply. Check that the voltage is correct for motor and that motor is turning in the proper direction.

MAINTENANCE

WARNING



Electrical Shock Hazard

Disconnect electrical power supply cord before performing maintenance on this product.

If product is hard wired into system, disconnect electrical power at the circuit breaker or fuse box before performing maintenance on this product.

Failure to follow these instructions can result in death, fire or electrical shock.

WARNING

Injury Hazard

Product surfaces become very hot during operation, allow product surfaces to cool before handling.

Air stream from product may contain solid or liquid material that can result in eye or skin damage, wear proper eye protection.

Clean this product in a well ventilated area.

Failure to follow these instructions can result in burns, eye injury or other serious injury.

It is your responsibility to:
- **Regularly inspect and make necessary repairs to product in order to maintain proper operation.**
- **Make sure that pressure and vacuum is released from product before starting maintenance.**

Check intake and exhaust filters after first 500 hours of operation. Clean filters and determine how frequently filters should be checked during future operation. This one procedure will help to assure the product's performance and service life.

Solvent Cleaning

Use only Gast AH255B Solvent or other non-petroleum based solvent. Do Not use kerosene or ANY other combustible solvent to clean product.

1. Remove the four (MOA) or five (DOA) screws in the top of the product. Remove the top plate.
2. Remove filters and clean with Gast AH255B solvent or other non-petroleum based solvent. Use compressed air to dry filters and make sure that all moisture is removed. Reinstall filters.
3. Clean the gasket with water and dry thoroughly. Reinstall gasket.
4. Reinstall top plate and screws.

Check that all external accessories such as relief valves and gauges are attached to cover and are not damaged before re-operating product.

SHUTDOWN PROCEDURES

It is your responsibility to follow proper shutdown procedures to prevent product damage.
NEVER ADD OIL TO THIS OIL-LESS PUMP.

Proper shutdown procedures must be followed to prevent pump damage. Failure to do so may result in premature pump failure. Gast Manufacturing Oil-Less Diaphragm Vacuum Pumps and Compressors are constructed of ferrous metals or aluminum which are subject to rust and corrosion when pumping condensable vapors such as water. Follow the steps below to assure correct storage and shutdown between operating periods.

1. Disconnect plumbing.
2. Operate product for at least 5 minutes without plumbing.
3. Run at maximum vacuum for 10 to 15 minutes.
4. Repeat step 2.
5. Disconnect power supply.
6. Plug open ports to prevent dirt or other contaminants from entering product.

SERVICE KIT INSTALLATION

WARNING



Electrical Shock Hazard

Disconnect electrical power supply cord before installing Service Kit.

If product is hard wired into system, disconnect electrical power at the circuit breaker or fuse box before installing Service Kit.

Disconnect air supply and vent all air lines to release pressure or vacuum.

Failure to follow these instructions can result in death, fire or electrical shock.

Gast will NOT guarantee field-rebuilt product performance. For performance guarantee, the product must be returned to a Gast Authorized Service Facility.

Service Kit contents vary. Most contain gaskets and filter parts.

1. Disconnect electrical power to pump.
2. Disconnect air supply and vent all air lines to release pressure or vacuum.
3. Remove the socket cap screws from the head of the pump. Remove the head of the pump.

Replacing Diaphragm

1. Remove the two Phillips-head screws then the retainer plate and diaphragm.
2. Install the new diaphragm, pattern side up for compressors, pattern side down for vacuum pumps,onto the connecting rod.
3. Replace the retainer plate and attach with two screws. Torque the screws to 30 in. lbs. on DOA and DAA units and to 12 in. lbs. on MOA and MAA units.

Replacing Inlet and Outlet Valves

1. Remove the slotted machine screw that holds each valve in place.
2. Clean the stainless steel valves with water. Valves are interchangeable on DOA and DAA units.
3. Replace the outlet valve or install a new valve so that the retaining bar is near the machine screw hole. The retainer bar holds the valve in place.
4. Replace the inlet valve or install a new valve so that the notch marked on the valve is in the lower right hand corner towards the inlet of the air chamber.

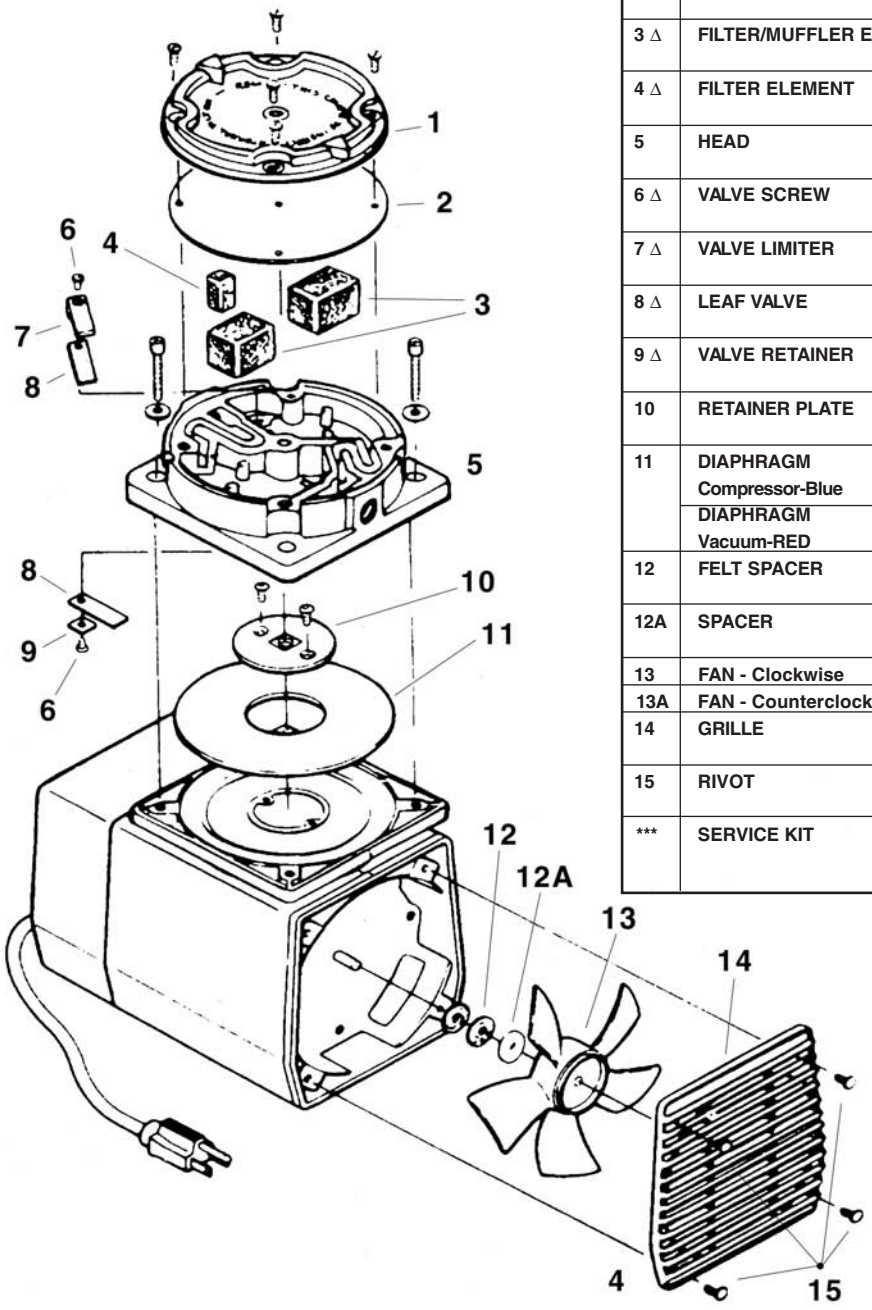
4. Replace the head on the pump. Torque the socket cap screws to 90-100 in. lbs. on the DOA and DAA units and 30 in. lbs. on the MOA and MAA units.

Do Not replace the connecting rod or motor bearings.

Check that all external accessories such as relief valves and gauges are attached to cover and are not damaged before re-operating product.

If pump still does not produce proper vacuum or pressure, send unit to a Gast Authorized Service Facility for repair.

EXPLODED PRODUCT VIEW, PARTS & ORDERING INFORMATION



DAA / DOA SERIES

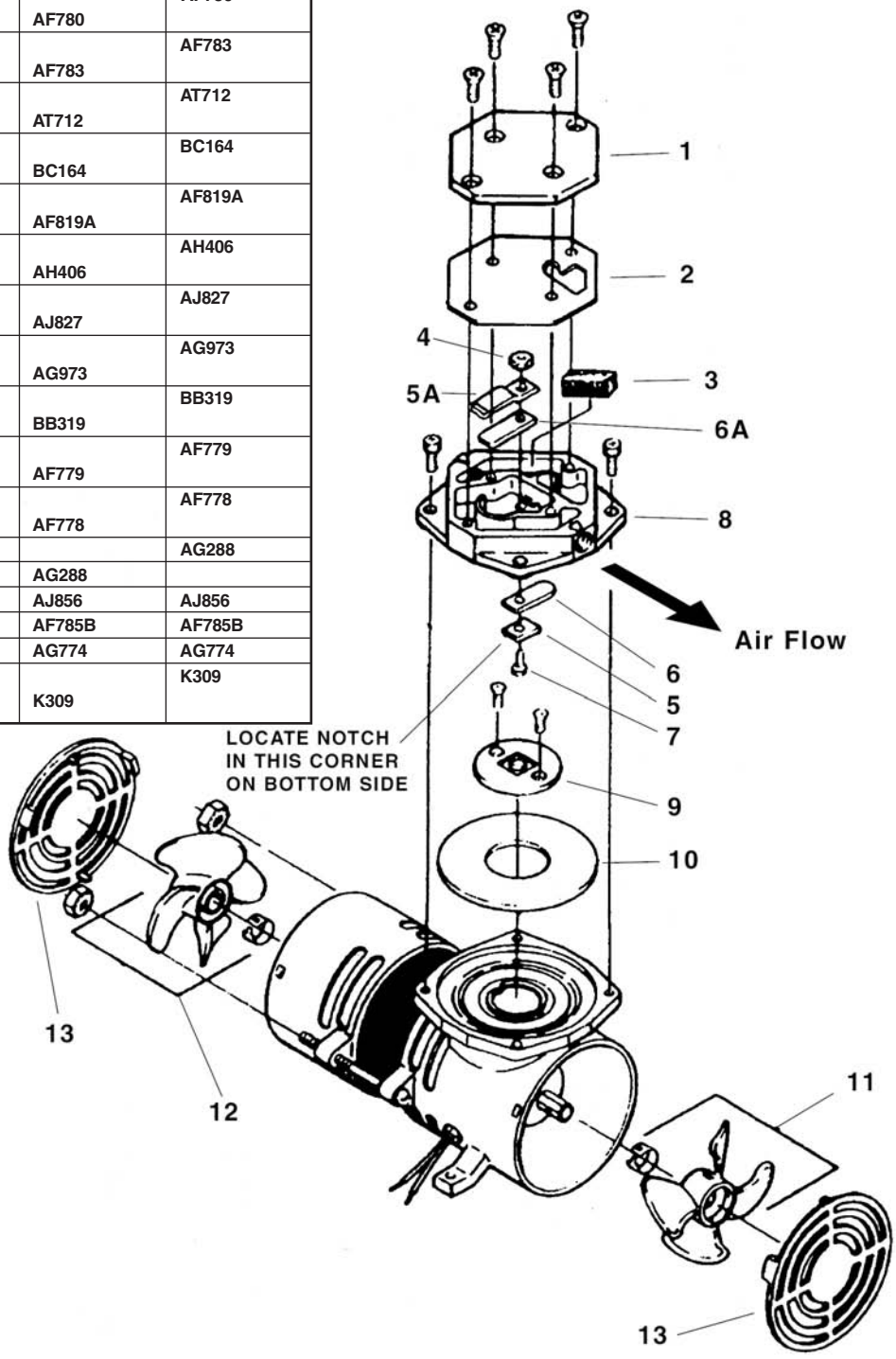
REF	DESCRIPTION	QTY	DOA-P101-AA DOA-P101-BN	DAA-V155-EB*
1	COVER	1 2	AF808	 AF808
2 Δ	HEAD GASKET	1 2	AF820	 AF820
3 Δ	FILTER/MUFFLER ELEMENT	2 4	AT713	 AT713
4 Δ	FILTER ELEMENT	1 2	AT712	 AT712
5	HEAD	1 2	AF804	 AF804
6 Δ	VALVE SCREW	2 4	BB317	 BB317
7 Δ	VALVE LIMITER	1 2	AF856	 AF856
8 Δ	LEAF VALVE	2 4	AF817	 AF817
9 Δ	VALVE RETAINER	1 2	AF819A	 AF819A
10	RETAINER PLATE	1 2	AF809	 AF809
11	DIAPHRAGM Compressor-Blue	1 2	AF818A****	 AF818A****
	DIAPHRAGM Vacuum-RED	 2		 AF818B
12	FELT SPACER	3 6	AA929	 AA929
12A	SPACER	1 2	AD996	 AD996
13	FAN - Clockwise	1	AT837	AT837
13A	FAN - Counterclockwise	1		AT837A
14	GRILLE	1 2	AF807	 AF807
15	RIVOT	4 8	AE946	 AE946
***	SERVICE KIT	1 2	K294A	 K294K

* DOA shown. The Double-ended (DAA – not illustrated) models are two DOAs mounted back to back with heads rotated.
*** Item not shown.
****Pattern side up for compressors. Pattern side down for vacuum pumps.
Δ Denotes parts included in the Service Kit.
Δ The service kit may contain parts for more than one model or style diaphragm pump. Parts not needed may be discarded.
Parts listed are for stock models. For specific OEM models, please consult the factory.
When corresponding or ordering parts, please give complete model and serial numbers.

EXPLODED PRODUCT VIEW, PARTS & ORDERING INFORMATION

MAA / MOA SERIES

REF	DESCRIPTION	QTY	MAA-V103-HB*	MOA-P101-AA MOA-P101-CD MOA-P101-JH**
1	COVER	1 2	 AF780	AF780
2 Δ	HEAD GASKET	1 2	 AF783	AF783
3 Δ	FILTER/MUFFLER ELEMENT	2 4	 AT712	AT712
4 Δ	NUT	1 2	 BC164	BC164
5 Δ	VALVE RETAINER	1 2	 AF819A	AF819A
5A Δ	LIMITER	1 2	 AH406	AH406
6 Δ	LEAF VALVE	1 2	 AJ827	AJ827
6A Δ	EXHAUST LEAF VALVE	1 2	 AG973	AG973
7 Δ	SCREW	1 2	 BB319	BB319
8	HEAD	1 2	 AF779	AF779
9	RETAINER PLATE	1 2	 AF778	AF778
10	DIAPHRAGM-Pressure-Red	1		AG288
****	DIAPHRAGM-Vacuum-Red	2	AG288	
11	FAN	1	AJ856	AJ856
12	**FAN	1	AF785B	AF785B
13	**GRILLE	2	AG774	AG774
***	SERVICE KIT	1 2	 K309	K309



* MOA shown. The Double-ended (MAA – not illustrated) models are two MOAs mounted back to back with heads rotated.
**MOA-P101-JH does not have an AF785B fan and has only qty (1) AG774 Grille (#13).
*** Item not shown.
****Pattern side up for compressors. Pattern side down for vacuum pumps.
Δ Denotes parts included in the Service Kit.
Δ The service kit may contain parts for more than one model or style diaphragm pump. Parts not needed may be discarded.
Parts listed are for stock models. For specific OEM models, please consult the factory.
When corresponding or ordering parts, please give complete model and serial numbers.

WARRANTY

Gast finished products, when properly installed and operated under normal conditions of use, are warranted by Gast to be free from defects in material and workmanship for a period of twelve (12) months from the date of purchase from Gast or an authorized Gast Representative or Distributor. In order to obtain performance under this warranty, the buyer must promptly (in no event later than thirty (30) days after discovery of the defect) give written notice of the defect to Gast Manufacturing Incorporated, PO Box 97, Benton Harbor Michigan USA 49023-0097 or an authorized Service Center (unless specifically agreed upon in writing signed by both parties or specified in writing as part of a Gast OEM Quotation). Buyer is responsible for freight charges both to and from Gast in all cases.

This warranty does not apply to electric motors, electrical controls, and gasoline engines not supplied by Gast. Gast's warranties also do not extend to any goods or parts which have been subjected to misuse, lack of maintenance, neglect, damage by accident or transit damage.

THIS EXPRESS WARRANTY EXCLUDES ALL OTHER WARRANTIES OR REPRESENTATIONS EXPRESSED OR IMPLIED BY ANY LITERATURE, DATA, OR PERSON. GAST'S MAXIMUM LIABILITY UNDER THIS EXCLUSIVE REMEDY SHALL NEVER EXCEED THE COST OF THE SUBJECT PRODUCT AND GAST RESERVES THE RIGHT, AT ITS SOLE DISCRETION, TO REFUND THE PURCHASE PRICE IN LIEU OF REPAIR OR REPLACEMENT.

GAST WILL NOT BE RESPONSIBLE OR LIABLE FOR INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND, however arising, including but not limited to those for use of any products, loss of time, inconvenience, lost profit, labor charges, or other incidental or consequential damages with respect to persons, business, or property, whether as a result of breach of warranty, negligence or otherwise. Notwithstanding any other provision of this warranty, BUYER'S REMEDY AGAINST GAST FOR GOODS SUPPLIED OR FOR NON-DELIVERED GOODS OR FAILURE TO FURNISH GOODS, WHETHER OR NOT BASED ON NEGLIGENCE, STRICT LIABILITY OR BREACH OF EXPRESS OR IMPLIED WARRANTY IS LIMITED SOLELY, AT GAST'S OPTION, TO REPLACEMENT OF OR CURE OF SUCH NONCONFORMING OR NON-DELIVERED GOODS OR RETURN OF THE PURCHASE PRICE FOR SUCH GOODS AND IN NO EVENT SHALL EXCEED THE PRICE OR CHARGE FOR SUCH GOODS. GAST EXPRESSLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE WITH RESPECT TO THE GOODS SOLD. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTIONS SET FORTH IN THIS WARRANTY, notwithstanding any knowledge of Gast regarding the use or uses intended to be made of goods, proposed changes or additions to goods, or any assistance or suggestions that may have been made by Gast personnel.

Unauthorized extensions of warranties by the customer shall remain the customer's responsibility.

CUSTOMER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF GAST PRODUCTS FOR CUSTOMER'S USE OR RESALE, OR FOR INCORPORATING THEM INTO OBJECTS OR APPLICATIONS WHICH CUSTOMER DESIGNS, ASSEMBLES, CONSTRUCTS OR MANUFACTURES.

This warranty can be modified only by authorized Gast personnel by signing a specific, written description of any modifications.

MAINTENANCE RECORD

DATE	PROCEDURE PERFORMED

TROUBLESHOOTING CHART

Low		High		Pump	Motor	Excess	Reason and remedy
Vacuum	Pressure	Vacuum	Pressure	Overheat	Overload	Noise	for problem.
•	•	At Pump		•	•		Filter dirty. Clean or replace.
•	•		At pump	•	•		Muffler dirty. Clean or replace.
•	•						Valves dirty or valves bent. Clean or replace.
•	•						Worn piston rings. Repair or replace.
			•	•	•		Relief valve set too high. Inspect and adjust.
•	•						Relief valve set too low. Inspect and adjust.
•	•	At pump	At pump	•	•		Plugged vacuum/pressure line. Inspect and repair.
•		At pump					Collapsed vacuum line. Inspect and repair.
				•	•		Low voltage, won't start. Check power source.
				•	•	•	Voltage wrong. Check power source.
•	•					•	Worn rings/piston hitting cylinder. Replace.
				•		•	Cylinder misadjustment. Realign.
•	•						Leaky hose or check valve. Replace.
•	•			•	•	•	Dirt or liquid on top of piston. Inspect and clean.
•	•			•	•		Motor not wired correctly. Check wiring diagram/line voltage.
•	•					•	Blown head gasket. Replace.

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49023-0097
Ph: 269/926-6171
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Gast Hong Kong
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Fax: (852) 2690 1012
www.gasthk.com

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APPENDIX X

Gransow Solenoid Valve

Series I

2-way, internally piloted, normally closed solenoid valve



3/8"-1 1/2"
Pipe Sizes

8W, 12W, 14W
Coils

0-200 psi
Operating Pressure

Materials of Construction	
Body:	**Stainless Steel 316**
Armature Tube:	**Stainless Steel 300**
Fixed Core:	**Stainless Steel 400**
Plunger:	**Stainless Steel 400**
Spring:	**Stainless Steel 300**
Shading Ring:	**Gold-plated Copper**

Electrical Connection	
Rating:	**NEMA 4**
Strain Relief Connector:	**Model 009**
1/2" Conduit Connector:	**Model 010**
6 ft. Power Cord:	**Model GRN100**

Note: For more detailed specifications, please refer to the datasheet of any individual solenoid valve model within this series.

Granzow, Inc.• 2300 Crownpoint Executive Drive, Charlotte, NC 28227-6702 • Phone (704) 845-2300 • Fax (704) 845-2301

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FKM	**14°- 280° F**	**DI water, Chemicals†**
Sealing Material	Temperature Range	Medium Examples

Series "I" solenoid valve models, with FKM sealing:

Model #	**Pipe Size** (Inch)	**Orifice Size** (Inch)	**Flow Factor** (CV)	**Watt Rating** (W)	**Min. Pressure** (PSI)	**Max. Pressure** (AC/DC)
I3000-00V	3/8"	9/16"	2.80	8	0	200/85
I3000-00V	3/8"	9/16"	2.80	12	0	200/200
I4000-00V	1/2"	5/8"	3.40	8	0	200/85
I4000-00V	1/2"	5/8"	3.40	12	0	200/200
I5000-00V	3/4"	13/16"	4.10	8	0	200/85
I5000-00V	3/4"	13/16"	4.10	12	0	200/200
I6000-00V	1"	1"	9.70	8	0	200/45
I6000-00V	1"	1"	9.70	12	0	200/116
I6000-00V	1"	1"	9.70	14	0	200/200
I7000-00V	1 1/4"	1 3/8"	20.10	14	0	200/100
I8000-00V	1 1/2"	1 9/16"	23.40	14	0	200/100

†Must be compatible with 316SS and FKM

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APPENDIX XI

Mean Well Power Supply

480W Single Output Industrial DIN RAIL with PFC Function

SDR-480 series



Features :

- High efficiency 94% and low power dissipation
- 150% peak load capability
- Built-in active PFC function, PF>0.94
- Protections: Short circuit / Overload / Over voltage / Over temperature
- Cooling by free air convection
- Built-in constant current limiting circuit
- Can be installed on DIN rail TS-35/7.5 or 15
- UL 508(industrial control equipment)approved
- EN61000-6-2(EN50082-2) industrial immunity level
- Built-in DC OK relay contact
- 100% full load burn-in test
- 3 years warranty

SPECIFICATION

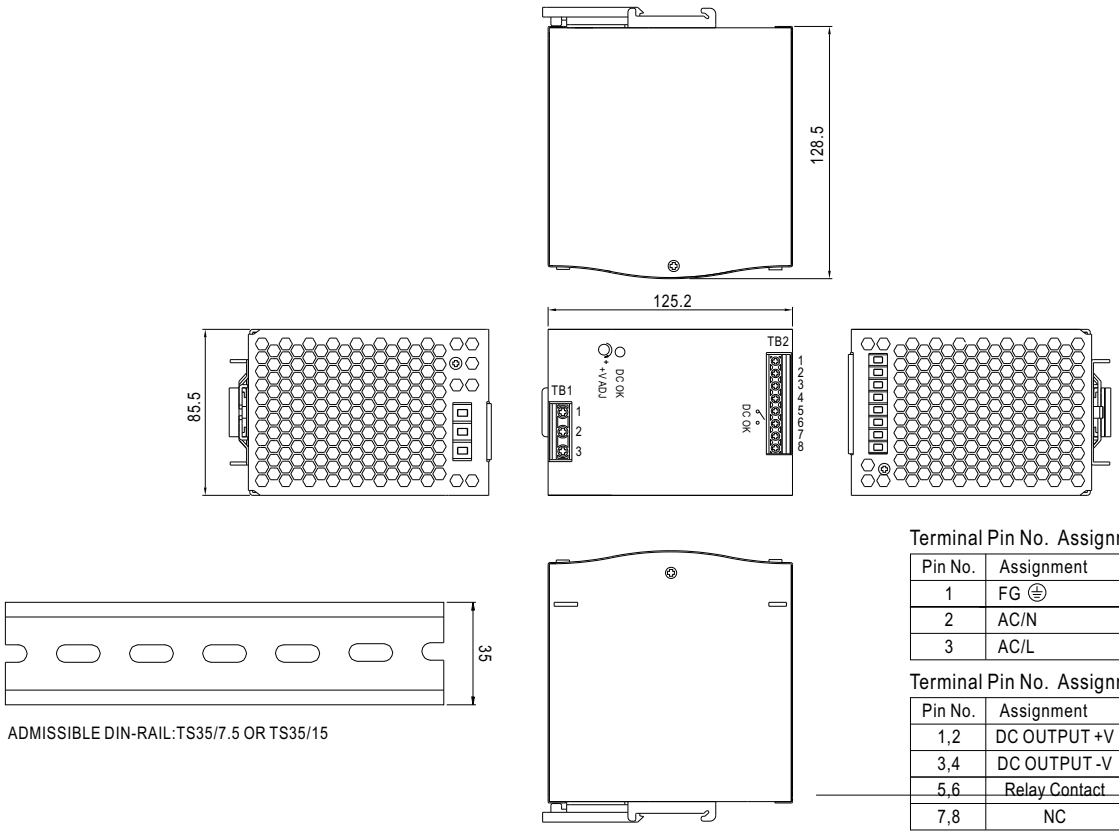
MODEL		SDR-480-24	SDR-480-48
OUTPUT	DC VOLTAGE	24V	48V
	RATED CURRENT	20A	10A
	CURRENT RANGE	0 ~ 20A	0 ~ 10A
	RATED POWER	480W	480W
	PEAK CURRENT	30A	15A
	PEAK POWER Note.6	720W (3sec.)	
	RIPPLE & NOISE (max.) Note.2	100mVp-p	120mVp-p
	VOLTAGE ADJ. RANGE	24 ~ 28V	48 ~ 55V
	VOLTAGE TOLERANCE Note.3	±1.2%	±1.0%
	LINE REGULATION	±0.5%	±0.5%
	LOAD REGULATION	±1.0%	±1.0%
	SETUP, RISE TIME	1500ms, 150ms/230VAC 3000ms, 150ms/115VAC at full load	
	HOLD UP TIME (Typ.)	14ms/230VAC at full load	
INPUT	VOLTAGE RANGE Note.7	90 ~ 264VAC 127 ~ 370VDC	
	FREQUENCY RANGE	47 ~ 63Hz	
	POWER FACTOR (Typ.)	0.94/230VAC 0.99/115VAC at full load	
	EFFICIENCY (Typ.)	94%	
	AC CURRENT (Typ.)	5A/115VAC 2.5A/230VAC	
	INRUSH CURRENT (Typ.)	40A/115VAC 80A/230VAC	
	LEAKAGE CURRENT	<0.8mA / 240VAC	
PROTECTION	OVERLOAD	Normally works within 110 ~ 150% rated output power for more than 3 seconds and then shut down o/p voltage with auto-recovery	
		>150% rated power, constant current limiting with auto-recovery within 2 seconds and may cause to shut down if over 2 seconds	
	OVER VOLTAGE	29 ~ 33V	56 ~ 65V
		Protection type : Shut down o/p voltage with auto-recovery or re-power on to recovery	
	OVER TEMPERATURE	105℃±5℃ (TSW : detect on heatsink of power switch)	
		Protection type : Shut down o/p voltage, recovers automatically after temperature goes down	
FUNCTION	DC OK REALY CONTACT RATINGS (max.)	60Vdc/0.3A, 30Vdc/1A, 30Vac/0.5A resistive load	
ENVIRONMENT	WORKING TEMP. Note.5	-25 ~ +70℃ (Refer to "Derating Curve")	
	WORKING HUMIDITY	20 ~ 95% RH non-condensing	
	STORAGE TEMP., HUMIDITY	-40 ~ +85℃, 10 ~ 95% RH	
	TEMP. COEFFICIENT	±0.03%/℃ (0 ~ 50℃)	
	VIBRATION	Component:10 ~ 500Hz, 2G 10min./1cycle, 60min. each along X, Y, Z axes; Mounting: Compliance to IEC60068-2-6	
SAFETY & EMC (Note 4)	SAFETY STANDARDS	UL508, TUV EN60950-1 approved	
	WITHSTAND VOLTAGE	I/P-O/P:3KVAC I/P-FG:1.5KVAC O/P-FG:0.5KVAC O/P-DC OK:0.5KVAC	
	ISOLATION RESISTANCE	I/P-O/P, I/P-FG, O/P-FG:>100M Ohms / 500VDC / 25℃/ 70% RH	
	EMC EMISSION	Compliance to EN55022 (CISPR22) Class B, EN61000-3-2,-3	
	EMC IMMUNITY	Compliance to EN61000-4-2,3,4,5,6,8,11, EN55024, EN61000-6-2 (EN50082-2), EN61204-3, heavy industry level, criteria A, SEMI F47, GL approved	
OTHERS	MTBF	112.9Khrs min. MIL-HDBK-217F (25℃)	
	DIMENSION	85.5*125.2*128.5mm (W*H*D)	
	PACKING	1.6Kg; 8pcs/13.8Kg/0.9CUFT	

NOTE

1. All parameters NOT specially mentioned are measured at 230VAC input, rated load and 25℃ of ambient temperature.
2. Ripple & noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a 0.1uf & 47uf parallel capacitor.
3. Tolerance : includes set up tolerance, line regulation and load regulation.
4. The power supply is considered a component which will be installed into a final equipment. The final equipment must be re-confirmed that it still meets EMC directives.
5. Installation clearances : 40mm on top, 20mm on the bottom, 5mm on the left and right side are recommended when loaded permanently with full power. In case the adjacent device is a heat source, 15mm clearance is recommended.
6. 3 seconds peak power max. and the average output power should not exceed the rate power.
7. Derating may be needed under low input voltage. Please check the derating curve for more details.

■ Mechanical Specification

Case No.984A Unit:mm



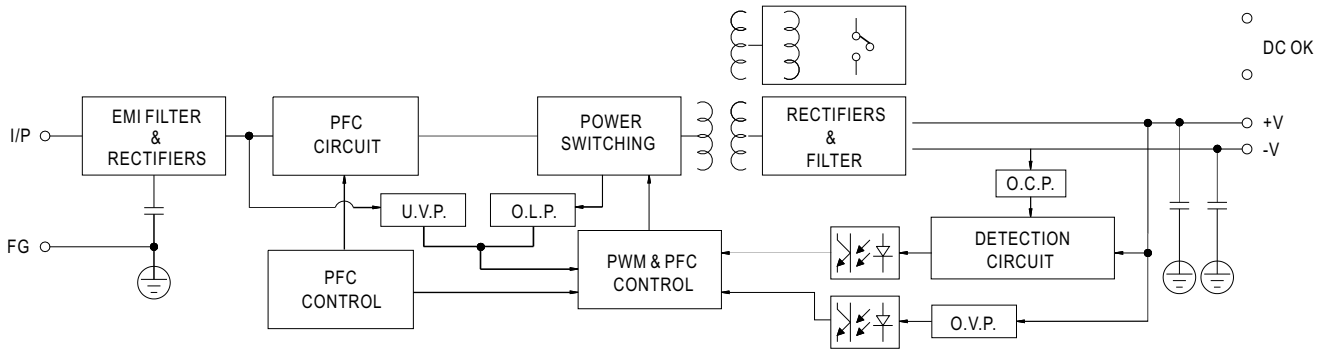
Terminal Pin No. Assignment (TB1)

Pin No.	Assignment
1	FG ⏚
2	AC/N
3	AC/L

Terminal Pin No. Assignment (TB2)

Pin No.	Assignment
1,2	DC OUTPUT +V
3,4	DC OUTPUT -V
5,6	Relay Contact
7,8	NC

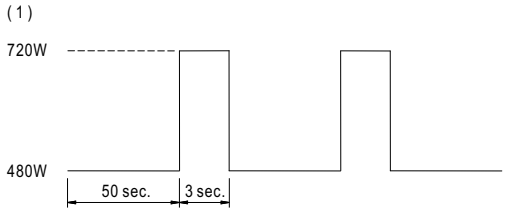
■ Block Diagram

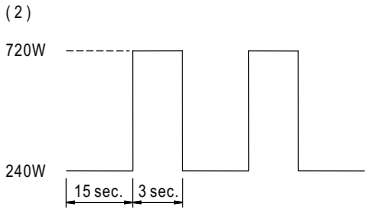


■ DC OK Relay Contact

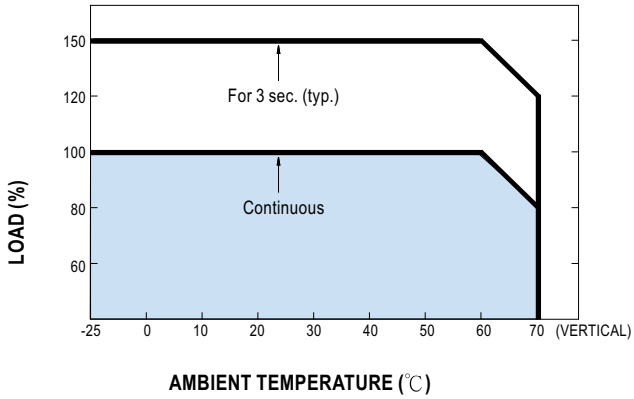
Contact Close	PSU turns on / DC OK.
Contact Open	PSU turns off / DC Fail.
Contact Ratings (max.)	30V/1A resistive load.

■ Peak Loading

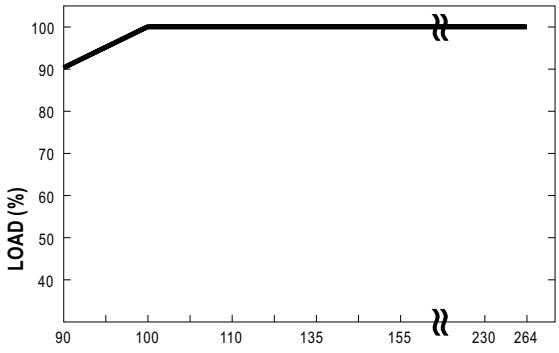




■ Derating Curve



■ Output derating VS input voltage



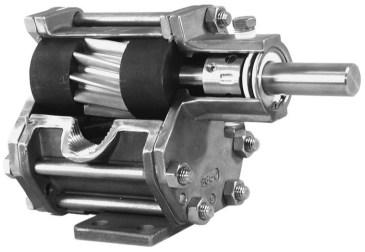
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APPENDIX XII

Oberdorfer Pump

CHEMSTEEL™ PUMP

CHEMSTEEL PUMPS SERIES S930 M



FEATURES

- Stainless or Alloy C housing construction.
- Gears available in 316 stainless,. W88 stainless and Alloy C. Also in Polytetrafluoroethylene, polyphenylenesulfide and polyetheretherketone.
- Shafts are 316 stainless steel or Alloy C.
- Bearings available in carbon or Polytetrafluoroethylene.
- Full range of seal options including lip seal, packing and mechanical seal designs.

Gear/bearing design allows for “trimming” for optimizing the pump’s maximum flow to reach minimum turndown or to match flow to a specific OEM’s requirement.

Special materials combinations are available for specific liquids.

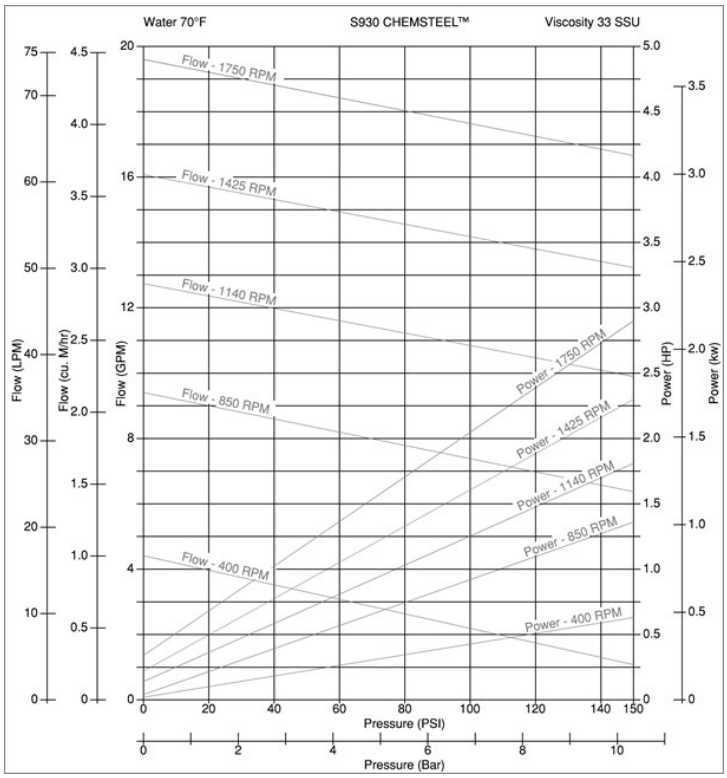
DRIVE

The pump is driven directly from the electric motor shaft by means of a flexible coupling. A close coupled adapter connects the pump to the motor.

LIQUIDS AND TEMPERATURE

This pump is suitable to handle clear lubricating and non lubricating fluids at temperatures to 450F. These pumps will handle viscous fluids to 100,000 cps (462,000 SSU) at reduced shaft speeds.

PERFORMANCE



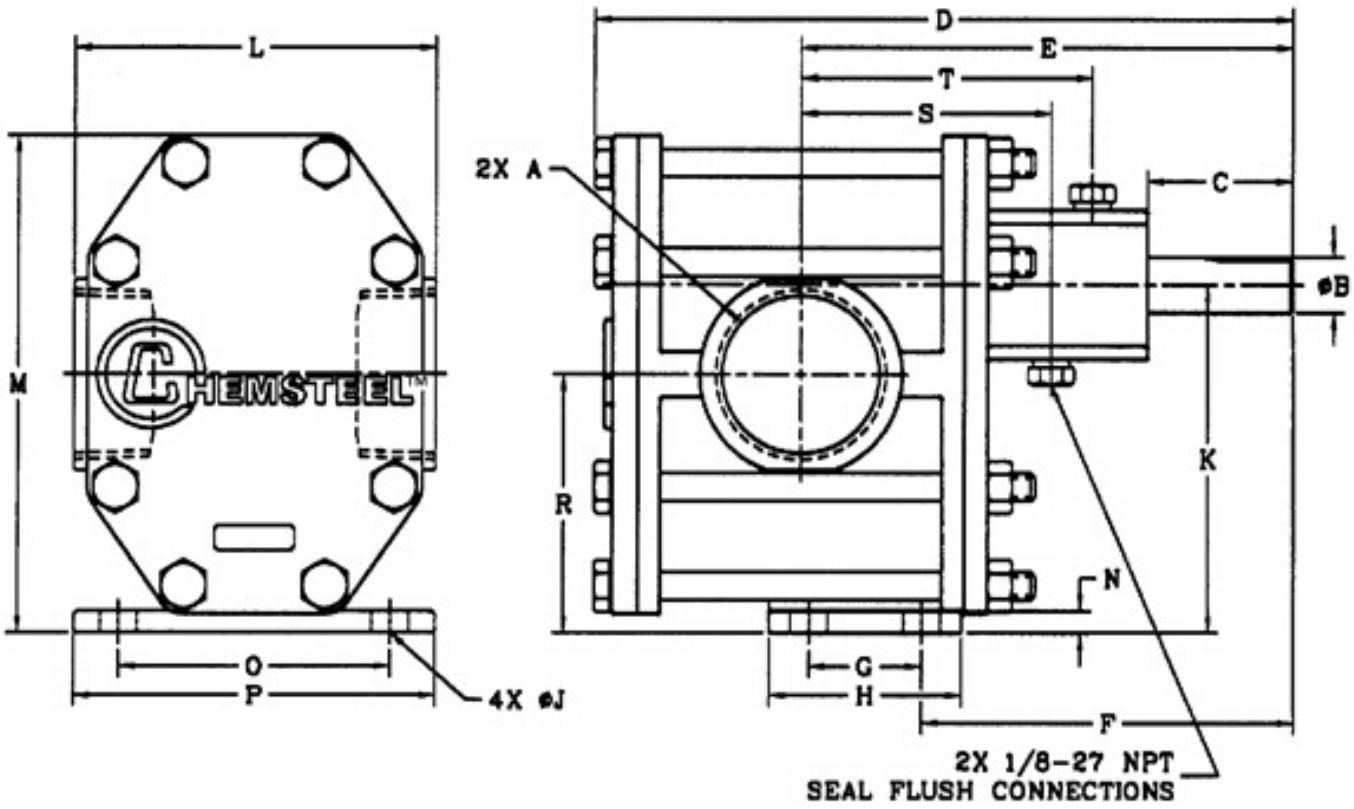
SUCTION LIFT

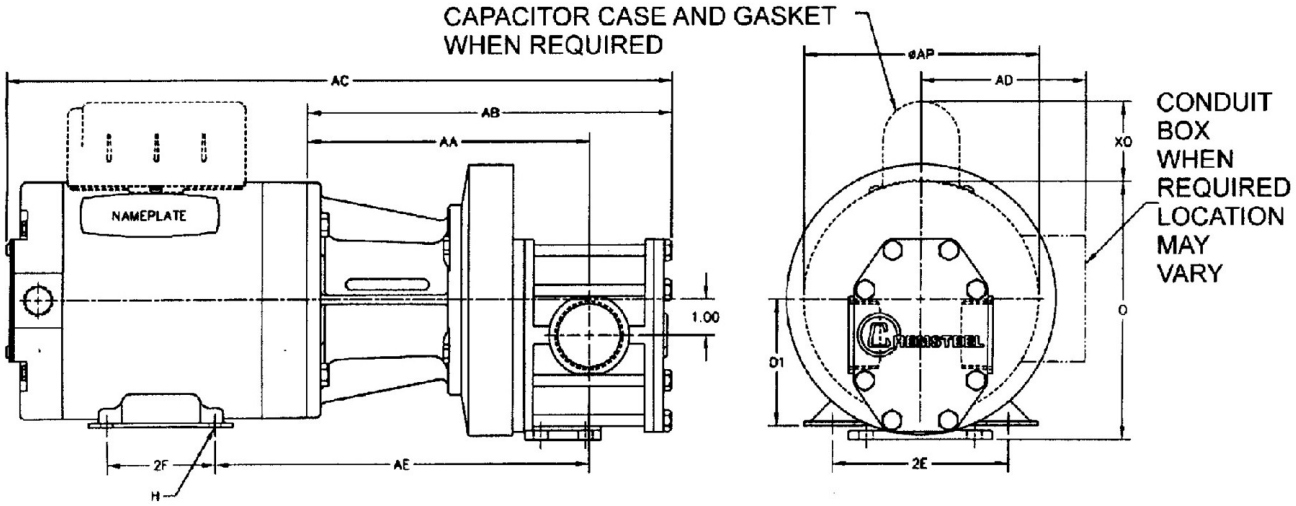
This pump has a suction lift capability of 20 feet for a new pump. Though gear pumps are self priming, a foot valve is recommended. If possible, wet gears with the liquid to be pumped for the first dry start. Liquid retained in the system and gear chambers serves to wet the pump on subsequent starts.

EXPLODED VIEW AND PARTS LIST

Series	Model	Repair Kit
S930 M	S9303ACF-C1	S9303ACF-C1K
	S9303ACF	S9303ACFK
	S93039CD-C6	S93039CD-C6K
	S93039CD	S93039CDK
	S9301FPN	S9301FPNK
	S9301FPC-C6	S9301FPC-C6K
	S9301FPC	S9301FPCK
	S9301FPA	S9301FPAK
	S9301FCL	S9301FCLK
	S9301FCA-C2	S9301FCA-C2K
	S9301FCA	S9301FCAK
	S9301ECC	S9301ECCK
	S9301ECB-C1	S9301ECB-C1K
	S9301ECB	S9301ECBK
	S9301BCJ-C2	S9301BCJ-C2K
	S9301BCJ	S9301BCJK
	S9301BCB-EC5	S9301BCB-EC5K
	S93017PQ	S93017PQK
	S93017PJ-C5	S93017PJ-C5K
	S93017PJ	S93017PJK
	S93017PC	S93017PCK

DIMENSIONS


L
D
E
T
S
2X A
C
øB
M
CHEMSTEEL
R
K
N
O
P
4X øJ
G
H
F
2X 1/8-27 NPT
SEAL FLUSH CONNECTIONS


CAPACITOR CASE AND GASKET
WHEN REQUIRED
øAP
AD
AC
AB
AA
NAMEPLATE
CONDUIT
BOX
WHEN
REQUIRED
LOCATION
MAY
VARY
XO
O
1.00
D1
2F
AE
H
2E

MAINTENANCE

A three-part housing provides easy disassembly and service. Full size bearings match the gear diameter, and eliminate the need for separate wear plates. TFE encapsulating silicone O-ring pump housing seals provide elastic memory to assure an effective long lasting seal and thus avoiding the re-torquing required of pumps using pure TFE. The upper shaft configuration lends itself to inline pump seal maintenance without the leakage of trapped chemicals from an incompletely drained pump.
To order a CHEMKIT™ parts kit, simply add a “K” to the end of the model number.
A repair kit contains the following parts: seals, bearings, gears, o-rings, shafts, keys, c clips, and retaining ring.

FIT

Connections are 1 1/2” female NPT or BSPT, pump hardware is metric and close couple adapters mount to both NEMA and IEC standard motor frame sizes for world wide acceptance. “Near” dimensional interchangeability offers easy upgrade to CHEMSTEEL™ pump. The port size is the same as competitive pumps.

CHEMSTEEL™ PUMP

CHEMSTEEL PUMPS SERIES R102 M



FEATURES

- Gear/bearing design allows for “trimming” for optimizing the pump’s maximum flow to reach minimum turndown or to match flow to a specific OEM’s requirement.
- Special materials combinations are available for specific liquids:
- Stainless or Alloy C housing construction.
- Gears available in 316 stainless, Alloy C. Also in Polytetrafluoroethylene (PTFE), and Polyetheretherketone.
- Shafts are 316 stainless steel or Alloy C.
- Bearings available in carbon or Polytetrafluoroethylene (PTFE)
- Full range of seal options including lip seal, packing and mechanical designs.

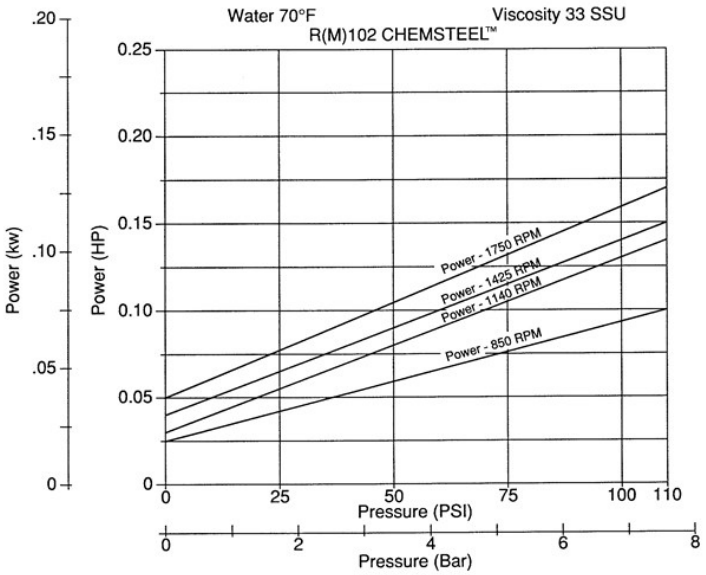
DRIVE

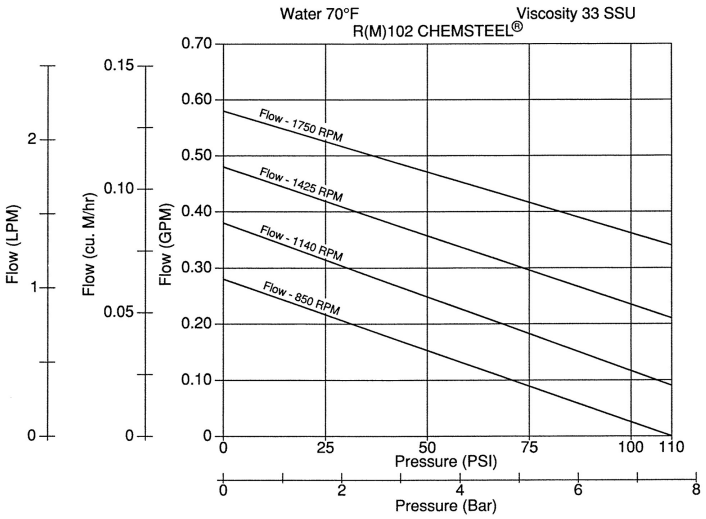
The pump is driven directly from the electric motor shaft by means of a flexible coupling. A close-coupled adapter connects the pump to the motor.

LIQUIDS AND TEMPERATURE

This pump is suitable to handle clear lubricating and non-lubricating fluids at temperatures to 450F. These pumps will handle viscous fluids to 100,000 cps (462,000 SSU) at reduced shaft speeds.

PERFORMANCE

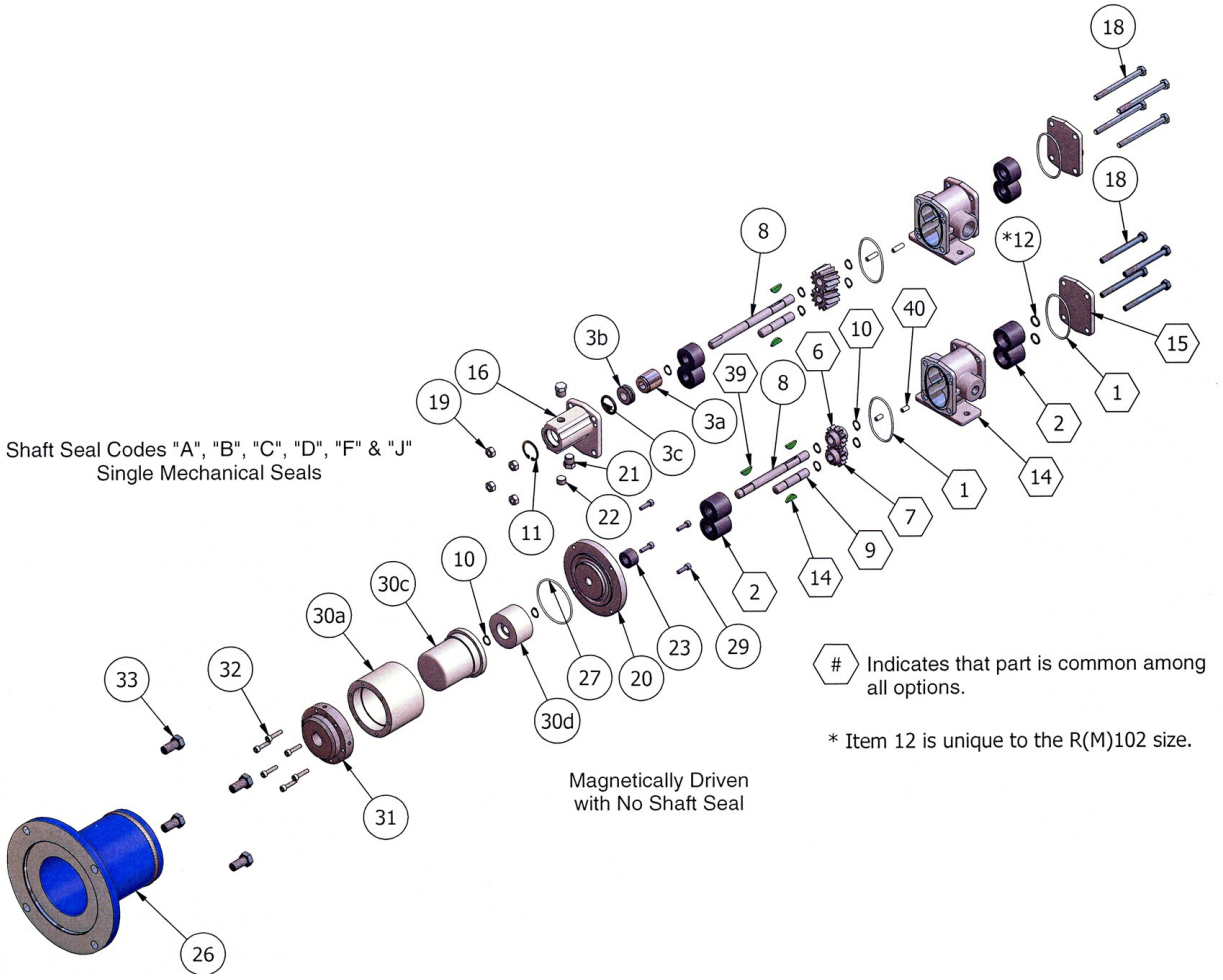


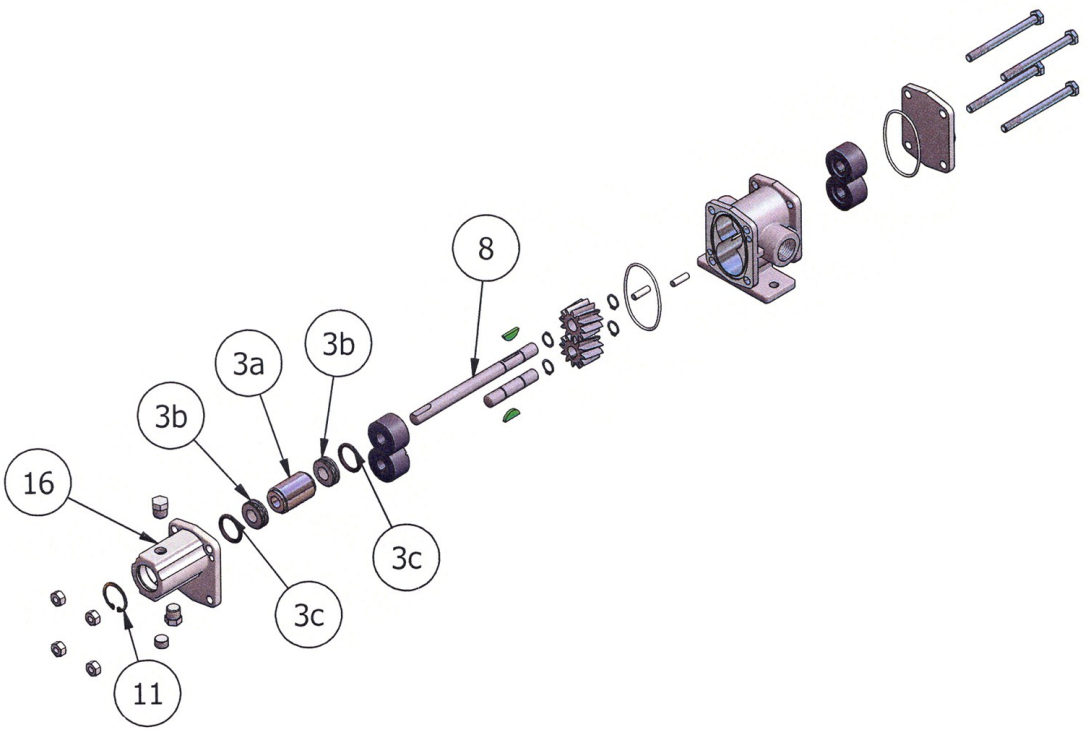


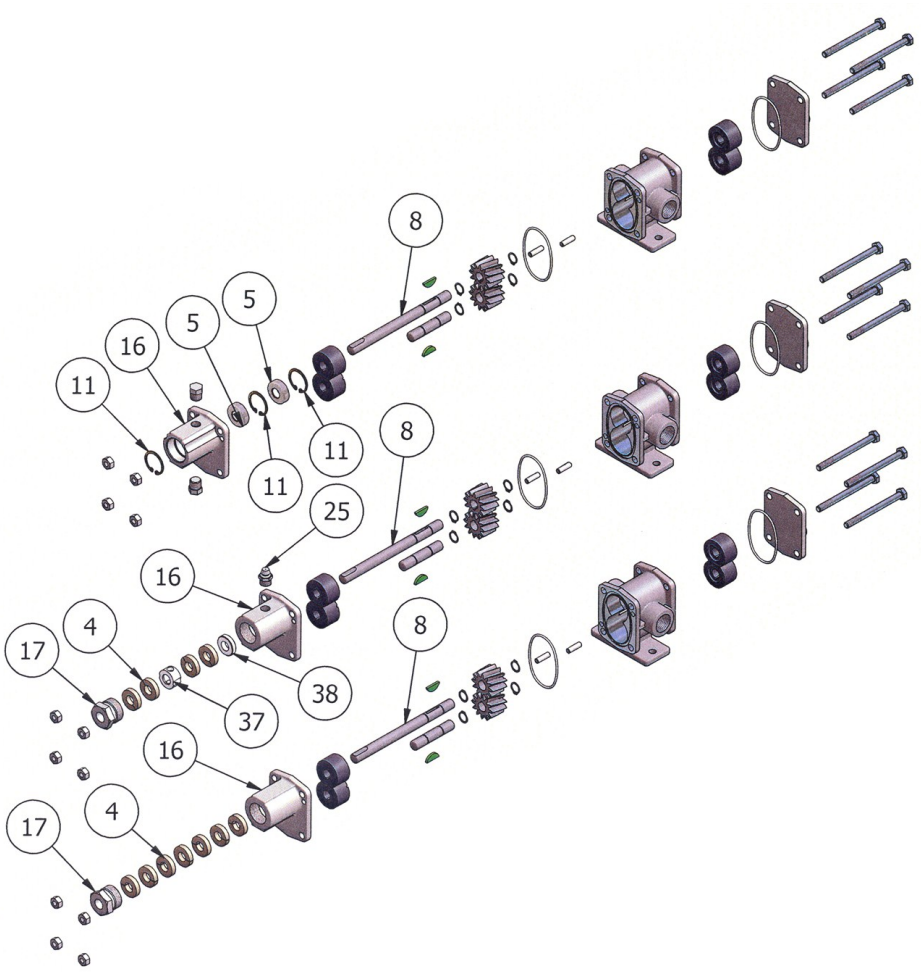
SUCTION LIFT

This pump has a suction lift capability of 20 feet for a new pump. Though gear pumps are self-priming, a foot valve is recommended. If possible, wet gears with the liquid to be pumped for the first dry start. Liquid retained in the system and gear chambers serves to wet the pump on subsequent starts.

EXPLODED VIEW AND PARTS LIST







Shaft Seal Codes ·.
Packing with Lante.

Shaft Seal Codes "N", "P" & "Q"
Packing

SERIES R102 / RM102 METAL PUMPS

Revised 01/27/05

CHEMkit Parts

No.	Part No.	Part Name	Req.	GEAR CODE											BEARING CODE	
				2	3	4	5		7		9			E	F	C	P
6	2315	Drive Gear-316 SS	1	■										■	■		
6	2320	Drive Gear-PEEK	1		■												
6	2319	Drive Gear-Alloy C	1			■	■				■						
6	2317	Drive Gear-Teflon	1						■								
7	2315	Idle Gear-316 SS	1											■			
7	2320	Idle Gear-PEEK	1	■	■						■						
7	2319	Idle Gear-Alloy C	1			■											
7	2317	Idle Gear-Teflon	1				■		■						■		
2	2318	Bearing, Carbon Graphite	4													■	
2	2316	Bearing, Teflon	4														■
23	2313	5th Bearing, Carbon Graphite	1													■	
23	2314	5th Bearing , Rulon	1														■

				SEAL CODE's																MAG CODE's	
				A	B	C	D	F	G	H	J	Z	L	N	P	Q	R	S	T	M	W
1	9355-031	O-Ring, Body -Teflon Encapsulating Silicone	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	32674A	Single Mech. Stainless Wedge Carb/Ceramic/TFE/Kalrez	1	■																	
3	32823	Single Mech. Alloy C Wedge Carb/Ceramic/TFE/Kalrez	1				■														
3	33067	Single Mech. Stainless Wedge Carb/SilCarb/TFE/Kalrez	1			■															
3	33068	Single Mech. Alloy C Wedge Carb/SilCarb/TFE/Kalrez	1					■													
3	33065	Single Mechanical Bellows Carb/Ceramic/Viton/Viton	1		■																
3	33073	Single Mechanical Bellows SilCarb/Silcarb/EPDM/EPDM	1								■										
3	33075	Double Mechanical Wedge Carb/SilCarb/TFE/Kalrez	1						■												
3	33078	Double Mechanical Bellows Carb/Ceramic/Viton/Viton	1							■											
3	33131	Single Mechanical Bellows SilCarb/Silcarb/Viton/Viton	1									■									
4	9140	Packing Ring, Teflon with Graphite	7 or 4											7			4				
4	9483	Packing Ring, Grafoil	7 or 4												7			4			
4	2498	Packing Ring, Teflon	8 or 5													8			5		
5	2748	Lip Seal	2										■								
8	3127	Drive Shaft - Single Mechanical Seals (Stainless)	1	■	■	■					■	■									
8	3128	Drive Shaft - Single Mechanical Seals (Alloy C)	1				■	■			■										
8	3129	Drive Shaft (Stainless)	1						■	■			■	■	■	■	■	■	■		
8	3130	Drive Shaft (Alloy C)	1						■	■			■	■	■	■	■	■	■		
8	2306	Drive Shaft - Mag (Stainless)	1																	■	■
8	2307	Drive Shaft - Mag (Alloy C)	1																	■	■
9	3131	Idle Shaft (Stainless)	1	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■
9	3132	Idle Shaft (Alloy C)	1				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
10	2067	Clip, Retaining (Stainless)	4,5, or 6	5	5	5	5	5	4	4	5	5	4	4	4	4	4	4	4	6	6
10	2068	Clip, Retaining (Alloy C)	4,5, or 6	5	5	5	5	5	4	4	5	5	4	4	4	4	4	4	4	6	6
11	7065	Retaining Ring	1 or 3	1	1	1	1	1	1	1	1	1	3								
12	2336	Wave Spring (Alloy C)	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
39	9524	Key, Woodruff	1																	■	■
14	9524	Key, Woodruff	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

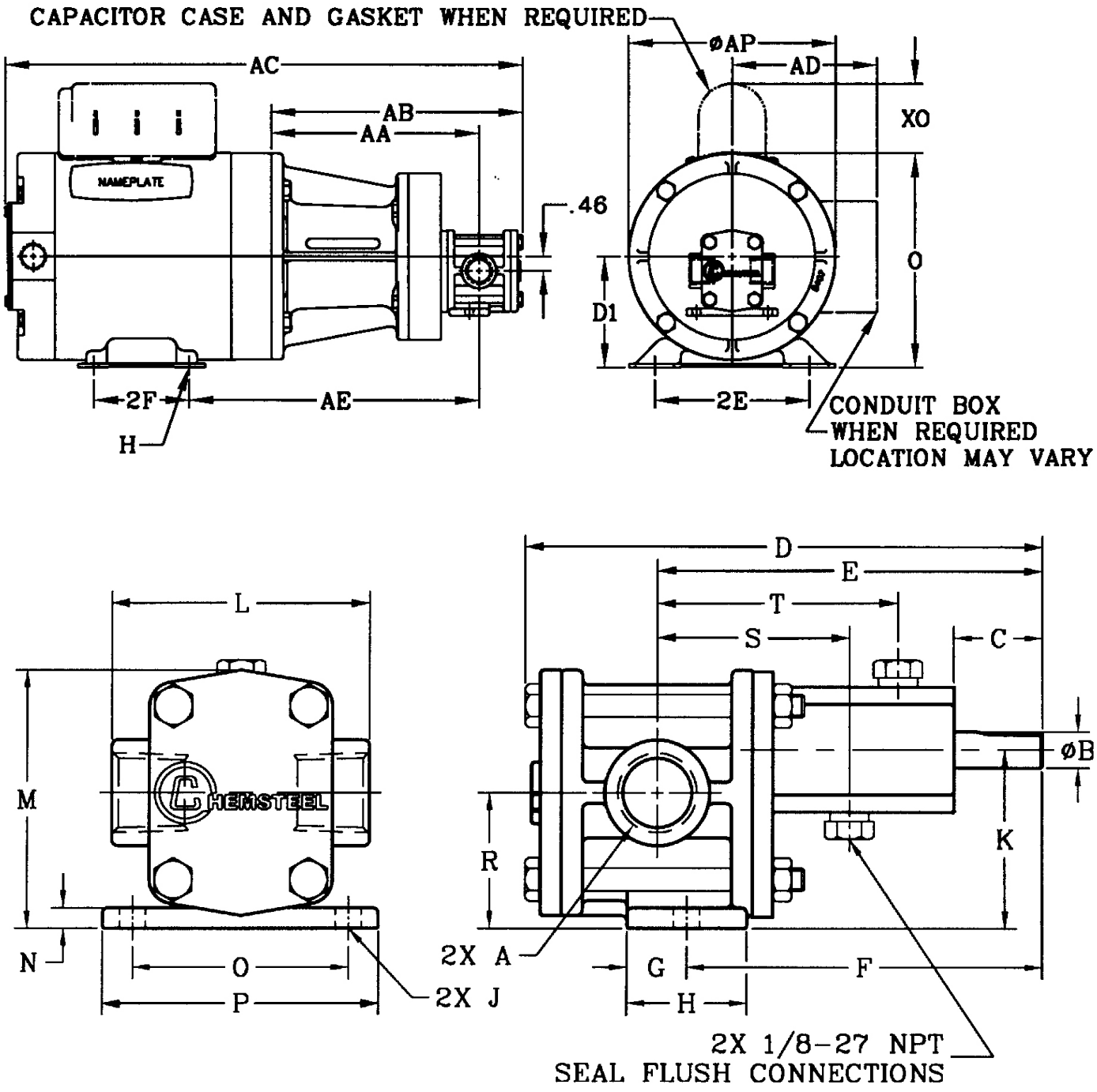
Other Parts

				SEAL CODE's																MAG CODE's	
				A	B	C	D	F	G	H	J	Z	L	N	P	Q	R	S	T	M	W
14	9127S-1P	Body with 1/4" NPT Ports (Stainless)	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
14	9127H-1P	Body with 1/4" NPT Ports (Alloy C)	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
15	9128S-1	Rear Cover (Stainless)	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
15	9128H-1	Rear Cover (Alloy C)	1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
16	9130S-3	Front Cover, Single/ Double Mechanical (Stainless)	1	■	■	■	■	■	■	■	■	■									
16	9130H-3	Front Cover, Single/ Double Mechanical (Alloy C)	1	■	■	■	■	■	■	■	■	■									
16	9129S-5	Front Cover, Lip (Stainless)	1										■								
16	9129S-1	Front Cover, Packing (Stainless)	1											■	■	■					
16	9129H-1	Front Cover, Packing (Alloy C)	1											■	■	■					
16	9129S-3	Front Cover, Lantern Packing (Stainless)	1														■	■	■		
16	9129H-3	Front Cover, Lantern Packing (Alloy C)	1														■	■	■		
17	9138	Pack Nut (Stainless)	1											■	■	■	■	■	■		
17	2746	Pack Nut (Alloy C)	1											■	■	■	■	■	■		
18	9365-070	Hex Head Cap Screws	4	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
18	9365-062	Hex Head Cap Screws (Mag)	4																	■	■
19	9367	Hex Nuts	4	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
40	9793	Dowel Pin	2	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
21	6600-01	Hex Head Pipe Plug (Stainless)	2	■	■	■	■	■	■	■	■	■	■								
21	6600-02	Hex Head Pipe Plug (Alloy C)	2	■	■	■	■	■	■	■	■	■	■								
25	5390-01	Grease Lubrication Fitting	1														■	■	■		
38	2695	Starter Ring	1														■	■	■		
37	2671	Lantern Ring	1														■	■	■		
20	2312S	Pump Adapter (Stainless)	1																	■	■
20	2312H	Pump Adapter (Alloy C)	1																	■	■
26	2302-01	Bell Housing	1																	■	■
27	9355-033	O-Ring, Containment Can -Teflon Encapsulating Silicone	1																	■	■
29	2481-014	Hex Head Cap Screws (Bell/Pump Adapter)	4																	■	■
30 a b c d	2023-3NS	Magnet Kit, Neo (Stainless)	1																	■	
30 a b c d	2023-3NH	Magnet Kit, Neo (Alloy C)	1																	■	
30a b c d	2023-3SS	Magnet Kit, Sam C (Stainless)	1																		■
30a b c d	2023-3SH	Magnet Kit, Sam C (Alloy C)	1																		■

31,32,33,34,35	catalog	Mag - Power End Kit (motor hub, adapters, hardware)
	2464	Optional Mag Foot Kit (not shown)
	catalog	Sealed - Close Coupled Adapter Kit (not shown- faceplate, motor adapter, couplings, hardware)
	catalog	Sealed- Long Mount Bedplate Kits (not shown - base, shims, couplings, coupling guard, hardware)
	catalog	Motors (not shown)
	catalog	Pressure Relief Valve (not shown)

Series	Model	Repair Kit
R102 M	R10212CA	R10212CAK
	R10212CB	R10212CBK
	R10212CB-C1	R10212CB-C1K
	R10212CB-C2	R10212CB-C2K
	R10212CB-E	R10212CB-EK
	R10212CZ	R10212CZK
	R10212CZ-C1	R10212CZ-C1K
	R10212PB	R10212PBK
	R10212PB-C1	R10212PB-C1K
	R10212PC	R10212PCK
	R10213CA	R10213CAK
	R10213CB	R10213CBK
	R10213CB-C1	R10213CB-C1K
	R10213CC	R10213CCK
	R10213CC-C1	R10213CC-C1K
	R10213CL-E	R10213CL-EK
	R10213PA	R10213PAK
	R10213PA-C1	R10213PA-C1K
	R10213PB	R10213PBK
	R10213PB-C1	R10213PB-C1K
	R10213PZ	R10213PZK
	R10213PZ-C1	R10213PZ-C1K
	R10216CA	R10216CAK

DIMENSIONS


CAPACITOR CASE AND GASKET WHEN REQUIRED
AC
AB
AA
NAMEPLATE
.46
ØAP
AD
XO
O
D1
2F
AE
H
2E
CONDUIT BOX
WHEN REQUIRED
LOCATION MAY VARY
L
M
N
O
P
2X J
D
E
T
S
C
ØB
K
R
2X A
G
F
H
2X 1/8-27 NPT
SEAL FLUSH CONNECTIONS

MAINTENANCE

A three-part housing provides easy disassembly and service. Full size bearings match the gear diameter, and eliminate the need for separate wear plates. TFE encapsulating silicone o-ring pump housing seals provide elastic memory to assure an effective long lasting seal and thus avoiding the re-torqueing required of pumps using pure TFE. The upper shaft configuration lends itself to in-line pump seal maintenance without the leakage of trapped chemicals from an incompletely drained pump. To order a CHEMKIT™ parts kit, simply add a “K” to the end of the model number. A repair kit contains the following parts: bearings, gears, o-rings, shafts, keys, c clips, and retaining ring.

LIFE CYCLE/COST OF OWNERSHIP

Pump design and materials selection, together provide the longest life available from a gear pump. Key attributes include:

- Gear & bearing combinations of metallic and nonmetallic wear surfaces.
- Slotted bearings to lubricate shaft and gear surfaces.
- Hydraulic porting to balance axial thrust and to reduce wear.
- Ample port sizing to reduce the likelihood of cavitation when inlet pressure is marginal.
- Effective housing seals with elastic memory prevent leakage of corrosives.

FIT

Connections are 1/4“ female NPT or BSPT, pump hardware is metric and close couple adapters mount to both NEMA and IEC standard motor frame sizes for worldwide acceptance. “Near” dimensional interchangeability offers easy upgrade to CHEMSTEEL™ pump. The port size is the same as competitive pumps.

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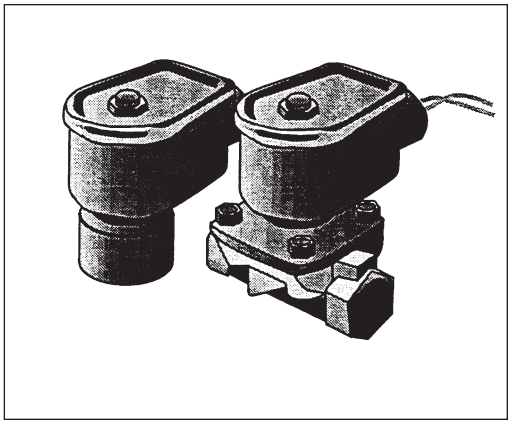
APPENDIX XIII

Omega Solenoid Valve

omega.com®
OMEGA®

SV100 and SV200 SERIES

Solenoid Valves



INSTRUCTION SHEET

M1103/0308

Shop online at: omega.com e-mail: info@omega.com
For latest product manuals: omegamanual.info

DESCRIPTION

The OMEGA® SV100 and SV200 Series Solenoid Valves for liquids and gases cover most industrial and laboratory applications. The valves are available in sizes ranging from 1/4" to 2" NPT, with CV's as high as 38. OMEGA also offers general purpose 2, 3, and 4-way valves made of brass or stainless steel, and specialty valves for hot water and steam applications.

WARNING: When using solenoid valves, the possibility of creating damaging water hammers exists. Install proper surge suppressors on the line in front of susceptible electronic pressure, flow, and pH equipment.

TWO-WAY VALVES

Two-way Normally Closed Valves (121-128, 201-207, 221-225, 231-235, 281-287)

When the valve is de-energized, flow through the valve is prevented. When the valve is energized, flow through the valve occurs.



Figure 1. Two-way Valves

Two-way Normally Open Valves (131-133, 211-217, 291-295)

When the valve is de-energized, flow through the valve occurs. When the valve energizes, flow through the valve is prevented.

Anti-Water Hammer Solenoid Valves (SV283-287, 291-295)

The closing time on these valves can be adjusted by a 4-position selector. Position 1 allows fast closing, while 4 allows slowest closing setting. SV281 and SV282 are anti-water hammer valves, but they do not have this adjustment for varying the closing time. Normally Closed anti-water hammer valves SV283-287 are supplied with a manual override.

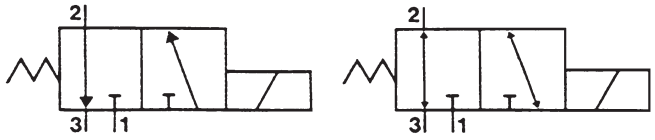
THREE-WAY VALVES

Three-way Normally Closed Valves (SV241, 242, 261)

A three-way Normally Closed valve has three ports labeled 1, 2, and 3. When de-energized, no flow occurs from Port 1, but there is flow from Port 2 to Port 3. When energized, flow occurs from Port 1 to 2, but no flow occurs from Port 3. Normally three-way valves are used to control larger pneumatically-activated valves. When controlling pneumatic-activated valves, Port 1 is connected to the pressure source, Port 2 is connected to the cylinder controlling the pneumatic activation, and Port 3 is the exhaust port vented to the room. Refer to Figure 2.

Multi-Purpose Three-Way Valve (SV251)

The SV251 has the same flow paths as above, except supply pressure can be connected to any of the ports to set a variety of functions. When the valve is being used to control a pneumatically-activated cylinder, it can serve as a Normally Open or a Normally Closed valve by selecting the proper ports. To configure it as a Normally Closed three-way valve, Port 1 is supply pressure, Port 2 is connected to pneumatic cylinder, and Port 3 is exhaust port. To configure as a Normally Open, three-way valve, Port 3 is pressure supply, Port 2 is connected to the pneumatic cylinder, Port 1 is exhaust port. Refer to Figure 2.



Normally Closed **Multi-purpose**

Figure 2. Three-way Valves

FOUR-WAY VALVE (SV271)

The SV271 is a four-way directional control valve. A four-way valve has ports labeled 1, 2, 3, 4, and 5. When de-energized, pressure is supplied to Port 1 which is open to cylinder Port 4, and closed to cylinder Port 2. Port 4 is closed to exhaust Port 5. When energized, pressure Port 1 is closed to cylinder Port 4, and is open to cylinder Port 2. Cylinder Port 2 is closed to exhaust Port 3. Cylinder Port 4 is open to exhaust Port 5. Refer to Figure 3.

The SV271 can be used as a three-way Normally Closed valve by plugging Port 4, or as a Normally Open valve by plugging Port 2, keeping Port 1 as supply pressure, and Ports 3 and 5 open as exhaust ports. Refer to Figure 3.

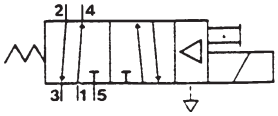


Figure 3. Four-way Valve

Note: Quick Exhaust Valve SV261 and four-way valve SV271 have sleeve pilot exhaust ports which cannot be blocked.

PRESSURE REQUIREMENTS

Actual line pressures must be below maximum line pressures listed on valve label. No minimum pressure is required except for the following valves:

128, 203-207, 211-217, 283-287, 291-295:	5 PSID
SV271:	15 PSID
SV281-282:	3 PSID
SV261:	2 PSID

LUBRICATION

Lubrication is not required, although it will increase valve life.

CAUTION: Hot water and steam valves have parts made of ethylene propylene rubber and must not be exposed to petroleum-based lubricants or other hydrocarbons.

MOUNTING POSITION

Valves are mounted directly on piping and are designed to operate in any position. SV128 must be mounted in an upright position.

PIPING INSTALLATION

Remove plastic caps from valve body. Connect piping to valve body. Use of thread compounds or sealants is permissible (OMEGA PTFE Tape).

CAUTION: Do not allow foreign particles or thread compound to enter valve.

Body port tightening torques should not exceed the following:

100 in-lbs for 1/8" NPT
175 in-lbs for 1/4" NPT
225 in-lbs for 3/8" NPT
300 in-lbs for 1/2" NPT
450 in-lbs for 3/4" NPT
600 in-lbs for 1v NPT
700 in-lbs for 1-1/4" NPT
750 in-lbs for 1-1/2" NPT
950 in-lbs for 2v NPT

MEDIA FILTRATION

Media filtration normally is not required, although direct or foreign material in media may cause excessive leakage, excessive wear, or in extreme cases, malfunction. If filtration is used, install the filter in the inlet side as close to the valve as possible. Clean periodically, depending on service. Filtration of 100 microns or better is recommended on 128, 203-207, 211-217. Filtration of 5-25 microns or better is recommended on SV241, 242, 251, 261, 271.

ELECTRICAL WIRING

Electrical supply must conform to nameplate rating. Connect coil leads to electrical circuit using standard electrical practice. If the coil is located in an inconvenient location, it may be re-oriented to facilitate installation. To re-orient the coil, loosen sleeve nut, rotate coil to desired position, re-tighten sleeve nut (43-53 in-lbs). The coils have two wires and either wire can be hot or neutral.

SPECIFICATIONS

CONSTRUCTION

All the solenoid valves are a two-piece modular construction. The two parts are the coil and valve body. To separate the two pieces, remove the nut on the top of the sleeve.

WETTED PARTS

SV100 Series:	Stainless steel, copper, and seal, 128 polysulfone additional
SV200 Series:	Brass, stainless steel, copper and seal SV201, 202, 281, 282 FKM additional; SV211, 212 ruby and FKM additional; SV241, 242, 251 Delrin additional; SV271 aluminum, Delrin, stainless steel, copper and seal

SEAL

Kel-F (3M trademark):	121
FKM:	122-127, 131-133, 241, 242, 251
PTFE:	128
Buna-N (Nitrile):	201-207, 211-217, 261, 271, 281-287, 291-295
EPDM (Ethylene Propylene Terpolymer):	SV221-225, 231-235

AMBIENT TEMPERATURE

10 watt coil:	15 to 150°F
22 watt coil:	15 to 77°F
Steam valves (SV231-235):	15 to 122°F

COIL

10 watts, 120 Vac, Class F:	121, 128, 201-207, 211-217, 221-225, 261, 271, 281-287, 291-295
10 watts, 120 Vac, Class H:	SV122-127, 131-133, 231-235, 241, 242, 251

FLUID CODES

Listed below are the codes utilized by Underwriters Laboratories (UL) and the Canadian Standards Association (CSA) for various common fluids. The codes for those fluids that are approved or certified by the agencies for use with each valve are printed on the outside of the individual packaging.

CODE	FLUID
A	Air or nontoxic, nonflammable gases
AC	Acetylene
F	Common refrigerants except ammonia
G	City gas supplied by public utilities
GA	Gasoline
HO	Petroleum-based hydraulic oils having viscosities from 125 to 400 SSU at 38°C
LP	Liquid propane gas
02	Nos. 1 and 2 fuel oils, oils having viscosities not more than 40 SSU at 38°C
02-06	No. 2 through No. 6 oil
OX	Oxygen
S	Steam
W	Water or other aqueous nonflammable liquids

For the maximum fluid temperature, as well as valve ambient limitations, check the valve part number on the nameplate and refer to the outside of the shipping package.

PART NO.	VALVE TYPE	PORT MARKING

2-Way Normally Closed Valves

SV121-127	Direct Acting	1 = OUT, 2 = IN
SV106, SV128	Pilot Operated	2 = IN, 1 = OUT
SV201, 202	Direct Lift	Flow
SV222-225, 232-235 SV203-207	Pilot Operated	Arrow
SV281-287 SV221, SV231	Direct Operated	1 = IN, 2 = OUT

2-Way Normally Open Valves

SV131-133	Direct Operated	2 = OUT, 3 = IN
SV211-217, 291-295	Pilot Operated	Flow Arrow

3-Way Normally Closed Valves

SV241, SV242	Direct Operated	1 = Pressure 2 = Cylinder 3 = Exhaust
SV261	Direct Operated	1 = Pressure 2 = Cylinder 3 = Exhaust (0 = Pilot Exhaust)

3-Way Multipurpose Valves

SV251	Direct Operated	1, 2 or 3 = Pressure

4-Way Directional Control Valves

SV271	Pilot Operated	1 = Pressure 2 = Cylinder A 3 = Exhaust A 4 = Cylinder B 5 = Exhaust B

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Tel: (514) 856-6928
FAX: (514) 856-6886
e-mail: info@omega.ca

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e-mail: sales@omega.co.uk

It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice. **WARNING:** These products are not designed for use in, and should not be used for, human applications.

MADE IN USA

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:
1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:
1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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APPENDIX XIV

Perkins
Engine Operation and Maintenance Manual

SEBU9064-07 (en-us)
December 2020

Perkins®

THE HEART OF EVERY GREAT MACHINE

Operation and Maintenance Manual

402F-05, 403F-07, 403F-11 and 403F-15 Industrial Engines

EG (Engine)
EH (Engine)
EJ (Engine)
EK (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions correctly.

Incorrect operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Perkins cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Perkins is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Perkins dealers or Perkins distributors have the most current information available.

⚠ WARNING

When replacement parts are required for this product Perkins recommends using Perkins replacement parts.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

Table of Contents

Foreword 4

Safety Section

Safety Messages 6

General Hazard Information 7

Burn Prevention 10

Fire Prevention and Explosion Prevention 11

Crushing Prevention and Cutting Prevention .. 13

Before Starting Engine 13

Engine Starting 14

Engine Stopping 14

Electrical System 14

Product Information Section

General Information 16

Product Identification Information 28

Operation Section

Lifting and Storage 30

Features and Controls 32

Engine Diagnostics 36

Engine Starting 39

Engine Operation 42

Cold Weather Operation 43

Engine Stopping 47

Maintenance Section

Refill Capacities 48

Maintenance Recommendations 65

Maintenance Interval Schedule 68

Warranty Section

Warranty Information 105

Reference Information Section

Reference Materials 106

Index Section

Index 107

Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.

WARNING – This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

This manual contains safety, operation instructions, lubrication, and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study, and keep the manual with the literature and engine information.

English is the primary language for all Perkins publications. The English used facilitates translation and consistency.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Perkins dealer or your Perkins distributor for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this product.

Operation

Operating techniques outlined in this manual are basic. The operating techniques assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and the capabilities of the engine.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating, and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation, and application. Perkins recommends that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. Perkins also recommends that a maintenance record be maintained as part of the permanent record of the engine.

Your authorized Perkins dealer or your Perkins distributor can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Perkins distributor or dealer. Your Perkins dealer or your Perkins distributor offers various options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available. Consult with your Perkins dealer or your Perkins distributor for information regarding these options.

Safety Section

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Safety Messages

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Become familiar with all warning signs.

Ensure that all the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Perkins dealer or your distributor can provide new warning signs.

(A) Universal Warning

⚠ WARNING

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.

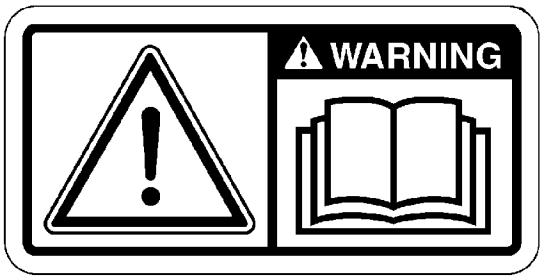


Illustration 1 g01154807

Typical example

Warning label (A) is installed in different locations. The location will change according to the physical size of the engine.

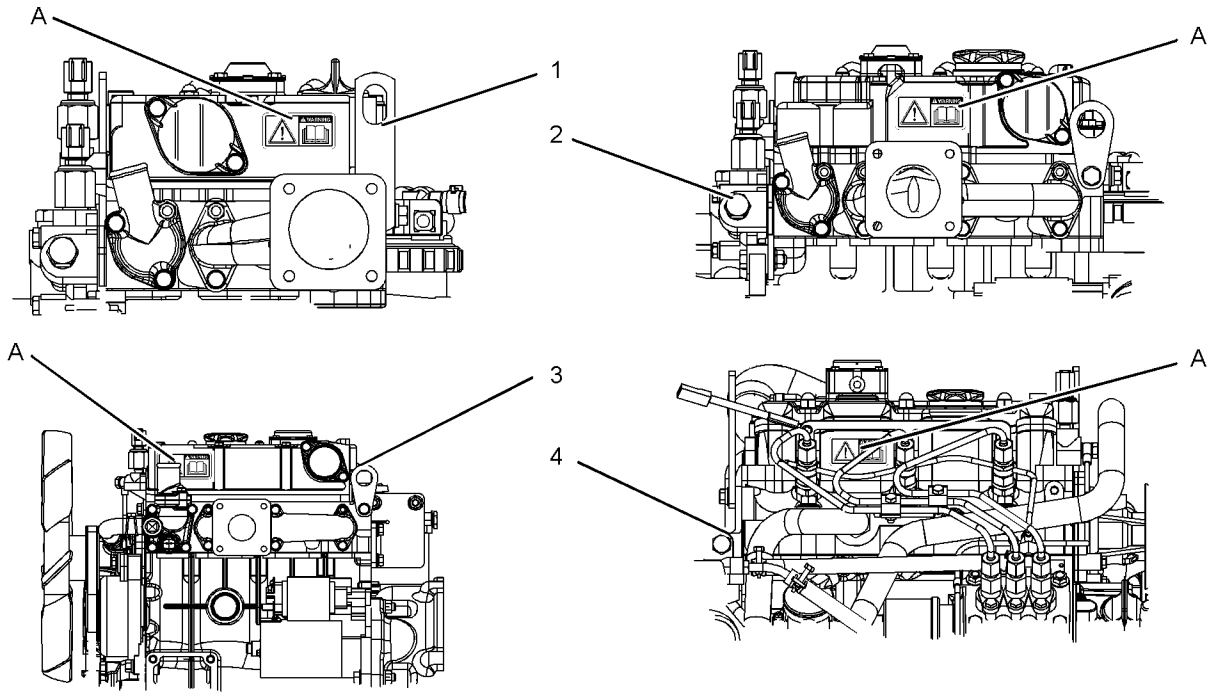


Illustration 2 g03378379

Typical examples

(A) Location of warning label
(1) 402F-05
(2) 403F-07
(3) 403F-11
(4) 403F-15

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General Hazard Information

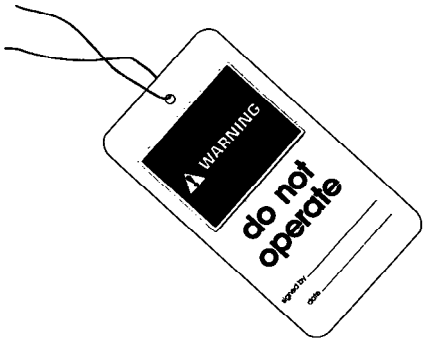


Illustration 3 g00104545

Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls before you service the equipment or before you repair the equipment.

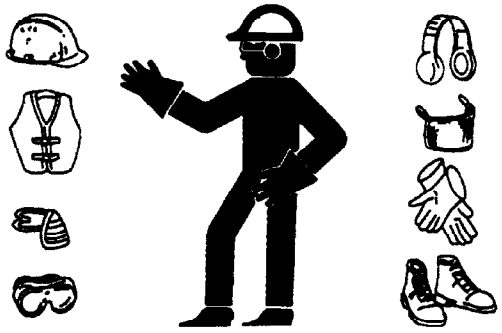


Illustration 4 g00702020

Wear a hard hat, protective glasses, and other protective equipment, as required.

Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.

Make sure that all protective guards and all covers are secured in place on the engine.

Keep the engine free from foreign material. Remove debris, oil, tools, and other items from the deck, from walkways, and from steps.

Never put maintenance fluids into glass containers. Drain all liquids into a suitable container.

Obey all local regulations for the disposal of liquids.

Use all cleaning solutions with care.

Report all necessary repairs.

Do not allow unauthorized personnel on the equipment.

Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads to help prevent sparks. If equipped, allow the diesel exhaust fluid to be purged before disconnecting the battery.

Perform maintenance on the engine with the equipment in the servicing position. Refer to the OEM information for the procedure for placing the equipment in the servicing position.

Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

For initial start-up of a new engine or for starting an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. The stopping of the engine may be accomplished by shutting off the fuel supply and/or the air supply to the engine. Ensure that only the fuel supply line is shut off. Ensure that the fuel return line is open.

Start the engine from the operators station (cab). Never short across the starting motor terminals or the batteries. This action could bypass the engine neutral start system and/or the electrical system could be damaged.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose to relieve any spring pressure or other pressure.

Pressure Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This action could result in personal injury.

The direct application of pressurized air or pressurized water to the body could result in personal injury.

When pressurized air and/or water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.

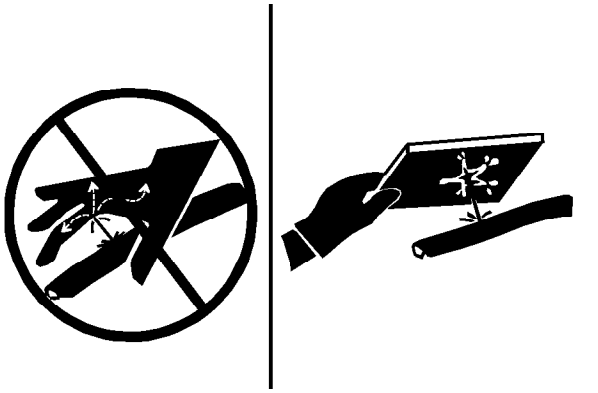


Illustration 5 g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the engine. Make provision to collect the fluid with a suitable container before any compartment is opened or before any component is disassembled.

- Only use the tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids.
- Only use the tools that are suitable for containing fluids and equipment that is suitable for containing fluids.

Obey all local regulations for the disposal of liquids.

Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel

The removal of sulfur and other compounds in ultra-low sulfur diesel fuel (ULSD fuel) decreases the conductivity of ULSD and increases the ability of ULSD to store static charge. Refineries may have treated the fuel with a static dissipating additive. Many factors can reduce the effectiveness of the additive over time. Static charges can build up in ULSD fuel while the fuel is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion. Ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system complies with fueling standards for proper grounding and bonding.

⚠ WARNING

Avoid static electricity risk when fueling. Ultra-low sulfur diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur contents. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

Inhalation

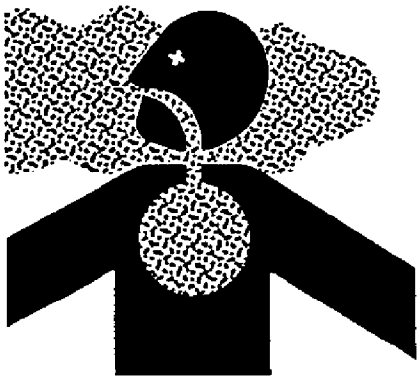


Illustration 6 g00702022

Exhaust

Use caution. Exhaust fumes can be hazardous to health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Hexavalent Chromium

Perkins equipment and replacement parts comply with applicable regulations and requirements where originally sold. Perkins recommends the use of only genuine Perkins replacement parts.

Hexavalent chromium has occasionally been detected on exhaust and heat shield systems on Perkins engines. Although laboratory testing is the only accurate way to know if hexavalent chromium is, in fact, present, the presence of a yellow deposit in areas of high heat (for example, exhaust system components or exhaust insulation) may be an indication of the presence of hexavalent chromium.

Use caution if you suspect the presence of hexavalent chromium. Avoid skin contact when handling items that you suspect may contain hexavalent chromium, and avoid inhalation of any dust in the suspect area. Inhalation of, or skin contact with, hexavalent chromium dust may be hazardous to your health.

If such yellow deposits are found on the engine, engine component parts, or associated equipment or packages, Perkins recommends following local health and safety regulations and guidelines, utilizing good hygiene, and adhering to safe work practices when handling the equipment or parts. Perkins also recommends the following:

- Wear appropriate Personal Protective Equipment (PPE)
- Wash your hands and face with soap and water prior to eating, drinking, or smoking, and also during rest room breaks, to prevent ingestion of any yellow powder
- Never use compressed air for cleaning areas suspected of containing hexavalent chromium
- Avoid brushing, grinding, or cutting materials suspected of containing hexavalent chromium
- Obey environmental regulations for the disposal of all materials that may contain or have come into contact with hexavalent chromium
- Stay away from areas that might have hexavalent chromium particles in the air.

Asbestos Information

Perkins equipment and replacement parts that are shipped from Perkins engine company limited are asbestos free. Perkins recommends the use of only genuine Perkins replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

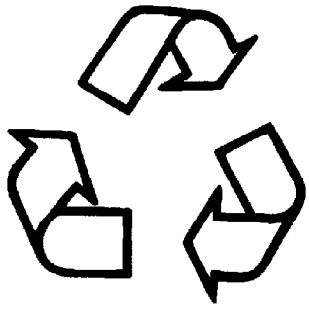


Illustration 7 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of in accordance with local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

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Burn Prevention

Do not touch any part of an operating engine. Operating engines exhaust gases could burn, do not come in contact with hot gases. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings, or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check that the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Skin may be irritated following repeated or prolonged exposure to mineral and synthetic base oils. Refer to your suppliers Material Safety Data Sheets for detailed information. Hot oil and lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Appropriate personal protective equipment should be used.

Diesel Fuel

Diesel may be irritating to the eyes, respiratory system, and skin. Prolonged exposure to diesel may cause various skin conditions. Appropriate personal protective equipment should be used. Refer to supplier Material safety Data sheets for detailed information.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

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Fire Prevention and Explosion Prevention



Illustration 8 g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within 15 minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Perkins dealer and/or your Perkins distributor for additional information about suitable protection devices.

Remove all flammable combustible materials or conductive materials such as fuel, oil, and debris from the engine. Do not allow any flammable combustible materials or conductive materials to accumulate on the engine.

Store fuels and lubricants in correctly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame-cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. Ensure that all electrical wires are correctly installed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and correctly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be correctly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be correctly installed. The filter housings must be tightened to the correct torque.



Illustration 9 g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

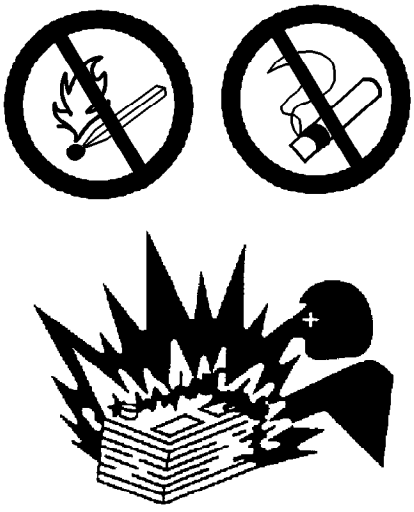


Illustration 10 g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Incorrect jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This action may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49° C (120° F). Keep ether cylinders away from open flames or sparks.

Lines, Tubes, and Hoses

Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install any lines that are bent or damaged. Do not clip any other items to the high-pressure lines.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Perkins dealer or your Perkins distributor for repair or for replacement parts.

Check lines, tubes, and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible parts of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, correct installation will help to prevent vibration, rubbing against other parts, and excessive heat.

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Crushing Prevention and Cutting Prevention

Support the component correctly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i05874054

Before Starting Engine

NOTICE
For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

Inspect the engine for potential hazards.

Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

See the Service Manual for repairs and for adjustments.

i02157354

Engine Starting

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Note: The engine is equipped with an automatic device for cold starting for normal conditions of operation. If the engine will be operated in very cold conditions, then an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for your region of operation.

The 400 Series engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting.

i02234873

Engine Stopping

Stop the engine according to the procedure in the Operation and Maintenance Manual, “Engine Stopping (Operation Section)” in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled.

To stop an electronically controlled engine, cut the power to the engine and/or shutting off the air supply to the engine.

i02176668

Electrical System

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “−” jump start cable should be connected last from the external power source to the negative “−” terminal of the starting motor. If the starting motor is not equipped with a negative “−” terminal, connect the jump start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Grounding Practices

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative “-” battery terminal with a wire that is adequate to handle the full charging current of the alternator.

Product Information Section

General Information

i08136270

Model View Illustrations

403F-15 Engine View

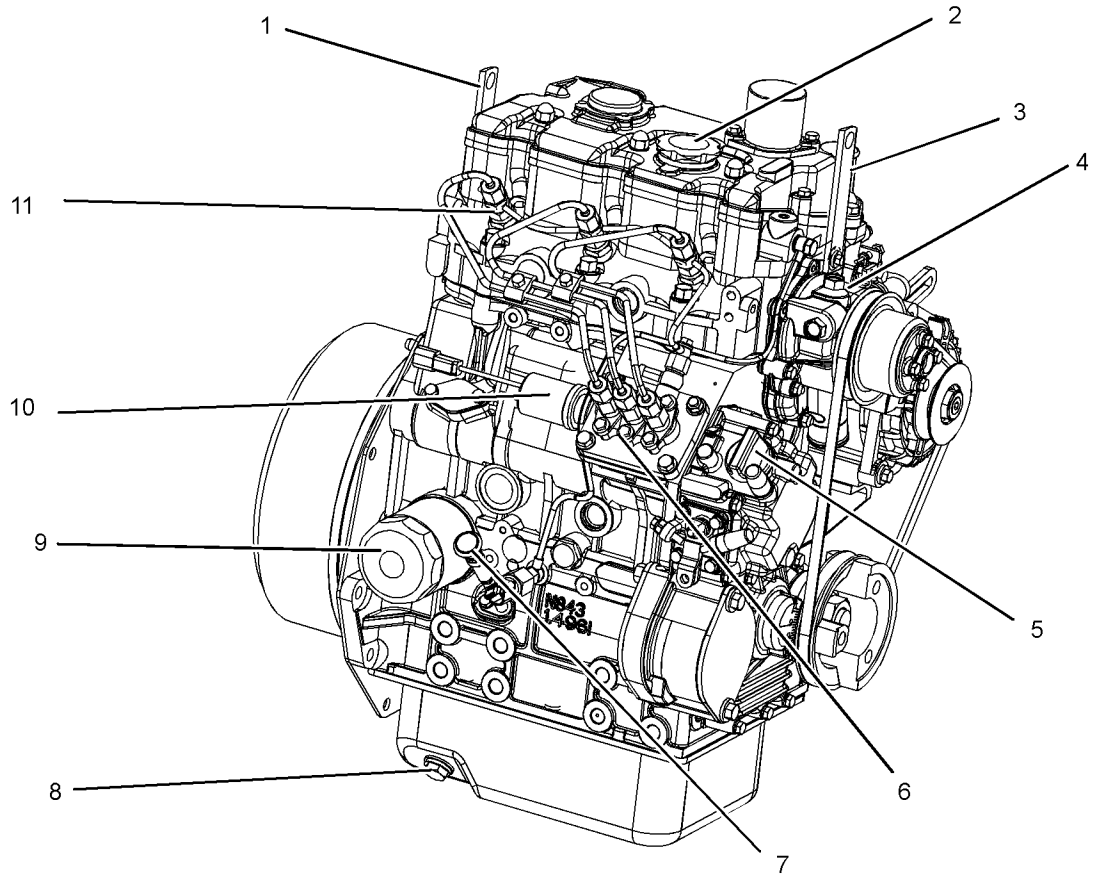


Illustration 11 g03378808

Typical example

(1) Rear lifting eye
(2) Top oil filler cap
(3) Front lifting eye
(4) Water pump
(5) Low mounted oil filler cap
(6) Fuel injection pump
(7) Oil gauge (Dipstick)
(8) Oil drain plug
(9) Oil filter
(10) Electronically controlled actuator or stop solenoid
(11) Injector

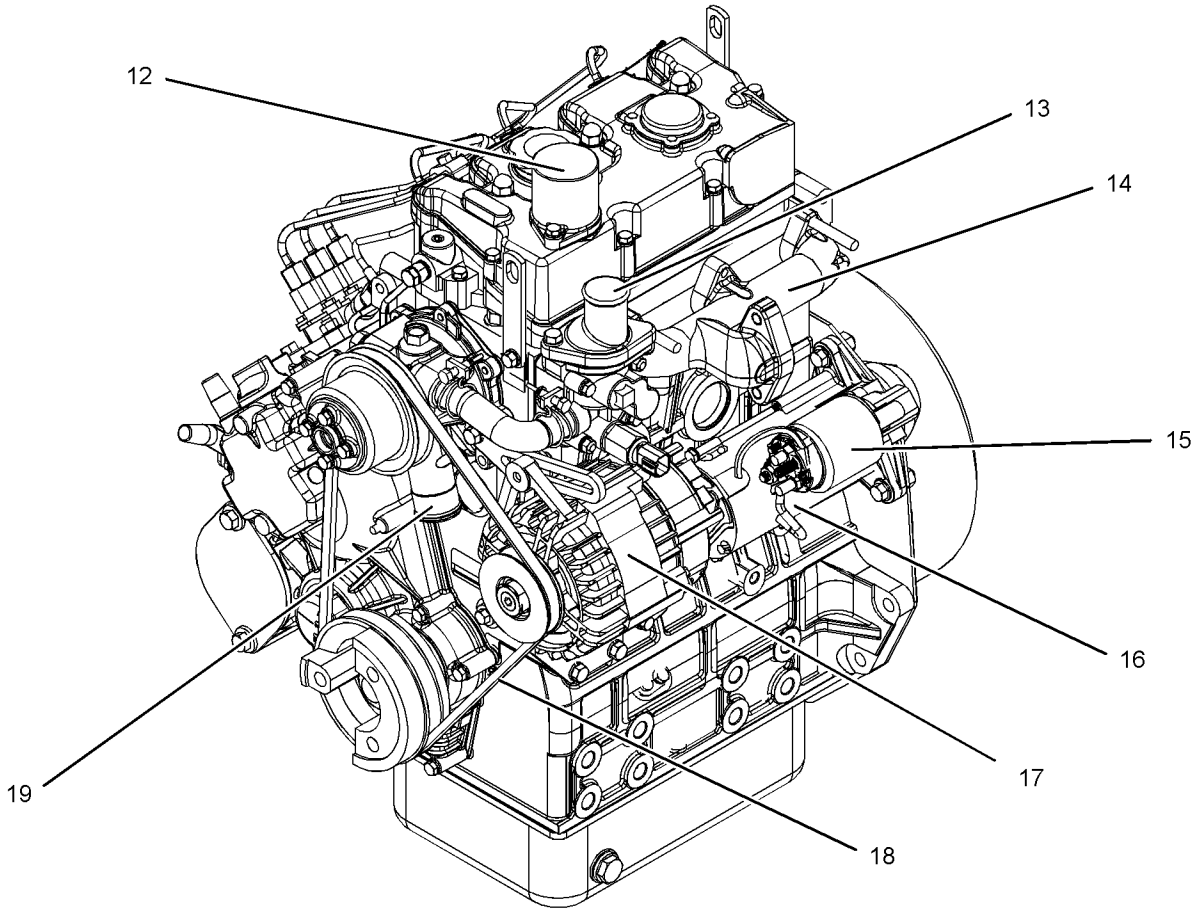


Illustration 12 g03379877

(12) Air intake
(13) Coolant outlet
(14) Exhaust manifold
(15) Solenoid for starter
(16) Starting motor
(17) Alternator
(18) Fan belt
(19) Coolant intake connection

403F-11 Engine View

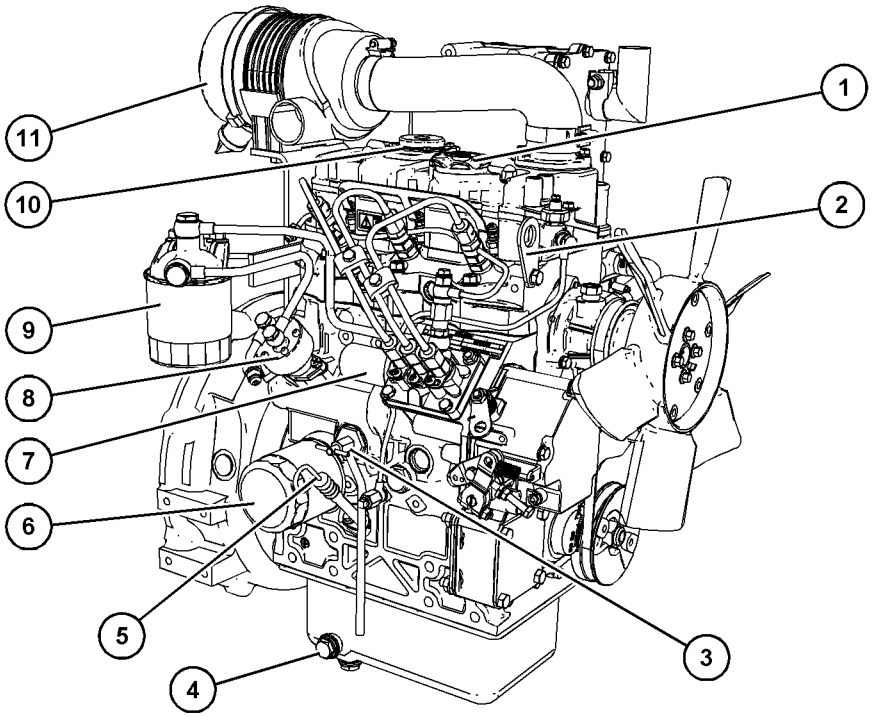


Illustration 13 g06563478

Typical example

(1) Oil filler cap
(2) Front engine lifting eye
(3) Coolant drain tap
(4) Oil drain plug
(5) Oil level gauge (dipstick)
(6) Oil filter
(7) Stop solenoid
(8) Fuel transfer pump
(9) Secondary fuel filter
(10) Valve mechanism cover breather
(11) Air cleaner assembly

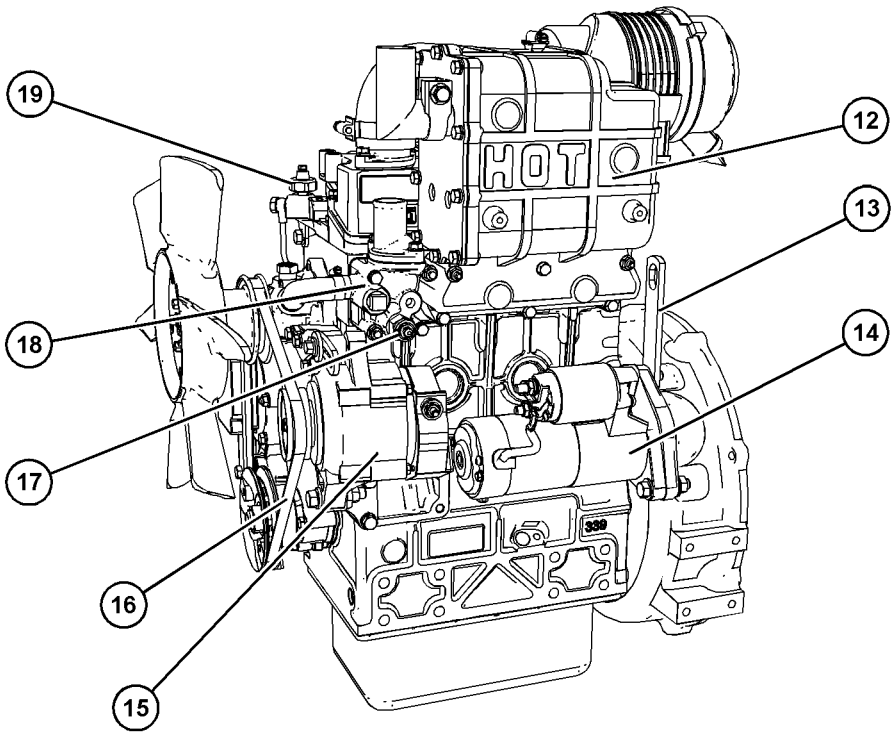


Illustration 14 g06563484

Typical example

(12) Exhaust manifold with combined silencer
(13) Rear engine lifting eye
(14) Starting motor
(15) Alternator
(16) Fan belt
(17) Coolant temperature sensor
(18) Coolant temperature regulator housing
(19) Oil pressure switch

403F-07 Engine View With Factory Radiator

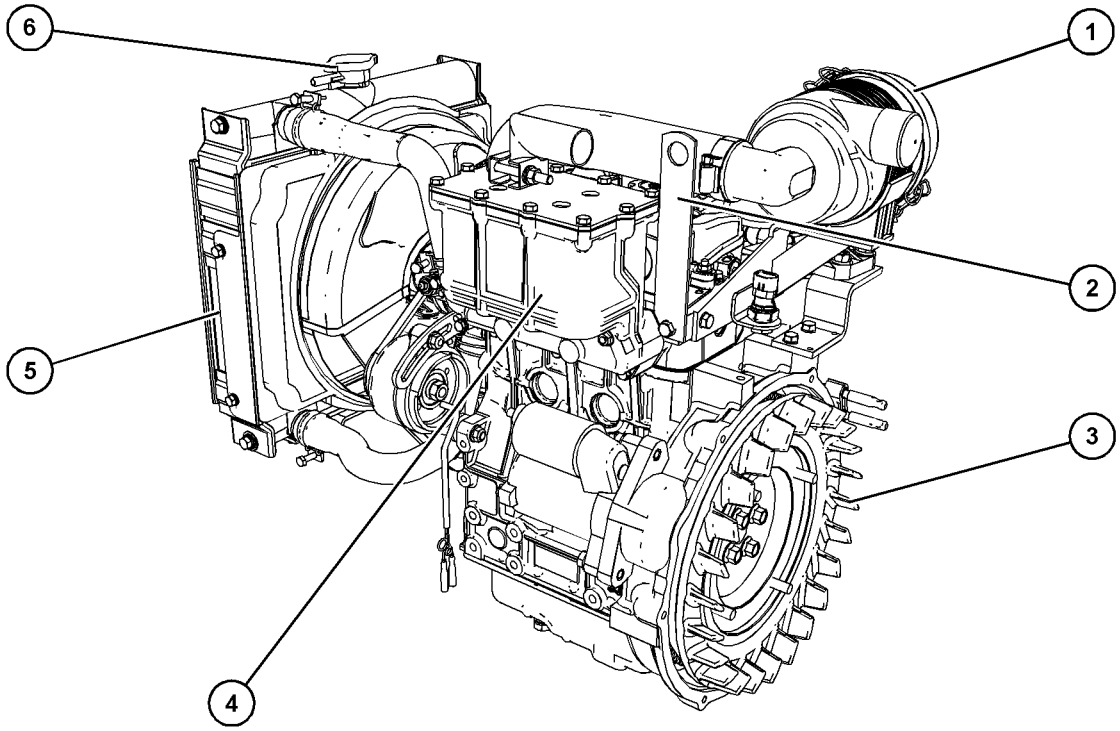


Illustration 15 g06537769

Typical example

(1) Air cleaner assembly
(2) Rear engine lifting eye
(3) Flywheel with cooling fins
(4) Exhaust manifold and muffler assembly
(5) Radiator assembly
(6) Radiator cap

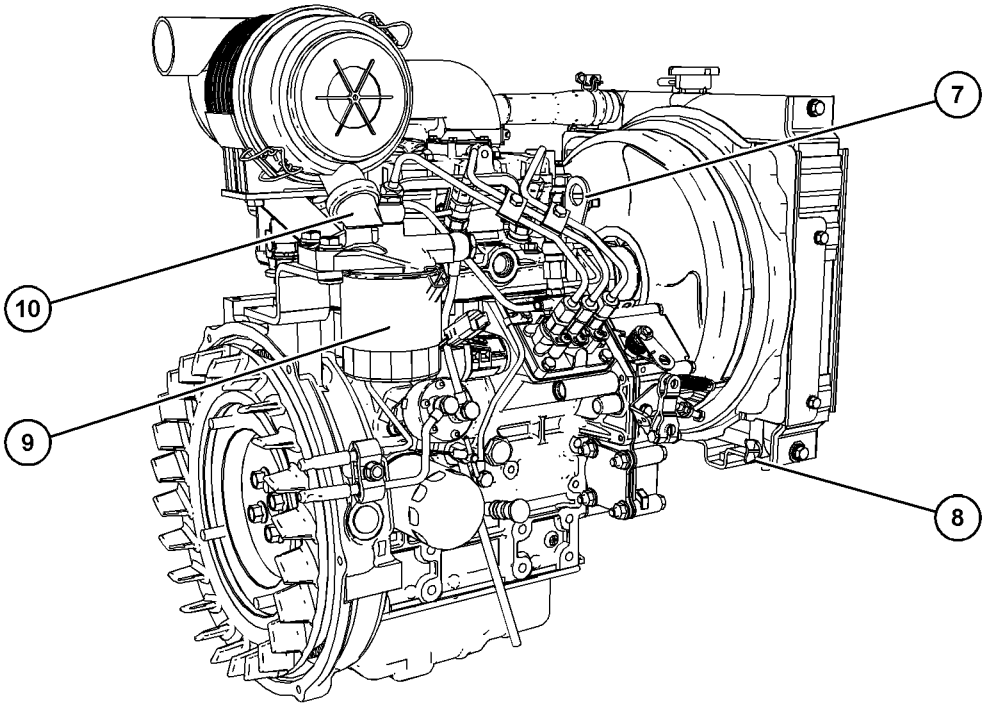


Illustration 16 g06537770

Typical example

(7) Front engine lifting eye
(8) Radiator coolant drain valve
(9) Secondary fuel filter
(10) Air cleaner assembly valve

402F-05 Engine View

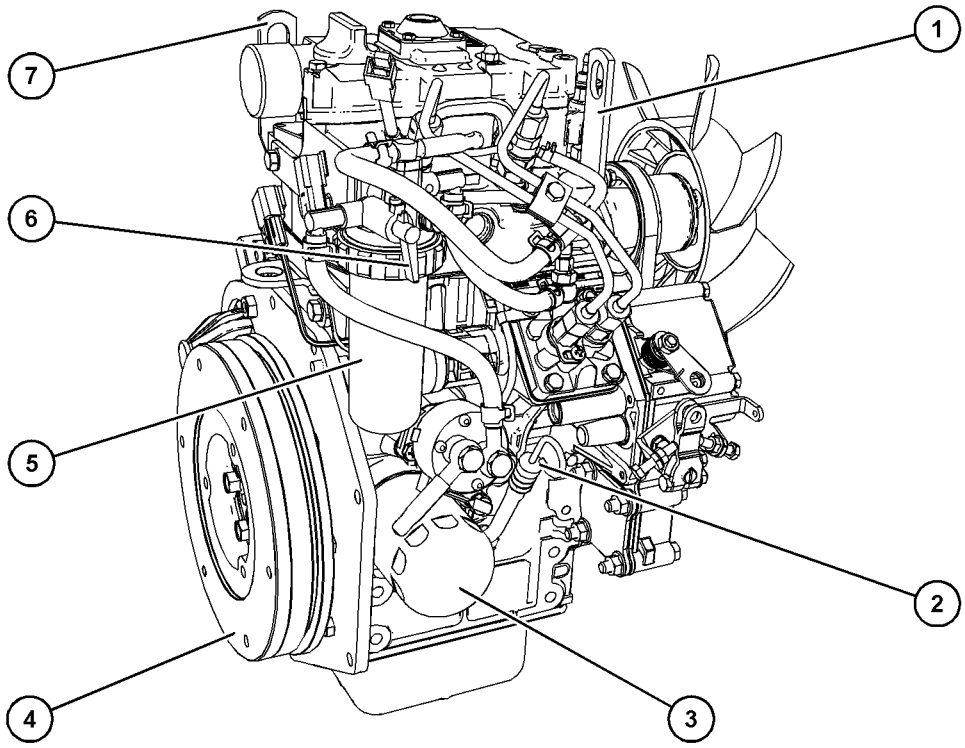


Illustration 17 g06538327

Typical example

(1) Front engine lifting eye
(2) Dipstick
(3) Oil filter
(4) Flywheel
(5) Secondary fuel filter
(6) Fuel valve
(7) Rear engine lifting eye

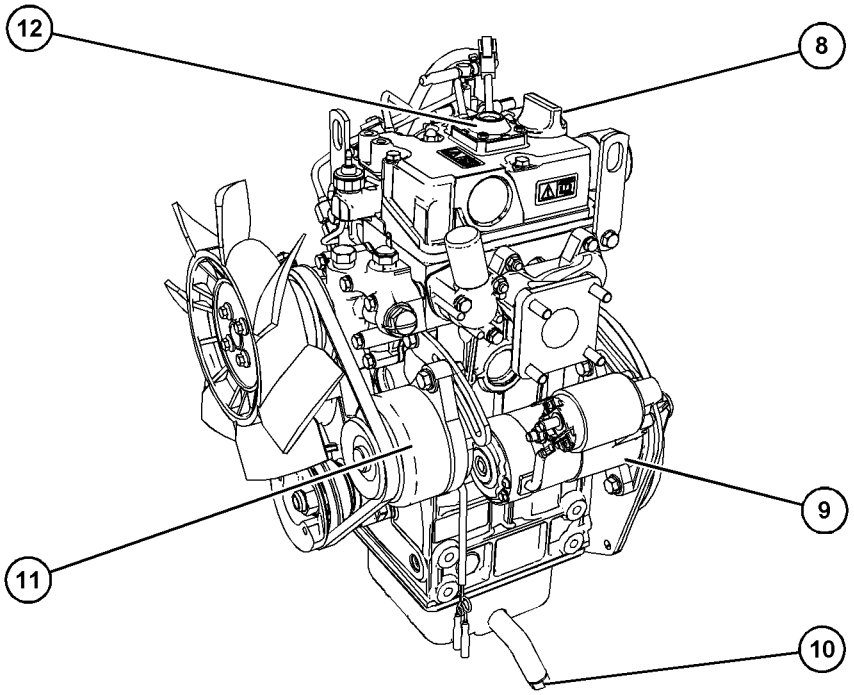


Illustration 18 g06538342

Typical example

(8) Oil filler cap
(9) Starting motor
(10) Oil drain plug
(11) Alternator
(12) Engine crankcase breather

Fuel System Components

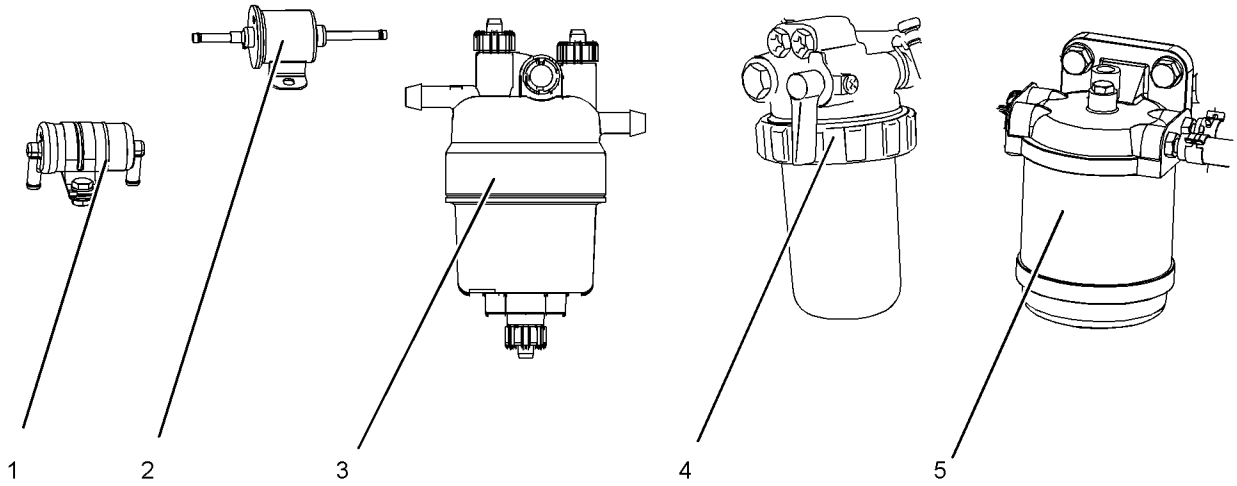


Illustration 19 g03379882

Typical examples

(1) In-line fuel filter
(2) Electric fuel pump

(3) Primary fuel filter (4) Secondary fuel filter (element type) (5) Secondary fuel filter

Note: The electric fuel pump is an option, engines may have a mechanical fuel lift pump installed.

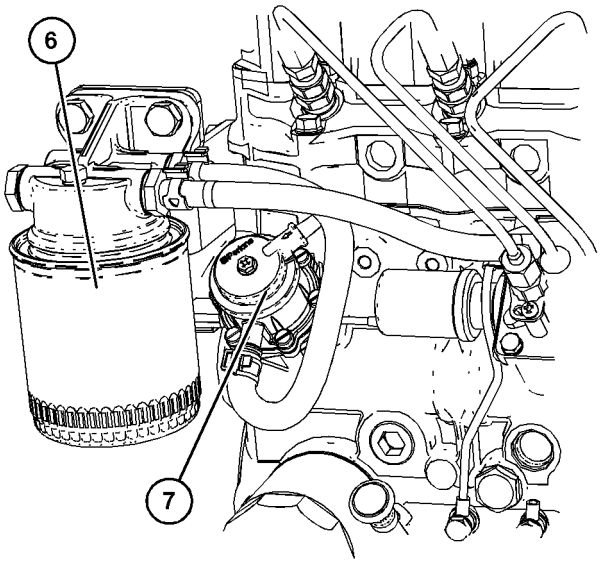


Illustration 20 g06119854

(6) Fuel filter for a 1000-hour service
(7) Mechanical fuel lift pump

Components for Electronic Control

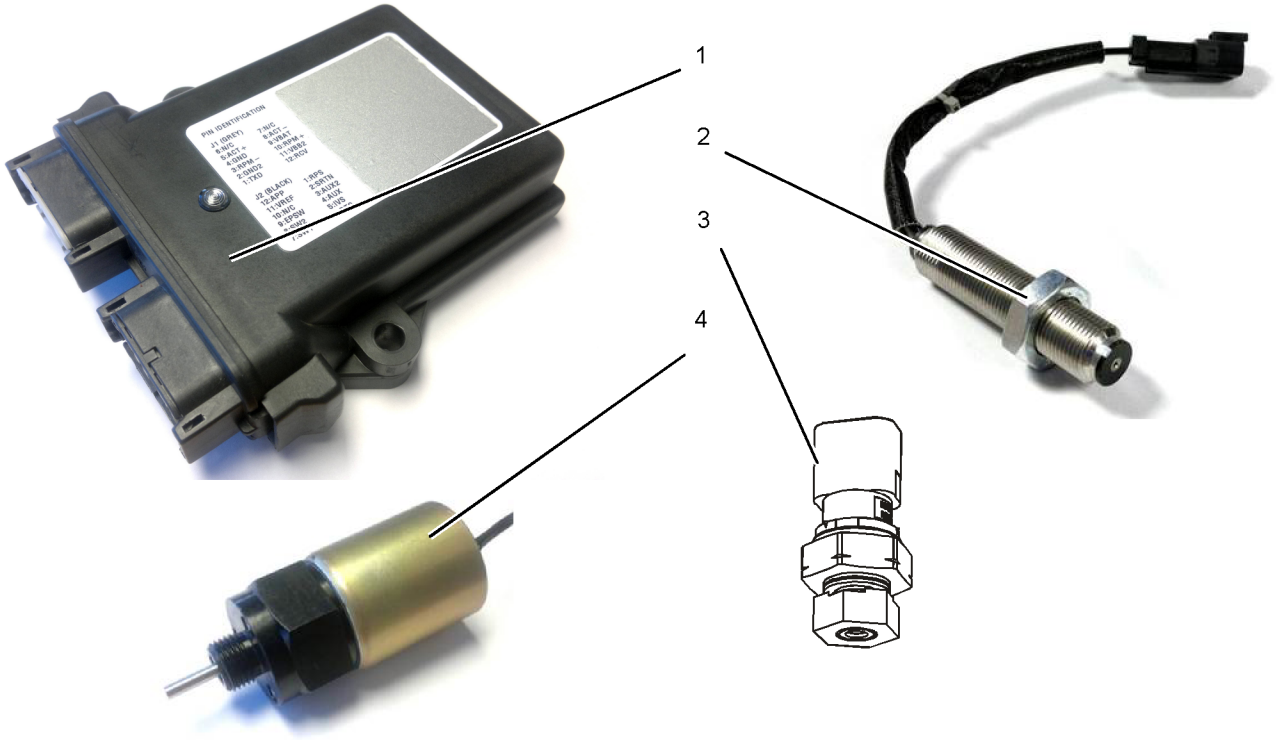


Illustration 21 g03379884

(1) Electronic Control Module (ECM)
(2) Speed sensor
(3) Atmospheric Pressure Sensor (Barometric Pressure Sensor)
(4) Actuator

Note: Due to individual applications the atmospheric pressure sensor (3) may appear different from the illustration.

i06944871

Product Description

There are four Perkins engines in the 400F series that are below 19Kw power band. These engines are, 402F-05, 403F-07, 403F-11, and the 403F-15. These engines have the following characteristics:

- In-Line 2 cylinder (402F-05)
- In-Line 3 cylinder (403F-07, 403F-11, and the 403F-15)
- Naturally aspirated
- Fuel limiter only on certain electronically governed fuel systems
- 2 Valves in each cylinder

The constant speed engine model 403F-11 with a prefix ET can be configured to operate with an extended service period.

The engine with extender service periods requires the correct oil filter, fuel filter, and the correct oil gauge (dipstick).

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.

402F-05 Engine

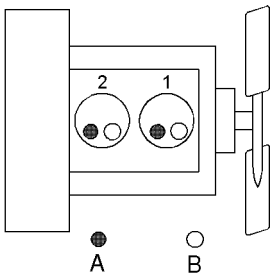


Illustration 22 g01108476

(A) Exhaust valves
(B) Inlet valves

Table 1

402F-05 Engine Specifications	
Maximum Operating Speed (rpm)	3600 rpm
Cylinders and Arrangement	In-Line 2 cylinder
Bore	67 mm (2.64 inch)
Stroke	72 mm (2.83 inch)
Displacement	0.507 L (30.939 in^3)
Aspiration	Naturally Aspirated
Compression Ratio	23.5:1
Firing Order	1-2
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

403F-07 Engine

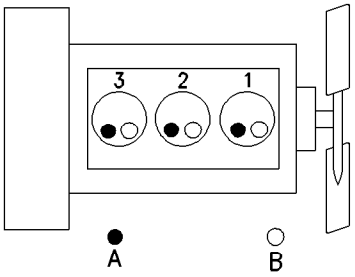


Illustration 23 g00852304

(A) Exhaust valves
(B) Inlet valves

Table 2

403F-07 Engine Specifications	
Maximum Operating Speed (rpm)	3600 rpm
Cylinders and Arrangement	In-Line 3 cylinder
Bore	67 mm (2.64 inch)
Stroke	72 mm (2.83 inch)
Displacement	0.762 L (46.500 in^3)

(continued)

(Table 2, contd)

Aspiration	Naturally Aspirated
Compression Ratio	23.5:1
Firing Order	1-2-3
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

403F-11 Engine

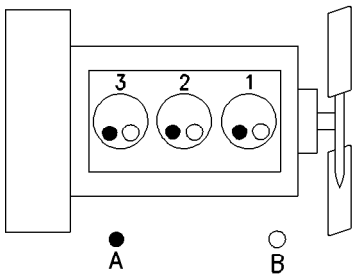


Illustration 24 g00852304

(A) Exhaust valves
(B) Inlet valves

Table 3

403F-11 Engine Specifications	
Maximum Operating Speed (rpm)	3600 rpm
Cylinders and Arrangement	In-Line 3 cylinder
Bore	77 mm (3.03 inch)
Stroke	81 mm (3.19 inch)
Displacement	1.131 L (69.018 in^3)
Aspiration	Naturally Aspirated
Compression Ratio	23:1
Firing Order	1-2-3
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

403F-15 Engine

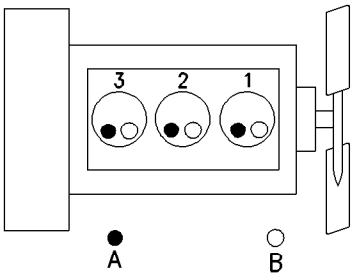


Illustration 25 g00852304

(A) Exhaust valves
(B) Inlet valves

Table 4

403F-15 Engine Specifications	
Maximum Operating Speed (rpm)	3000 rpm
Cylinders and Arrangement	In-Line 3 cylinder
Bore	84 mm (3.31 inch)
Stroke	90 mm (3.54 inch)
Displacement	1.496 L (91.291 in^3)
Aspiration	Naturally Aspirated
Compression Ratio	22.5:1
Firing Order	1-2-3
Rotation that is viewed from the flywheel	Counterclockwise
Valve Lash Setting (Inlet)	0.20 mm (0.008 inch)
Valve Lash Setting (Exhaust)	0.20 mm (0.008 inch)
Injection	Indirect

Product Identification Information

i05333660

Plate Locations and Film Locations

Perkins engines are identified by a serial number. This serial number is shown on a serial number plate. The plate is mounted above the fuel injection pump on the right-hand side of the engine block.

A typical example of an engine number is EK*****N000001X.

E _____ Engine family

K _____ Type of engine

***** _____ The list number of the engine

N _____ Country of manufacture

0 _____ The first digit is a production code.

00001 _____ Engine Serial Number

X _____ Year of Manufacture

Perkins dealers or Perkins distributors need all of these numbers in order to determine the components that were included with the engine. This information permits accurate identification of replacement part numbers.

i07785792

Emissions Certification Film

EMISSION CONTROL INFORMATION	
Perkins®	PERKINS SMALL ENGINES LTD.
ENGINE FAMILY	######
POWER CATEGORY	######
DISPLACEMENT	###### L
EMISSION-CONTROL SYSTEM	IFI ECM
USEFUL LIFE DEFINED BY	CARB: 5 YEARS OR 3000h
DATE OF MANUFACTURE: ######	
THIS ENGINE CONFORMS TO 2013 U.S. EPA AND CALIFORNIA REGULATIONS FOR LARGE NON-ROAD STATIONARY COMPRESSION-IGNITION ENGINES	
ULTRA LOW SULFUR FUEL ONLY	
EC TYPE- APPROVAL No: ##################	
###### ###### ######	

Illustration 26 g06435423

Typical example

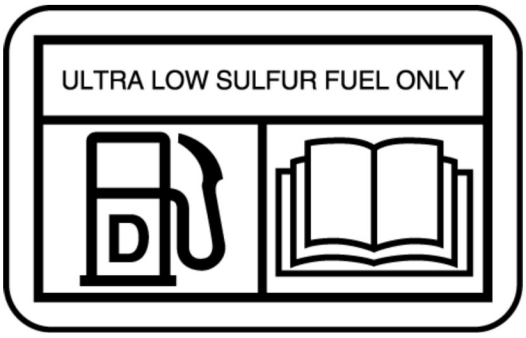


Illustration 27 g02157153

Typical example

Illustration 27 is a representation of the label that will be installed next to the fuel filler cap on the fuel tank of the application.

i05335976

Reference Information

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information in the appropriate space. Make a copy of this list for a record. Keep the information for future reference.

Record for Reference

Engine Model _____

Engine Serial Number _____

ECM Serial Number _____

Engine Low Idle rpm _____

Engine Full Load rpm _____

In-Line Fuel Filter _____

Primary Fuel Filter _____

Secondary Fuel Filter Element _____

Lubrication Oil Filter Element _____

Auxiliary Oil Filter Element _____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element _____

Alternator Belt _____

Operation Section

Lifting and Storage

i08137513

Product Lifting

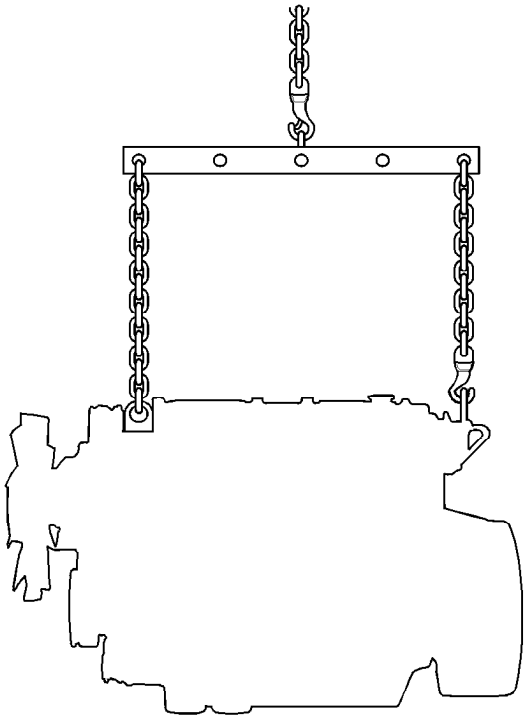


Illustration 28 g01097527

Perpendicular engine lifting

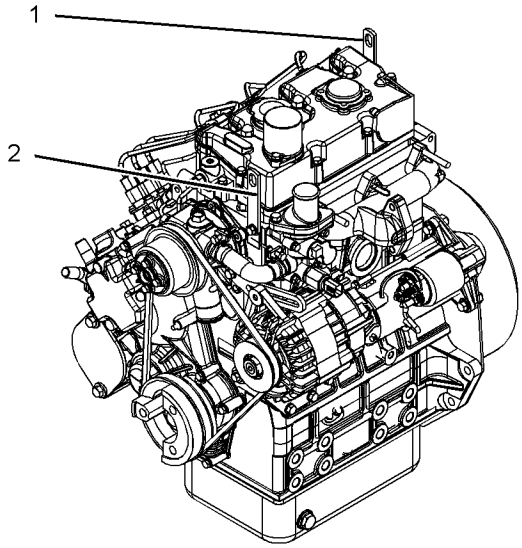


Illustration 29 g03380038

Typical example

(1) Rear lifting eye
(2) Front lifting eye

NOTICE

Always inspect lifting eyebolts and all other lifting equipment for damage before performing any lifting. Never bend the eyebolts and the brackets. Never perform product lifting if components are damaged. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures to obtain correct balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for specific engine arrangements. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that correct lifting devices are provided. Consult your Perkins dealer or your Perkins distributor for information regarding fixtures for correct engine lifting.

i05335259

Product Storage

Perkins are not responsible for damage which may occur when an engine is in storage after a period in service.

Your Perkins dealer or your Perkins distributor can assist in preparing the engine for extended storage periods.

Condition for Storage

The engine must be stored in a water proof building. The building must be kept at a constant temperature. Engines that are filled with Perkins ELC will have coolant protection to an ambient temperature of −36° C (−32.8° F). The engine must not be subjected to extreme variations in temperature and humidity.

Storage Period

An engine can be stored for up to 6 months provided all the recommendation are adhered to.

Storage Procedure

Keep a record of the procedure that has been completed on the engine.

Note: Do not store an engine that has biodiesel in the fuel system.

1. Ensure that the engine is clean and dry.

a. If the engine has been operated using biodiesel, the system must be drained and new filters installed. The fuel tank will require flushing.

b. Fill the fuel system with an ultra low sulfur fuel. For more information on acceptable fuels refer to this Operation and Maintenance Manual, “Fluid recommendations”. Operate the engine for 15 minutes in order to remove all biodiesel from the system.

2. Drain any water from the primary filter water separator. Ensure that the fuel tank is full.

3. The engine oil will not need to be drained in order to store the engine. Provided the correct specification of engine oil is used the engine can be stored for up to 6 months. For the correct specification of engine oil refer to this Operation and Maintenance Manual, “Fluid recommendations”.

4. Remove the fan belt from the engine.

Sealed Coolant System

Ensure that the cooling system is filled with Perkins ELC, or an antifreeze that meets “ASTM D6210” specification.

Open Cooling System

Ensure that all cooling drain plugs have been opened. Allow the coolant to drain. Install the drain plugs. Place a vapor phase inhibitor into the system. The coolant system must be sealed once the vapor phase inhibitor has been introduced. The effect of the vapor phase inhibitor will be lost if the cooling system is open to the atmosphere.

For maintenance procedures ref to this Operation and Maintenance Manual.

Monthly Checks

The crankshaft must be rotated in order to change the spring loading on the valve train. Rotate the crankshaft more than 180 degrees. Visibly check for damage or corrosion to the engine.

Ensure that the engine is covered completely before storage. Log the procedure in the record for the engine.

Features and Controls

i05336041

Gauges and Indicators

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Perkins dealer or your Perkins distributor for assistance.

NOTICE
If no oil pressure is indicated, STOP the engine. If maximum coolant temperature is exceeded, STOP the engine. Engine damage can result.



Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical engine oil pressure with SAE10W30 is 207 to 413 kPa (30 to 60 psi) at rated rpm.

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.

2. Reduce engine speed to low idle.

3. Check and maintain the oil level.



Jacket Water Coolant Temperature – Typical temperature range is 71 to 96°C (160 to 205°F). The maximum allowable temperature with the pressurized cooling system at 90 kPa (13 psi) is 125° C (257° F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine rpm.

2. Inspect the cooling system for leaks.

3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



Tachometer – This gauge indicates engine speed (rpm). When the throttle controller is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle controller is at the full throttle position with maximum rated load.

NOTICE
To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. The engine can be operated at high idle without damage, but should never be allowed to exceed high idle rpm.



Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of “0” (zero).



Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge operates when the “START/STOP” switch is in the “ON” position.



Service Hour Meter – The gauge indicates operating time of the engine.

Indicators and Lamps

The following indicator lamps can be installed, for more information refer to the Original Equipment Manufacturer (OEM)

- Shutdown lamp
- Warning lamp
- Low-pressure oil lamp

A multi function lamp is installed on the electric control module.

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Monitoring System

NOTICE
The Engine Monitoring System is not a guarantee against catastrophic failures. Programmed delays and derate schedules are designed to minimize false alarms and provide time for the operator to stop the engine.

The following parameters are monitored:

- Coolant temperature
- Oil pressure
- Engine speed
- Atmospheric pressure (Barometric pressure)

The coolant temperature, oil pressure, and the engine speed can trigger an engine shutdown.

- Atmospheric pressure (Barometric pressure) can trigger an engine de-rate.

The atmospheric pressure sensor (Barometric pressure sensor) can de-rate the engine. Operating the engine and increasing the altitude will de-rate the engine in accordance with emission regulations. The start of the de-rate will be determined by the flash file that is installed.

i06946627

Overspeed

- 402F-05 _____3600 Revolutions Per Minute (RPM)
- 403F-07 _____3600 RPM
- 403F-11 _____3600 RPM
- 403F-15 _____3000 RPM

The overspeed is plus 700 RPM above the given speed for engines shown.

i06946629

Sensors and Electrical Components

The following sensors or switches are installed on the 402F-05, 403F-07, 403F-11, and the 403F-15 engines:

- Oil pressure switch
- Coolant temperature sensor
- Atmospheric pressure sensor (Barometric pressure sensor)
- Speed sensor
- Throttle actuator

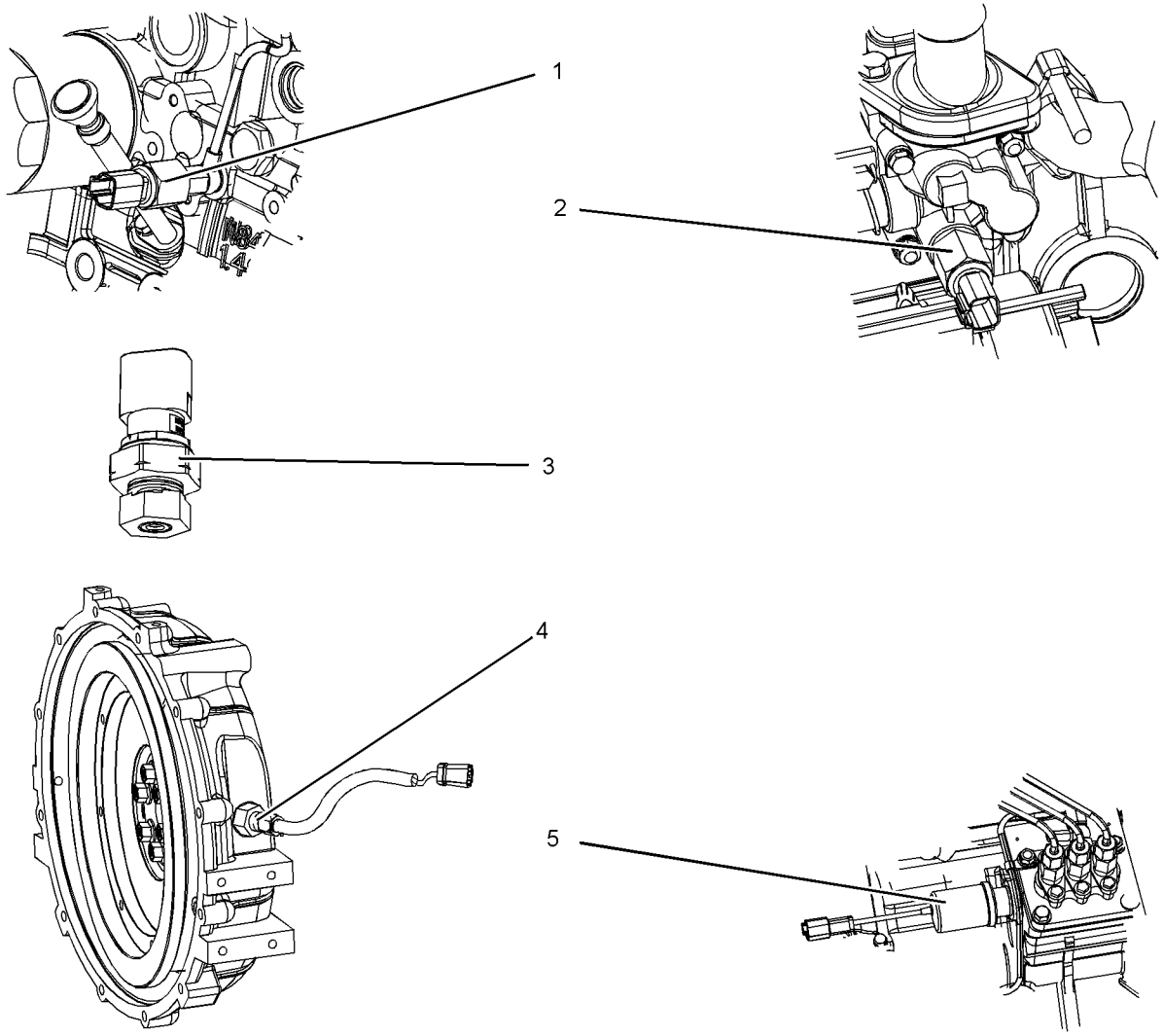


Illustration 30 g03381125

Typical examples

(1) Oil pressure sensor
(2) Coolant temperature sensor
(3) Atmosphere pressure sensor (Barometric pressure sensor)
(4) Speed sensor
(5) Throttle actuator or stop solenoid

Note: Due to individual applications the atmosphere pressure sensor (3) may appear different from the illustration.

Electrical components install on the 402F-05, 403F-07, 403F-11, and the 403F-15 engines:

- Alternator
- Starting motor
- Glow plugs
- Electronic control governor (Location will depend on the application)
- Electric fuel pump

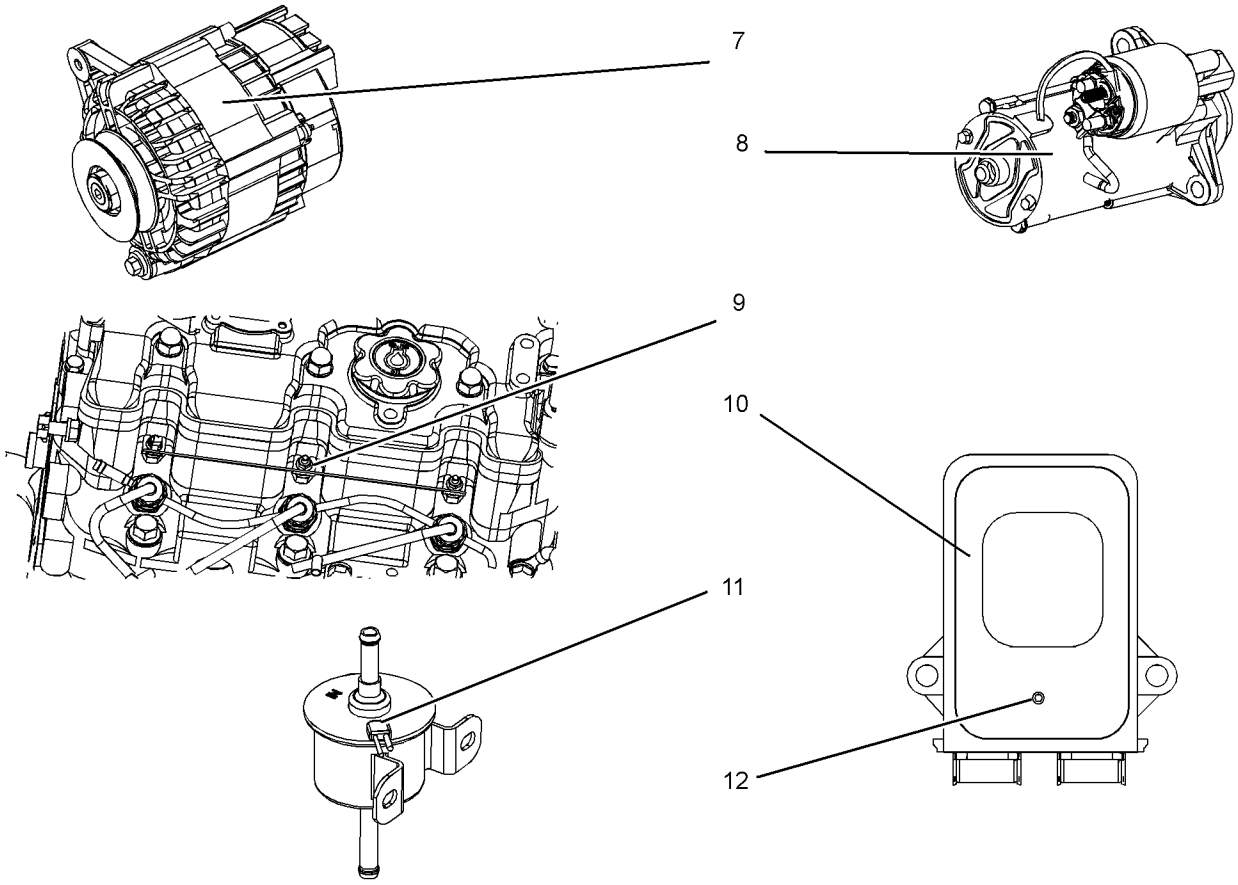


Illustration 31 g03381126

Typical examples

(7) Alternator
(8) Starting motor
(9) Glow plugs
(10) Electronic control model (Controller)
(11) Fuel pump
(12) Multi-function lamp

When the keyswitch is in the OFF position, the multi-function lamp will not be illuminated. With the keyswitch in the ON position the multi-function lamp will flash once. The flash will indicate that the system is powered and ready for operation.

The multi-function lamp can be used as a diagnostic lamp. For information as a diagnostic lamp refer to this Operation and Maintenance Manual, “Diagnostic Lamp”.

Engine Diagnostics

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Self-Diagnostics

The electronic engines can perform a self-diagnostics test. When the system detects an active problem, a diagnostic lamp is activated. This lamp is a multi function lamp that is located on the electronic control module. The lamp will flash a code that will give am indication of the fault. For more information on the flash codes, refer to this Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval”.

i07039491

Diagnostic Lamp

The multi-function lamp that is installed remotely or on the engine controller can operate as a diagnostic lamp. The diagnostic function is used to indicate the existence of an active fault. The active fault is transmitted as a flash code.

For information on flash codes refer to this Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval”.

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Diagnostic Flash Code Retrieval

The multi function lamp will flash a two-digit code in a given sequence in order to show the flash code diagnostic massage. By counting the number of flashes in a given sequence you can determine the flash code.

After the flash code as finished, the flash code sequence will continual to be repeated. If a second flash code has been activated, then the system will repeat both codes in the given sequence.

Four short flashes will indicate a flash code of 04. Three long flashes of one second each followed by one short flash will indicate a flash code of 31.

If there is more than one code to be indicated, the system will flash the first code then after a delay interval the next code is flashed.

Table 5

Flash Codes with Key ON (Engine not in Operation)			
Flash Code	Description	Engine status	Operator Action
13	Oil pressure switch malfunction. Disconnection of Oil pressure switch. Disconnection of Oil pressure harness.	Engine will start, but the engine will shut down after 180 seconds	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
22	Pressure sensor malfunction. Disconnection of Pressure sensor connector. Disconnection of Pressure sensor harness.	Engine will start, but the engine go to limp home mode.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
33	Actuator position sensor malfunction. Disconnection of Actuator position sensor connector. Disconnection of Actuator position sensor harness.	Engine will start, but the engine go to limp home mode.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
04	Actuator drive malfunction. Disconnection of Speed sensor connector. Disconnection of Speed sensor harness.	Engine will not start.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.

Table 6

Flash Codes During Engine Cranking			
Flash Code	Description	Engine status	Operator Action
13	Speed sensor malfunction. Disconnection of Speed sensor connector. Disconnection of Speed sensor harness.	Engine will not start.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.

Table 7

Flash Codes with Engine in Operation			
Flash Code	Description	Engine status	Operator Action
31	Oil pressure decline. Weak signal from oil pressure switch. Short-circuiting.	Engine will go to limp home mode but the engine may shut down.	Check engine oil. (1) Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
22	Pressure sensor malfunction. Disconnection of Pressure sensor connector. Disconnection of Pressure sensor harness.	The engine will go into limp home mode.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
33	Actuator position sensor malfunction. Disconnection of Actuator position sensor connector. Disconnection of Actuator position sensor harness.	The engine will go into limp home mode.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.

(continued)

(Table 7, contd)

04	Actuator drive malfunction. Disconnection of Speed sensor connector. Disconnection of Speed sensor harness.	The engine will shut down.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.
15	Speed sensor malfunction. Disconnection of Speed sensor connector. Disconnection of Speed sensor harness.	The engine will go into limp home mode.	Check harness connection. If the fault remains contact your Perkins dealer or your Perkins distributor.

(1) Checking engine oil is part of the daily engine check. Operating an engine will a low level of engine oil can damage your engine.

For more information on diagnostic messages and diagnostic tools contact your Perkins dealer or your Perkins distributor.

Engine Starting

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Before Starting Engine

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for more information.

- Ensure that the engine has an adequate fuel supply.
- Open the fuel supply valve (if equipped).

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information on priming the fuel system. Also, check that the fuel specification is correct and that the fuel condition is correct. Refer to the Operation and Maintenance Manual, “Fuel Recommendations”.

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.
- Reset all of the shutoffs or alarm components.
- Ensure that any driven equipment has been disengaged. Minimize electrical loads or remove any electrical loads.

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Starting the Engine

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

1. Disengage any equipment that is driven by the engine.
2. Turn the keyswitch to the RUN position. Check the multi-function lamp on the ECM.
3. If the lamp flashes once only, the engine can be started normally. If the lamp flashes again, then a fault has been detected. Refer to this Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval” for more information.

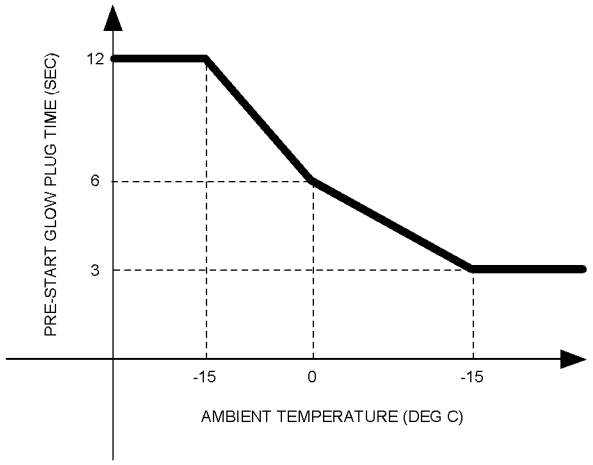


Illustration 32 g06038854

4. During cold weather the keyswitch will need to be in the heat position for a time period to allow the glow plug operation. Some systems will have a wait to start lamp.
5. The wait to start lamp must be extinguished before starting the engine. Refer to the original equipment manufacture for information on how to start an engine in cold weather.

Note: The ambient weather condition will determine the amount of time the glow plugs will require. If the engine is warm, heat from the glow plugs will not be required to start the engine.

6. Turn the engine start switch to the HEAT position. Hold the engine start switch in the HEAT position for time shown in illustration 32 .

NOTICE
Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

7. Turn the keyswitch to operate the starter motor, and allow the engine to crank. After the engine has started, allow the keyswitch to return to the RUN position.

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Starting with Jump Start Cables

⚠ WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

NOTICE
Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engines accessories.

2. Connect one positive end of the jump-start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump-start cable to the positive cable terminal of the electrical source.

3. Connect one negative end of the jump-start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump-start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.

Note: The engine electronic control module must be powered before the starting motor is operated or damage can occur.

4. Start the engine in the normal operating procedure. Refer to this Operation and Maintenance Manual, “Starting the Engine”.

5. Immediately after the engine is started, disconnect the jump-start cables in reverse order.

After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped.

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After Starting Engine

Note: In temperatures from 0°C to 60°C (32°F to 140°F), the warm-up time is approximately 3 minutes. In temperatures below 0°C (32°F), extra warm-up time may be required.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. This action may not be possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

Constant speed engines should be allowed to operate at low idle for 3 minutes before used at operational speed. If the low idle option is not available, then operate the engine at operational speed with no load for 2 minutes.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation

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Engine Operation

General Engine Operation

Correct operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

Check that there are no flash codes active. Refer to this Operation and Maintenance Manual, “Diagnostic Flash Code Retrieval” for more information.

The engine can be operated at the rated rpm after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

Engine Operation and Altitude

In accordance with emissions regulation of the United States Environmental Protection Agency the engine power and emission will be reduced the higher the altitude that the engine is operated.

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Fuel Conservation Practices

The efficiency of the engine can affect the fuel economy. Perkins design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels. Refer to the Operations and Maintenance Manual, “Fuel Recommendations”for further information.

- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.

- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This fault will consume excess power and excess fuel.

- The belt should be in good condition.

- Ensure that all of the connections of the hoses are tight. The connections should not leak.

- Ensure that the driven equipment is in good working order.

- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Cold Weather Operation

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Cold Weather Operation

Perkins Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine is dependent on the following items:

- The type of fuel that is used
- The viscosity of the engine oil
- The operation of the glow plugs
- Battery condition

This section will cover the following information:

- Potential problems that are caused by cold-weather operation
- Suggest steps which can be taken in order to minimize starting problems and operating problems when the ambient air temperature is between 0° to−40 °C (32° to 40 °F).

The operation and maintenance of an engine in freezing temperatures is complex . This complexity is because of the following conditions:

- Weather conditions
- Engine applications

Recommendations from your Perkins dealer or your Perkins distributor are based on past proven practices. The information that is contained in this section provides guidelines for cold-weather operation.

Hints for Cold Weather Operation

- If the engine will start, operate the engine until a minimum operating temperature of 80° C (176° F) is achieved. Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.
- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. This means that an engine can be shut down for a period and the engine can still have the ability to start readily.
- Install the correct specification of engine lubricant before the beginning of cold weather. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the recommended viscosity of oil.
- Check all rubber parts (hoses, fan drive belts,) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm by ensuring that the engine is allowed to operated at normal operating temperature.
- Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.
- Ensure that the glow plugs are in working order.

WARNING

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

- For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, “Starting with Jump Start Cables.” for instructions.

Viscosity of the Engine Lubrication Oil

Correct engine oil viscosity is essential. Oil viscosity affects lubrication properties and wear protection that the oil provides for the engine. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the recommended viscosity of oil.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to this Operation and Maintenance Manual, “Fluid Recommendations” for the recommended coolant mixture.

In cold weather, check the coolant often for the correct glycol concentration in order to ensure adequate freeze protection.

Engine Block Heaters

Engine block heaters (if equipped) heat the engine jacket water that surrounds the combustion chambers. This heat provides the following functions:

- Startability is improved.
- Warm up time is reduced.

An electric block heater can be activated once the engine is stopped. A block heater can be 110 V dc or 240 V dc. The output can be 750/1000W. Consult your Perkins dealer or your Perkins distributor for more information.

Idling the Engine

When idling after the engine is started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This idling will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. The engine should not be “raced” in order to speed up the warm-up process.

While the engine is idling, the application of a light load (parasitic load) will assist in achieving the minimum operating temperature. The minimum operating temperature is 80° C (176° F).

Recommendations for Coolant Warm Up

Warm up an engine that has cooled below normal operating temperatures due to inactivity. This warm -up should be performed before the engine is returned to full operation. During operation in very cold temperature conditions, damage to engine valve mechanisms can result from engine operation for short intervals. This damage can happen if the engine is started and the engine is stopped many times without being operated in order to warm up completely.

When the engine is operated below normal operating temperatures, fuel and oil are not completely burned in the combustion chamber. This fuel and oil causes soft carbon deposits to form on the valve stems. Generally, the deposits do not cause problems and the deposits are burned off during operation at normal engine operating temperatures.

When starting and stopping an engine many times without being operated in order to warm up completely, the carbon deposits become thicker. This starting and stopping can cause the following problems:

- Valves become stuck.
- Pushrods may become bent.
- Other damage to valve train components can result.

When an engine is started, the engine must be operated until the coolant temperature is 80° C (176° F) minimum. Carbon deposits on the valve stems will be kept at a minimum and the free operation of the valves and the valve components will be maintained.

The engine must be thoroughly warmed in order to keep other engine parts in better condition. The service life of the engine will be generally extended. Lubrication will be improved. There will be less acid and less sludge in the oil. This condition will provide longer service life for the engine bearings, the piston rings, and other parts. However, limit unnecessary idle time to 10 minutes in order to reduce wear and unnecessary fuel consumption.

The Water Temperature Regulator and Insulated Heater Lines

The engine is equipped with a water temperature regulator. When the engine coolant is below the correct operating temperature, jacket water circulates through the engine cylinder block and into the engine cylinder head. The coolant then returns to the cylinder block via an internal passage that bypasses the valve of the coolant temperature regulator. This return ensures that coolant flows around the engine under cold operating conditions. The water temperature regulator begins to open when the engine jacket water has reached the correct minimum operating temperature. As the jacket water coolant temperature rises above the minimum operating temperature, the water temperature regulator opens further allowing more coolant through the radiator to dissipate excess heat.

The progressive opening of the water temperature regulator operates the progressive closing of the bypass passage between the cylinder block and head. This action ensures maximum coolant flow to the radiator in order to achieve maximum heat dissipation.

Note: Do not restrict the air flow. Restriction of the air flow can damage the fuel system. Perkins discourages the use of all air flow restriction devices such as radiator shutters. Restriction of the air flow can result in the following: high exhaust temperatures, power loss, excessive fan usage and reduction in fuel economy.

A cab heater is beneficial in very cold weather. The feed from the engine and the return lines from the cab should be insulated in order to reduce heat loss to the outside air.

Recommendation for Crankcase Breather Protection

Crankcase ventilation gases contain a large quantity of water vapor. This water vapor can freeze in cold ambient conditions and can plug or damage the crankcase ventilation system. If the engine is operated in temperatures below −25° C (−13° F), measures must be taken to prevent freezing and plugging of the breather system. In extreme weather conditions insulating the breather hose will help to protect the system.

Consult with your Perkins dealer or your Perkins distributor for the recommended breather components for operation from −25° to -40°C (−13° to -72.°F).

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Fuel and the Effect from Cold Weather

Note: Only use grades of fuel that are recommended by Perkins. Refer to this Operation and Maintenance Manual, “Fluid Recommendations”.

The following fuels can be used in this series of engine.

- Group 1
- Group 2
- Group 3
- Special Fuels

Perkins prefer only Group 1 and Group 2 fuels for use in this series of engines.

Group 1 fuels are the preferred group of fuels for general use by Perkins. Group 1 fuels maximize engine life and engine performance. Group 1 fuels are usually less available than Group 2 fuels. Frequently, Group 1 fuels are not available in colder climates during the winter.

Note: Group 2 fuels must have a maximum wear scar of 650 micrometers (HFRR to ISO 12156-1).

Group 2 fuels are considered acceptable for issues of warranty. This group of fuels may reduce the life of the engine, the engines maximum power, and the engines fuel efficiency.

When Group 2 diesel fuels are used, the following components provide a means of minimizing problems in cold weather:

- Glow plugs
- Engine coolant heaters, which may be an Original Equipment Manufacture (OEM) option
- Fuel heaters, which may be an OEM option
- Fuel line insulation, which may be an OEM option

There are three major differences between Group 1 fuels and Group 2 fuels. Group 1 fuels have the following different characteristics to Group 2 fuels.

- A lower cloud point
- A lower pour point
- A higher energy per unit volume of fuel

Note: Group 3 fuels reduce the life of the engine. The use of Group 3 fuels is not covered by the Perkins warranty.

Group 3 fuels include Low Temperature Fuels and Aviation Kerosene Fuels.

Special fuels include Biofuel.

The cloud point is a temperature that allows wax crystals to form in the fuel. These crystals can cause the fuel filters to plug.

The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel lines, fuel filters, and fuel pumps.

Be aware of these facts when diesel fuel is purchased. Consider the average ambient air temperature for the engines application. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the fuel for waxing.

Low temperature fuels may be available for engine operation at temperatures below 0 °C (32 °F). These fuels limit the formation of wax in the fuel at low temperatures.

For more information on cold-weather operation, refer to the Operation and Maintenance Manual, “Cold Weather Operation and Fuel Related Components in Cold Weather”.

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Fuel Related Components in Cold Weather

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes and refueling of the fuel tank. This procedure will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

The engine must have an in-line fuel filter installed between the fuel tank and the electric operated fuel lift pump. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing.

For further information on fuel heaters, consult your Perkins dealer or distributor.

Engine Stopping

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Stopping the Engine

NOTICE
Stopping the engine immediately after it has been working under load, can result in overheating and accelerated wear of the engine components.

Avoid accelerating the engine prior to shutting it down.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Note: Individual applications will have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines to stop the engine.

1. Remove the load from the engine. Reduce the engine speed (rpm) to low idle. Allow the engine to idle for 5 minutes to cool the engine.

2. Stop the engine after the cool down period according to the shutoff system on the engine. Turn the ignition key switch to the OFF position. If necessary, refer to the instructions that are provided by the OEM.

NOTICE
Before any service or repairs are performed, ensure that the power supply to the engine is disconnected.

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Emergency Stopping

NOTICE
Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

The Original Equipment Manufacturer (OEM) may have equipped the application with an emergency stop button. For more information about the emergency stop button, refer to the OEM information.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

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After Stopping Engine

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

- Check the crankcase oil level. Maintain the oil level between the “MIN” mark and the “MAX” mark on the engine oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- If the engine is equipped with a service hour meter, note the reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

NOTICE
Only use antifreeze/coolant mixtures recommended in the Refill Capacities and Recommendations topic that is in this Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
- If freezing temperatures are expected, check the coolant for correct antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the correct coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Maintenance Section

Refill Capacities

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Refill Capacities

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, “Maintenance Section” for more information on Lubricant Specifications.

402F-05 Engine

Table 8

402F-05 Engine Refill Capacities		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	1.61 L (1.7 qt)	2.01 L (2.1 qt)
Total Lubrication System(2)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.
(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

403F-07 Engine

Table 9

403F-07 Engine Refill Capacities		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	2.35 L (2.5 qt)	3.05 L (3.2 qt)
Total Lubrication System(2)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

(continued)

(Table 9, contd)

(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

403F-11 Engine Oil Capacity For 500 Hour Service

Table 10

403F-11 Engine Refill Capacities For 500 Hour Service		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	3.4 L (3.6 qt)	4.4 L (4.7 qt)
Total Lubrication System(2)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.
(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

403F-11 Engine Oil Capacity For 1000 Hour Service

Table 11

403F-11 Engine Refill Capacities For 1000 Hour Service		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	3.4 L (3.6 qt)	4.9 L (5.1 qt)
Total Lubrication System(2)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.
(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

403F-15 Engines

Table 12

403F-15 Engines Refill Capacities		
Compartment or System	**Minimum**	**Maximum**
Crankcase Oil Sump(1)	4.5 L (4.8 qt)	6 L (6.3 qt)
Total Lubrication System(2)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require more oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.
(2) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity of factory installed oil filters and other filters added to the lubrication system. Enter the value for the capacity of the Total Lubrication System in this row.

Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate capacity is for the engine cooling system. External System capacities will vary among applications. Refer to the OEM specifications for the External System capacity. This capacity information will be needed to determine the amount of coolant that is required for the Total Cooling System.

402F-05 Engine

Table 13

402F-05 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	1.1	1.2
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.
(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

403F-07 Engine

Table 14

403F-07 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	1.2	1.3
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.
(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

403F-11 Engine

Table 15

403F-11 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	1.9	2.0
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.
(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

403F-15 Engine

Table 16

403F-15 Engine Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	2.6	2.7
External System Per OEM(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

(continued)

(Table 16, contd)

(2) The Total Cooling System capacity includes the capacity of the Engine plus the External System. Enter the value for the capacity of the Total Cooling System in this row.

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Fluid Recommendations (General Fuel Information)

- **Glossary**
- ISO _____International Standards Organization
- ASTM _____American Society for Testing and Materials
- HFRR _____High Frequency Reciprocating Rig for Lubricity testing of diesel fuels
- FAME _____Fatty Acid Methyl Esters
- CFR _____Co-ordinating Fuel Research
- ULSD _____Ultra Low Sulfur Diesel
- RME _____Rape Methyl Ester
- SME _____Soy Methyl Ester
- EPA _____Environmental Protection Agency of the United States
- PPM _____Parts Per Million
- DPF _____Diesel Particulate Filter
- v/v _____(volume of solute)/(volume of solution)
- CFPP _____Cold Filter Plugging Point
- BTL _____Biomass to liquid
- GTL _____Gas to liquid
- CTL _____Coal to liquid
- HVO_____Hydrotreated Vegetable Oil

General Information

NOTICE
Every attempt is made to provide accurate, up-to-date information. By use of this document you agree that Perkins Engines Company Limited is not responsible for errors or omissions.

NOTICE
These recommendations are subject to change without notice. Contact your local Perkins distributor for the most up-to-date recommendations.

Diesel Fuel Requirements

Perkins is not in a position to continuously evaluate and monitor all worldwide distillate diesel fuel specifications that are published by governments and technological societies.

The "Perkins Specification for Distillate Diesel Fuel" provides a known reliable baseline to judge the expected performance of distillate diesel fuels that are derived from conventional sources.

Satisfactory engine performance depends on the use of a good quality fuel. The use of a good quality fuel will give the following results: long engine life and acceptable exhaust emissions levels. The fuel must meet the minimum requirements that are stated in the table 17 .

NOTICE
The footnotes are key part of the Perkins "Specification for Distillate Diesel Fuel" Table. Read ALL of the footnotes.

Table 17

"Perkins Specification for Distillate Diesel Fuel"				
Property	**UNITS**	**Requirements**	**“ASTM”Test**	**“ISO/Other”Test**
Aromatics	%Volume	35% maximum	“D1319”	“ISO 3837”
Ash	%Weight	0.01% maximum	“D482”	“ISO 6245”
Carbon Residue on 10% Bottoms	%Weight	0.35% maximum	“D524”	“ISO 4262”
Cetane Number(1)	-	40 minimum	“D613 or D6890”	“ISO 5165”
Cloud Point	°C	The cloud point must not exceed the lowest expected ambient temperature.	“D2500”	“ISO 3015”
Copper Strip Corrosion	-	No. 3 maximum	“D130”	“ISO 2160”
Distillation	°C	10% at 238° C (460.4° F) maximum	“D86”	“ISO 3405”
		90% at 350° C (662° F) maximum		
Density at 15 °C (59 °F) (2)	kg/M^3	800 minimum and 860 maximum	No equivalent test	“ISO 3675”“ISO 12185”
Flash Point	°C	legal limit	“D93”	“ISO 2719”
Thermal Stability	-	Minimum of 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	“D6468”	No equivalent test
Pour Point	°C	6 °C (42.8 °F) minimum below ambient temperature	“D97”	“ISO 3016”
Sulfur(3)	%mass	0.0015 % maximum	“D5453”	“ISO 20846”
Kinematic Viscosity (4)	MM2/S (cSt)	The viscosity of the fuel that is delivered to the fuel injection pump. 1.4 minimum and 4.5 maximum	“D445”	“ISO 3405”
Water and sediment	% weight	0.05% maximum	“D1796”	“ISO 3734”
Water	% weight	0.05% maximum	“D1744”	No equivalent test
Sediment	% weight	0.05% maximum	“D473”	“ISO 3735”
Gums and Resins (5)	mg/100mL	10 mg per 100 mL maximum	“D381”	“ISO 6246”
Lubricity correctedwear scar diameter at 60 °C (140 °F). (6)	mm	0.52 maximum	“D6079”	“ISO 12156-1”
Fuel Cleanliness (7)	-	“ISO 18/16/13”	“D7619”	“ISO 4406”
Trace Metals (8)	mg/mg	Max 1 or non-detectable	“D7111”	
Oxidation Stability	g/m^3	Max 25	“D2274”	“ISO 12205”
	Hours(9)	Min 20		“EN 15751”

(1) To insure minimum cetane number of 40 a distillate diesel fuel should have minimum cetane index of 44 when“ASTM D4737” test method is used. A fuel with a higher cetane number is recommended to operate at a higher altitude or in cold weather
(2) Density range allowed includes summer and winter diesel fuel grades.
(3) Ultra Low Sulfur Diesel Fuel with sulphur content less than 0.0015 percent 15 PPM (mg/kg) must be used. Use of diesel fuel with higher than 15 PPM sulphur limit in these engines will harm or permanently damage emissions control systems. Also, use of diesel fuel with higher than 15 PPM sulphur limit can shorten service interval.

(continued)

(Table 17, contd)

(4) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. Fuel should also meet the minimum viscosity requirement and the fuel should meet the maximum viscosity requirements at 40 °C (104 °F) of either the “ASTM D445” test method or the “ISO 3104” test method. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain “1.4 cSt”or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters to lower the viscosity to “1.4 cSt” at the fuel injection pump.

(5) Follow the test conditions and procedures for gasoline (motor).

(6) The lubricity of a fuel is a concern with low sulfer and ultra low sulfur fuel. To determine the lubricity of the fuel, use the “ISO 12156-1 or ASTM D6079 High Frequency Reciprocating Rig (HFRR)” test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

(7) Recommended cleanliness level for fuel as dispensed into machine or engine fuel tank is“ISO 18/16/13”or cleaner as per “ISO 4406”. Refer to the “Contamination Control Recommendations for Fuels.

(8) Examples of trace metals include but not limited to Cu, Fe, Mn, Na, P, Pb, Si, and Zn. Use of metal-based additives is not allowed.

(9) Additional limit for fuel containing FAME. Fuel containing more than 2% v/v FAME must meet both tests.

Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the United States Environmental Protection Agency. Engines that are manufactured by Perkins are certified with the fuel that is prescribed by the European Certification. Perkins does not certify diesel engines on any other fuel.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the EPA and other appropriate regulatory agencies.

NOTICE
Operating with fuels that do not meet the Perkins recommendations can cause the following effects: Starting difficulty, reduced fuel filter service life, poor combustion, deposits in the fuel injectors, significantly reduce service life of the fuel system. Also, the creation of deposits in the combustion chamber and reduced service life of the engine.

NOTICE
The Perkins 402F and 403F series of diesel engine must be operated using Ultra Low Sulfur Diesel. The sulphur content of this fuel must be lower than 15 PPM. This fuel complies with the emissions regulations that are prescribed by the Environmental Protection Agency of the United States.

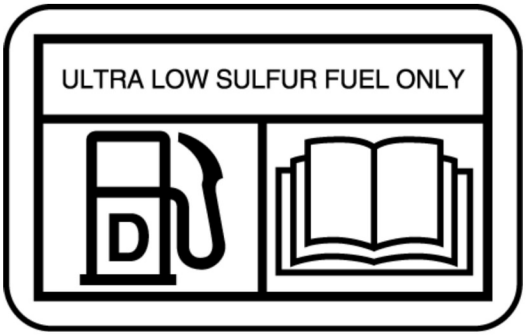


Illustration 33 g02157153

Illustration 33 is a representation of the label that will be installed next to the fuel filler cap on the fuel tank of the application.

The fuel specifications that are listed in the table 18 are released as acceptable to use on all 402F and 403F series of engine.

Table 18

Acceptable Fuel Specification for the 402F and 403F Series of Engines(1)	
Fuel Specification	Comments
EN590	European Automotive Diesel Fuel (DERV)
“ASTM D975 GRADE 1D S15”	“North American Light Distillate Diesel fuel with less than 15 PPM sulfur level”
“ASTM D975 GRADE 2D S15”	“North American Middle Distillate general-purpose Diesel fuel with less than 15 PPM sulfur level”
“JIS K2204”	“Japanese Diesel Fuel” Must meet the requirements that are stated in the section Lubricity.
“BS 2869: 2010 CLASS A2 or EU equivalent”	“EU Off-Road Diesel fuel. Acceptable from 2011 MUST have less than 10 PPM sulfur level”

(1) **All the fuels must comply with the specification in the table for the Perkins Specification Distillate Diesel Fuel.**

Diesel Fuel Characteristics

Cetane Number

Fuel that has a high cetane number will give a shorter ignition delay. A high cetane number will produce a better ignition quality. Cetane numbers are derived for fuels against proportions of cetane and heptamethylnonane in the standard CFR engine. Refer to “ISO 5165” for the test method.

Cetane numbers more than 45 are normally expected from current diesel fuel. However, a cetane number of 40 may be experienced in some territories. The United States of America is one of the territories that can have a low cetane value. A minimum cetane value of 40 is required during average starting conditions. A fuel with higher cetane number is recommended for operations at high altitudes or in cold-weather operations.

Fuel with a low cetane number can be the root cause of problems during a cold start.

Viscosity

Viscosity is the property of a liquid of offering resistance to shear or flow. Viscosity decreases with increasing temperature. This decrease in viscosity follows a logarithmic relationship for normal fossil fuel. The common reference is to kinematic viscosity. Kinematic viscosity is the quotient of the dynamic viscosity that is divided by the density. The determination of kinematic viscosity is normally by readings from gravity flow viscometers at standard temperatures. Refer to “ISO 3104” for the test method.

The viscosity of the fuel is significant because fuel serves as a lubricant for the fuel system components. Fuel must have sufficient viscosity to lubricate the fuel system in both extremely cold temperatures and extremely hot temperatures. If the kinematic viscosity of the fuel is lower than “1.4 cSt” at the fuel injection pump, damage to the fuel injection pump can occur. This damage can be excessive scuffing and seizure. Low viscosity may lead to difficult hot restarting, stalling, and loss of performance. High viscosity may result in seizure of the pump.

Perkins recommends kinematic viscosities of 1.4 and 4.5 mm2/sec that is delivered to the fuel injection pump. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters to lower the viscosity to 4.5 cSt at the fuel injection pump.

Density

Density is the mass of the fuel per unit volume at a specific temperature. This parameter has a direct influence on engine performance and a direct influence on emissions. This influence determines from a heat output given injected volume of fuel. This parameter is quoted in the following kg/m^3 at 15 °C (59 °F).

Perkins recommends a density of 841 kg/m ^{3} to obtain the correct power output. Lighter fuels are acceptable but these fuels will not produce the rated power.

Sulfur

The level of sulfur is governed by emissions legislations. Regional regulation, national regulations, or international regulations can require a fuel with a specific sulfur limit. The sulfur content of the fuel and the fuel quality must comply with all existing local regulations for emissions.

Perkins 402F, 403F, and 403F series diesel engines have been designed to operate only with ULSD. By using the test methods “ASTM D5453, or ISO 20846”, the content of sulfur in ULSD fuel must be below 15 PPM (mg/kg) or 0.0015% mass.

NOTICE
Use of diesel fuel with higher than 15 PPM sulphur limit in these engines will harm or permanently damage emissions control systems and/or shorten service interval.

Lubricity

Lubricity is the capability of the fuel to prevent pump wear. The fluids lubricity describes the ability of the fluid to reduce the friction between surfaces that are under load. This ability reduces the damage that is caused by friction. Fuel injection systems rely on the lubricating properties of the fuel. Until fuel sulfur limits were mandated, the fuels lubricity was generally believed to be a function of fuel viscosity.

The lubricity has particular significance to the current ultra low sulfur fuel, and low aromatic fossil fuels. These fuels are made to meet stringent exhaust emissions.

The lubricity of these fuels must not exceed wear scar diameter of 0.52 mm (0.0205 inch). The fuel lubricity test must be performed on an HFRR, operated at 60 °C (140 °F). Refer to “ISO 12156-1”.

NOTICE
The fuels system has been qualified with fuel having lubricity up to 0.52 mm (0.0205 inch) wear scar diameter as tested by “ISO 12156-1”. Fuel with higher wear scar diameter than 0.52 mm (0.0205 inch) will lead to reduced service life and premature failure of the fuel system.

Fuel additives can enhance the lubricity of a fuel. Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use, and for the proper level of treatment.

Distillation

Distillation is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of lightweight hydrocarbons can affect the characteristics of combustion.

Recommendation for Biodiesel and Using B20

Biodiesel is a fuel that can be defined as mono-alkyl esters of fatty acids. Biodiesel is a fuel that can be made from various feedstocks. The most commonly available biodiesel in Europe is Rape Methyl Ester (RME). This biodiesel is derived from rapeseed oil. Soy Methyl Ester (SME) is the most common biodiesel in the United States. This biodiesel is derived from soybean oil. Soybean oil or rapeseed oil are the primary feedstocks. These fuels are together known as Fatty Acid Methyl Esters (FAME).

Raw pressed vegetable oils are NOT acceptable for use as a fuel in any concentration in compression engines. Without esterification, these oils solidify in the crankcase and the fuel tank. These fuels may not be compatible with many of the elastomers that are used in engines that are manufactured today. In original forms, these oils are not suitable for use as a fuel in compression engines. Alternate base stocks for biodiesel may include animal tallow, waste cooking oils, or various other feedstocks. To use any of the products that are listed as fuel, the oil must be esterified.

Fuel made of 100 percent FAME is generally referred to as B100 biodiesel or neat biodiesel.

Biodiesel can be blended with distillate diesel fuel. The blends can be used as fuel. The most commonly available biodiesel blends are B5, which is 5 percent biodiesel and 95 percent distillate diesel fuel. B20, which is 20 percent biodiesel and 80 percent distillate diesel fuel.

Note: The percentages given are volume-based.

The U.S. distillate diesel fuel specification “ASTM D975-09a” includes up to B5 (5 percent) biodiesel.

European distillate diesel fuel specification EN590: 2010 includes up B7 (7 percent) biodiesel.

Note: Engines that are manufactured by Perkins are certified by use of the prescribed Environmental Protection Agency (EPA) and European Certification fuels. Perkins does not certify engines on any other fuel. The user of the engine has the responsibility of using the correct fuel that is recommended by the manufacturer and allowed by the EPA and other appropriate regulatory agencies.

Specification Requirements

The neat biodiesel must conform to the latest “EN14214 or ASTM D6751” (in the USA). The biodiesel can only be blended in mixture of up to 20% by volume in acceptable mineral diesel fuel meeting latest edition of “EN590 or ASTM D975 S15” designation.

In United States Biodiesel blends of B6 to B20 must meet the requirements listed in the latest edition of “ASTM D7467” (B6 to B20) and must be of an API gravity of 30-45.

In North America biodiesel and biodiesel blends must be purchased from the BQ-9000 accredited producers and BQ-9000 certified distributors.

In other areas of the world, the use of biodiesel that is BQ-9000 accredited and certified, or that is accredited and certified by a comparable biodiesel quality body to meet similar biodiesel quality standards is required.

Engine Service Requirements

Aggressive properties of biodiesel fuel may cause debris in the fuel tank and fuel lines. The aggressive properties of biodiesel will clean the fuel tank and fuel lines. This cleaning of the fuel system can prematurely block of the fuel filters. Perkins recommend that after the initial usage of B20 biodiesel blended fuel the fuel filters must be replaced at 50 hours.

Glycerides present in biodiesel fuel will also cause fuel filters to become blocked more quickly. Therefore the regular service interval should be reduced to 250 hours.

When biodiesel fuel is used, crank case oil and aftertreatment systems may be influenced. This influence is due to the chemical composition and characteristics of biodiesel fuel, such as density and volatility, and to chemical contaminants that can be present in this fuel, such as alkali and alkaline metals (sodium, potassium, calcium, and magnesium).

- Crankcase oil fuel dilution can be higher when biodiesel or biodiesel blends are used. This increased level of fuel dilution when using biodiesel or biodiesel blends is related to the typically lower volatility of biodiesel. In-cylinder emissions control strategies utilized in many of the industrial latest engine designs may lead to a higher level of biodiesel concentration in the sump. The long-term effect of biodiesel concentration in crankcase oil is unknown currently.
- Perkins recommend the use of oil analysis to check the quality of the engine oil if biodiesel fuel is used. Ensure that the level of biodiesel in the fuel is noted when the oil sample is taken.

Performance Related Issues

Due to the lower energy content than the standard distillate fuel B20 will cause a power loss in order of 2 to 4 percent. In addition, over time the power may deteriorate further due to deposits in the fuel injectors.

Biodiesel and biodiesel blends are known to cause an increase in fuel system deposits, most significant of which are deposits within the fuel injector. These deposits can cause a loss in power due to restricted or modified fuel injection or cause other functional issues associated with these deposits.

Note: Perkins T40-0012 Fuel Cleaner is most effective in cleaning and preventing the formation of deposits. Perkins Diesel Fuel Conditioner helps to limit deposit issues by improving the stability of biodiesel and biodiesel blends. For more information refer to Perkins Diesel Fuel Cleaner.

Biodiesel fuel contains metal contaminants (sodium, potassium, calcium, and/or magnesium) that form ash products upon combustion in the diesel engine. The ash can have an impact on the life and performance of aftertreatment emissions control devices and can accumulate in DPF. The ash accumulation may cause the need for more frequent ash service intervals and cause loss of performance

General Requirements

Biodiesel has poor oxidation stability, which can result in long-term problems in the storage of biodiesel. Biodiesel fuel should be used within 6 months of manufacture. Equipment should not be stored with the B20 biodiesel blends in the fuel system for longer than 3 months.

Due to poor oxidation stability and other potential issues, it is strongly recommended that engines with limited operational time either not use B20 biodiesel blends or, whilst accepting some risk, limit biodiesel blend to a maximum of B5. Examples of applications that should limit the use of biodiesel are the following: Standby Generator sets and certain emergency vehicles.

For standby generator sets and emergency vehicles that cannot avoid use of biodiesel blends fuel quality in the engine fuel tank must be sampled and checked monthly. Test should include acid number (EN14104), oxidation stability (EN 15751 commonly know as the Rancimant test), and sediment (ISO12937). For standby generator sets oxidation stability of biodiesel blend must be 20 hours or more as per EN 15751. If the test shows that the fuel has degraded, fuel tank must be drained and engine flashed by running with the fresh high-quality diesel fuel.

Perkins strongly recommended that seasonally operated engines have the fuel systems, including fuel tanks, flashed with conventional diesel fuel before prolonged shutdown periods. An example of an application that should seasonally flush the fuel system is a combine harvester.

Microbial contamination and growth can cause corrosion in the fuel system and premature plugging of the fuel filter. Consult your supplier of fuel for assistance in selecting appropriate anti-microbial additive.

Water accelerates microbial contamination and growth. When biodiesel is compared to distillate fuels, water is naturally more likely to exist in the biodiesel. Therefore check frequently and if necessary, drain the water separator.

Materials such as brass, bronze, copper, lead, tin, and zinc accelerate the oxidation process of the biodiesel fuel. The oxidation process can cause deposits formation therefore these materials must not be used for fuel tanks and fuel lines.

Renewable and Alternative Fuels

Perkins supports development and use of renewable fuels through sustainability initiatives. In recent years various forms of renewable and alternative (synthetic) diesel fuels have started to emerge.

Synthetic diesel fuels are produced by gasification of various feedstock and then synthesis to liquid to obtain paraffinic diesel fuel. Based on the feedstock used these fuels are commonly referred to as Biomass to liquid (BTL), Gas to liquid (GTL) and Coal to liquid (CTL). Hydrotreating of vegetable oils and animal fats is another emerging process for production of bio based diesel fuel called Hydrotreated Vegetable Oil (HVO).

BTL and HVO fuels are considered to be low carbon fuels as they reduce carbon foot print compared to fossil fuels and are commonly referred to as renewable fuels. These fuels must not be confused with biodiesel FAME which is fundamentally different fuel and is discussed in a separate section in this manual.

These paraffinic fuels have virtually no sulphur or aromatics and have very high cetane numbers which enable very clean burning and efficient engine operation. Chemically these fuels are similar to diesel fuel derived from petroleum and are therefore suitable to use in diesel engines as a replacement or blend stock with conventional diesel fuel. To be acceptable renewable and alternative fuels must meet latest edition of the paraffinic diesel fuel specification “CENTS 15940”. The fuel should also meet requirements described in table 17 , Perkins Specification for Distillate Diesel Fuel, EN590, or latest ASTM D975 specification.

Ensure that the fuel has got appropriate cold flow properties (cloud point and CFPP) for the minimum statistical ambient temperature the engine is expected to see in the operation. The Fuel must also meet lubricity requirements as specified in the lubricity section of this “Operation and Maintenance Manual” Fluid Recommendations

Fuel for Cold-Weather Operation

The European standard “EN590” contains climate dependant requirements and a range of options. The options can be applied differently in each country. There are five classes that are given to arctic climates and severe winter climates. 0, 1, 2, 3 and 4.

Fuel that complies with “EN590” CLASS 4 can be used at temperatures as low as −44 °C (−47.2 °F). Refer to “EN590” fora detailed discretion of the physical properties of the fuel.

The diesel fuel “ASTM D975 1-D” used in the United States of America may be used in very cold temperatures that are below −18 °C (−0.4 °F).

Aftermarket Fuel Additives

NOTICE

Perkins does not warrant the quality or performance of non-Perkins fluids and filters.

When auxiliary devices, accessories, or consumables (filters, additives) which are made by other manufacturers are used on Perkins products, the Perkins warranty is not affected simply because of such use.

However, failures that result from the installation or use of other manufacturers devices, accessories, or consumables are NOT Perkins defects. Therefore, the defects are NOT covered under the Perkins warranty.

Supplemental diesel fuel additives are not generally recommended. This recommendation is due to potential damage to the fuel system or the engine. Your fuel supplier or the fuel manufacturer will add the appropriate supplemental diesel fuel additives.

Perkins recognizes the fact that additives may be required in some special circumstances.

Note: Some anti-corrosion additives can lead to injector fouling, this fouling can cause the injector to operate incorrectly.

Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can recommend the appropriate fuel additive and the correct level of treatment.

Note: For the best results, your fuel supplier should treat the fuel when additives are required. The treated fuel must meet the requirements that are stated in table 17 .

Perkins Diesel Fuel System Cleaner

Perkins T40-0012 Fuel Cleaner is the only fuel cleaner that is recommended by Perkins.

If biodiesel or biodiesel blends of fuel are to be used, Perkins require the use of Perkins fuel cleaner. The use of the fuel is to remove deposits within the fuel system that is created with the use of biodiesel. For more information on the use of biodiesel and biodiesel blends refer to Recommendation for Biodiesel and Using B20.

Perkins fuel cleaner will remove deposits that can form in the fuel system with the use of biodiesel and biodiesel blends. These deposits can create a loss of power and engine performance.

Once the fuel cleaner has been added to the fuel, the deposits within the fuel system are removed after 30 hours of engine operation. For maximum results, continue to use the fuel cleaner for up to 80 hours. Perkins fuel cleaner can be used on an on-going basis with no adverse impact on engine or fuel system durability.

Details instruction on the rate of which the fuel cleaner must be use are on the container.

Note: Perkins fuel cleaner is compatible with existing and U.S. EPA Tier 4 nonroad certified diesel engine emission control catalysts and particulate filters. Perkins fuel system cleaner contains less than 15 ppm of sulfur and is acceptable for use with ULSD fuel.

Contamination Control Recommendations for Fuels

Fuels of “ISO 18/16/13” cleanliness level or cleaner as dispensed into the engine or application fuel tank should be used. This will reduce risk of power loss, fuel system failures, and related down time of engines. This cleanliness level is important for new fuel system designs such as common rail injection systems and unit injectors. These fuels systems utilize higher fuel injection pressures and have tight clearances between moving parts to meet required stringent emissions regulations. Peak injection pressures in current fuel injection systems may exceed 2000 bar (29000 psi). Clearances in these systems are less than 5 µm. As a result, particle contaminants as small as 4 µm can cause scoring and scratching of internal pump and injector surfaces and of injector nozzles.

Water in the fuel causes cavitation, corrosion of fuel system parts, and provides an environment where microbial growth in the fuel can flourish. Other sources of fuel contamination are soaps, gels, or other compounds that may result from undesirable chemical interactions in the fuels, particularly in ULSD. Gels and other compounds can also form in biodiesel fuel at low temperatures or if biodiesel is stored for extended periods. The best indication of microbial contamination, fuel additives, or cold temperature gel is rapid filter plugging of bulk fuel filters or application fuel filters.

To reduce downtime due to contamination, follow these fuel maintenance guidelines.

- Use high-quality fuels per recommended and required specifications
- Fill fuel tanks with fuels of “ISO 18/16/13” cleanliness level or cleaner, in particular for engines with common rail and unit injection systems. When you refuel the tank, filter the fuel through a 4 µm absolute filter (Beta 4 = 75 up to 200) to reach the recommended cleanliness level. This filtration should be installed at the device that dispenses the fuel to the fuel tank. In addition, filtration at the dispensing point should remove water to ensure that fuel is dispensed at 500 ppm water or less.
- Perkins recommends the use of bulk fuel filter / coalescer units which clean the fuel of both particulate contamination and water in a single pass.
- Ensure that you use Perkins Advanced Efficiency Fuel Filters. Change your fuel filters per recommended service requirements or as needed.
- Drain your water separators daily.
- Drain your fuel tanks of sediment and water per the Operation and Maintenance Manual instructions.
- Install and maintain a properly designed bulk filter / coalescer filtration system. Continuous bulk filtration systems may be required to ensure that dispensed fuel meets the cleanliness target. Consult your Perkins distributor for availability of bulk filtration products.
- Centrifugal filters may need to be used as a pre-filter with fuel that is severely contaminated with gross amounts of water and/or large particulate contaminants. Centrifugal filters can effectively remove large contaminants. Centrifugal filters may not be able to remove the small abrasive particles required to achieve the recommended “ISO” cleanliness level. Bulk filter / coalescers are necessary as a final filter to achieve the recommended cleanliness level.
- Install desiccant type breathers of 4 µm or less absolute efficiency with the ability to remove water on bulk storage tanks.
- Follow proper practices of fuel transportation. Filtration from the storage tank to the application promotes the delivery of clean fuel. Fuel filtration can be installed at each transport stage to keep the fuel clean.
- Cover, protect, and ensure cleanliness of all connection hoses, fittings, and dispensing nozzles.

Consult your local Perkins distributor for additional information on Perkins designed and produced filtration products.

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Fluid Recommendations

General Coolant Information

NOTICE
Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE
If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE
Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

NOTICE
Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: Overheating, leakage of the water pump and plugged radiators or heat exchangers.

These failures can be avoided with correct cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: Water, additives, and glycol.

Water

Water is used in the cooling system to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: Hard water, softened water that has been conditioned with salt and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 19 .

Table 19

Acceptable Water	
Property	**Maximum Limit**
Chloride (Cl)	40 mg/L
Sulfate (SO_4)	100 mg/L
Total Hardness	170 mg/L
Total Solids	340 mg/L
Acidity	pH of 5.5 to 9.0

For a water analysis, consult one of the following sources:

- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically.

Additives must be added at the correct concentration. Over concentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing

- Cavitation of the water pump

For optimum performance, Perkins recommends a 1:1 mixture of a water/glycol solution.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of −13 °C (8.6 °F).

Most conventional antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. Refer to Table 20 and refer to table 21 .

Table 20

Ethylene Glycol	
Concentration	**Freeze Protection**
50 Percent	−36 °C (−33 °F)
60 Percent	−51 °C (−60 °F)

NOTICE
Do not use propylene glycol in concentrations that exceed 50 percent glycol because of the reduced heat transfer capability of propylene glycol. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 21

Propylene Glycol	
Concentration	**Freeze Protection**
50 Percent	−29 °C (−20 °F)

To check the concentration of glycol in the coolant, measure the specific gravity of the coolant.

Coolant Recommendations

- ELC Extended Life Coolant
- SCA Supplement Coolant Additive
- ASTM American Society for Testing and Materials

The following two coolants are used in Perkins diesel engines:

Preferred – Perkins ELC

Acceptable – A commercial heavy-duty antifreeze that meets “ASTM D6210” specifications

NOTICE
The Perkins industrial engines must be operated with a 1:1 mixture of water and glycol.

NOTICE
Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light automotive applications.

Perkins recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as an antifreeze. This ratio may be increased to 1:2 water to glycol if extra freezing protection is required.

Table 22

Coolant Service Life	
Coolant Type	**Service Life (1)**
Perkins ELC	6,000 Service Hours or Three Years
Commercial Heavy-Duty Antifreeze that meets “ASTM D6210”	3000 Service Hours or Two Year
Commercial SCA inhibitor and Water	3000 Service Hours or One Year

(1) Use the interval that occurs first. The cooling system must also be flushed out at this time.

ELC

Perkins provides ELC for use in the following applications:

- Heavy-duty spark ignited gas engines
- Heavy-duty diesel engines
- Automotive applications

The anti-corrosion package for ELC is different from the anti-corrosion package for other coolants. ELC is an ethylene glycol base coolant. However, ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Perkins ELC has been formulated with the correct amount of these additives to provide superior corrosion protection for all metals in engine cooling systems.

ELC is available in a premixed cooling solution with distilled water. ELC is a 1:1 mixture. The Premixed ELC provides freeze protection to −36 °C (−33 °F). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

Containers of several sizes are available. Consult your Perkins distributor for the part numbers.

ELC Cooling System Maintenance

Correct additions to the Extended Life Coolant

NOTICE
Use only Perkins products for pre-mixed or concentrated coolants.

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

To maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of ELC. Lowering the proportion of antifreeze lowers the proportion of additive. Lowering the ability of the coolant to protect the system will form pitting, from cavitation, from erosion, and from deposits.

NOTICE
Do not use a conventional coolant to top-off a cooling system that is filled with Extended Life Coolant (ELC).

Do not use standard supplemental coolant additive (SCA).

When using Perkins ELC, do not use standard SCA's or SCA filters.

ELC Cooling System Cleaning

Note: If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when ELC is drained from the cooling system.

Before the cooling system is filled, the heater control (if equipped) must be set to the HOT position. Refer to the OEM to set the heater control. After the cooling system is drained and the cooling system is refilled, operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture to fill the system to the specified level.

Changing to Perkins ELC

To change from heavy-duty antifreeze to the Perkins ELC, perform the following steps:

NOTICE
Care must be taken to ensure that all fluids are contained during performance of inspection, maintenance, testing, adjusting and the repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant into a suitable container.
2. Dispose of the coolant according to local regulations.
3. Fill the cooling system with a 33 percent solution of Perkins ELC and operate the engine, ensure that the thermostat opens. Stop the engine and allow the engine to cool. Drain the coolant.

Note: Use distilled or deionized water in the solution.

4. Again, fill the cooling system with a 33 percent solution of Perkins ELC and operate the engine ensure that the thermostat opens. Stop the engine and allow to cool.
5. Drain the cooling system.

NOTICE
Incorrect or incomplete flushing of the cooling system can result in damage to copper and other metal components.

6. Fill the cooling system with the Perkins Premixed ELC. Operate the engine. Ensure that all coolant valves open then stop the engine. When cool check the coolant level.

ELC Cooling System Contamination

NOTICE
Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Perkins Products for premixed or concentrate coolants. Failure to follow these recommendations can result in shortened cooling system component life.

ELC cooling systems can withstand contamination to a maximum of 10 percent of conventional heavy-duty antifreeze or SCA. If the contamination exceeds 10 percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with a 5 to 10 percent solution of Perkins ELC. Fill the system with the Perkins ELC.
- Drain a portion of the cooling system into a suitable container according to local regulations. Then, fill the cooling system with premixed ELC. This procedure should lower the contamination to less than 10 percent.
- Maintain the system as a conventional Heavy-Duty Coolant. Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Heavy-Duty Coolant.

Commercial Heavy-Duty Antifreeze and SCA

NOTICE
Commercial Heavy-Duty Coolant which contains Amine as part of the corrosion protection system must not be used.

NOTICE
Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the correct operating temperature. Cooling system problems can develop without water temperature regulators.

Check the antifreeze (glycol concentration) to ensure adequate protection against boiling or freezing. Perkins recommends the use of a refractometer for checking the glycol concentration. A hydrometer should not be used.

Perkins engine cooling systems should be tested at 500-hour intervals for the concentration of SCA.

Additions of SCA are based on the results of the test. An SCA that is liquid may be needed at 500-hour intervals.

Adding the SCA to Heavy-Duty Coolant at the Initial Fill

Use the equation that is in Table 23 to determine the amount of SCA that is required when the cooling system is initially filled.

Table 23

Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill
V × 0.07 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 24 is an example for using the equation that is in Table 23 .

Table 24

Example Of The Equation For Adding The SCA To The Heavy-Duty Coolant At The Initial Fill		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
15 L (4 US gal)	× 0.07	1.05 L (35.5 oz)

Adding The SCA to The Heavy-Duty Coolant For Maintenance

Heavy-duty antifreeze of all types REQUIRE periodic additions of an SCA.

Test the antifreeze periodically for the concentration of SCA. For the interval, refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section). Cooling System Supplemental Coolant Additive (SCA) Test/Add.

Additions of SCA are based on the results of the test. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 25 to determine the amount of SCA that is required, if necessary:

Table 25

Equation For Adding The SCA To The Heavy-Duty Coolant For Maintenance
V × 0.023 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 26 is an example for using the equation that is in Table 25 .

Table 26

Example Of The Equation For Adding The SCA To The Heavy-Duty Coolant For Maintenance		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
15 L (4 US gal)	× 0.023	0.35 L (11.7 oz)

Cleaning the System of Heavy-Duty Antifreeze

- Clean the cooling system after used coolant is drained or before the cooling system is filled with new coolant.

- Clean the cooling system whenever the coolant is contaminated or whenever the coolant is foaming.

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Fluid Recommendations

General Lubricant Information

Because of government regulations regarding the certification of exhaust emissions from the engine, the lubricant recommendations must be followed.

- API_____American Petroleum Institute
- SAE_____Society Of Automotive Engineers Inc.
- ACEA_____Association des Constructers European Automobiles.
- ECF_____Engine Crankcase Fluid

Licensing

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) and the Association des Constructers European Automobiles (ACEA) is recognized by Perkins. For detailed information about this system, see the latest edition of the “API publication No. 1509”. Engine oils that bear the API symbol are authorized by API.

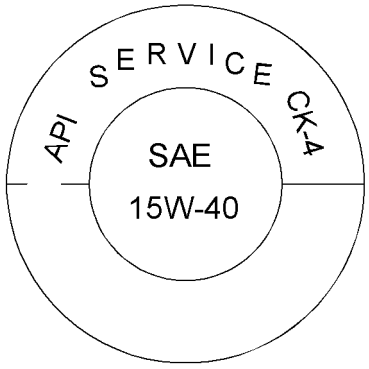


Illustration 34 g06183768

Typical API symbol

Terminology

Certain abbreviations follow the nomenclature of “SAE J754”. Some classifications follow “SAE J183” abbreviations, and some classifications follow the “EMA Recommended Guideline on Diesel Engine Oil”. In addition to Perkins definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, “Fluid Recommendations/ Engine Oil” topic (Maintenance Section).

Engine Oil

Commercial Oils

NOTICE
Perkins require the use of the following specification of engine oil. Failure to use the appropriate specification of engine oil will reduce the life of your engine.

Table 27

Classifications for the 400J Industrial Engines
Oil Specification
CK-4 ACEA E9 ECF-3

API CK-4 and ACEA E9 oil categories have the following chemical limits:

- 0.1 percent maximum sulfated ash
- 0.12 percent maximum phosphorous
- 0. 4 percent maximum sulfur

The chemical limits were developed to maintain the expected life of the engine.

Maintenance intervals for engines that use biodiesel – The oil change interval can be adversely affected by the use of biodiesel. Use oil analysis to monitor the condition of the engine oil. Use oil analysis also to determine the oil change interval that is optimum.

Note: These engine oils are not approved by Perkins and these engine oils must not be used: CC, CD, CD-2, CF-4, CG-4, CH-4, and CI-4.

Lubricant Viscosity Recommendations

The correct SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to illustration 35 (minimum temperature) to determine the required oil viscosity for starting a cold engine.

Refer to illustration 35 (maximum temperature) to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

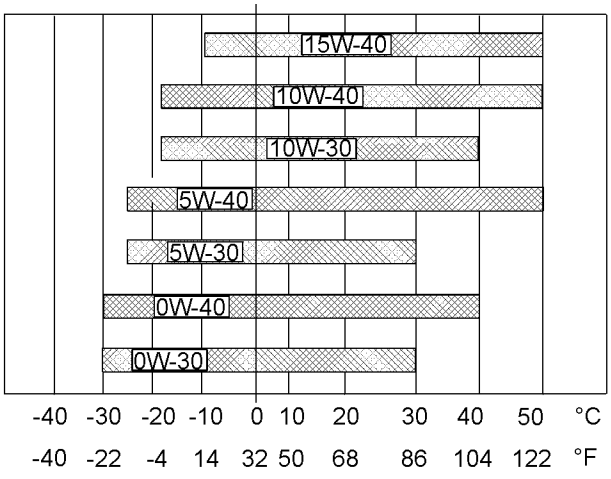


Illustration 35 g02932046

Lubricant Viscosities

Supplemental heat is recommended for cold soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold soaked starts to occur when the engine has not been operated for a period of time. This interval will allow the oil to become more viscous due to cooler ambient temperatures.

Aftermarket Oil Additives

Perkins does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives to achieve the engines maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oils additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This failure could produce sludge in the crankcase. Perkins discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Perkins engine, conform to the following guidelines:

- See the appropriate “Lubricant Viscosities”. Refer to the illustration 35 to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.

Oil analysis

Some engines may be equipped with an oil sampling valve. If oil analysis is required, the oil sampling valve is used to obtain samples of the engine oil. The oil analysis will complement the preventive maintenance program.

Note: Ensure that there is sufficient quantity of oil in the engine before taking a sample of oil with the engine in operation. The engine oil capacity must not go below the minimum quantity specified on the oil level gauge. Refer to this Operation and Maintenance Manual, “Engine Oil Level - Check” for the correct procedure.

The oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured by using oil analysis. The oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engines metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil.
- Tests are conducted to detect contamination of the oil by water, glycol, or fuel.

- The Oil Condition Analysis determines the loss of the oils lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

Maintenance Recommendations

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System Pressure Release

Coolant System

⚠ WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

Ensure that the power supply is isolated before any service or repair is performed.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly in order to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

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Welding on Engines with Electronic Controls

NOTICE
Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Perkins dealer regarding welding on a chassis frame or rail.

Correct welding procedures are necessary to avoid damage to the engines ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit equipped with an Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE
Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage.

Note: Perform the welding in areas that are free from explosive hazards.

1. Stop the engine. Turn the switched power to the OFF position.
2. Ensure that the fuel supply to the engine is turned off.
3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
4. Disconnect all electronic components from the wiring harnesses. Include the following components:
   - Electronic components for the driven equipment
   - ECM
   - Sensors
   - Electric operated fuel pump
   - Electronically controlled valves
   - Relays
   - Aftertreatment ID module

NOTICE
Do not use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.

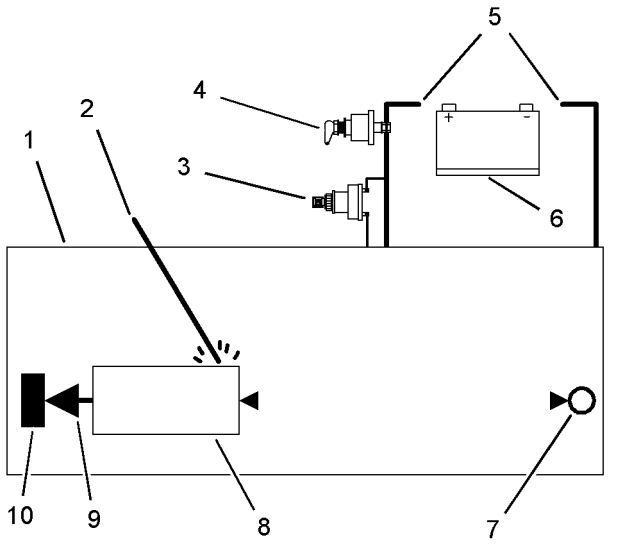


Illustration 36 g06477753

Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

(1) Engine
(2) Welding electrode
(3) Keyswitch in the OFF position
(4) Battery disconnect switch in the open position
(5) Disconnected battery cables
(6) Battery
(7) Electrical/Electronic component
(8) The component that is being welded
(9) Current path of the welder
(10) Ground clamp for the welder

5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld to reduce the possibility of welding current damage to the following components. Bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

6. Protect the wiring harness from welding debris and spatter.

7. Use standard welding practices to weld the materials.

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Severe Service Application

Severe service is the application of an engine that exceeds the current published standards for that engine. Perkins maintains standards for the following engine parameters:

- Performance such as power range, speed range, and fuel consumption
- Fuel quality
- Operational Altitude
- Maintenance intervals
- Oil selection and maintenance
- Coolant type and maintenance
- Environmental qualities
- Installation
- The temperature of the fluid in the engine

Refer to the standards for the engine or consult your Perkins dealer or your Perkins distributor in order to determine if the engine is operating within the defined parameters.

Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Perkins dealer or your Perkins distributor for the unique maintenance that is necessary for the engine.

The operating environment, incorrect operating procedures, and incorrect maintenance procedures can be factors which contribute to a severe service application.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in cold temperatures. Hot intake air reduces engine performance.

Quality of the air – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt, and dust can encase components.

Maintenance can be difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals, and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Incorrect Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Incorrect Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants, and coolant/antifreeze

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Maintenance Interval Schedule

When Required

“ Battery - Replace” 71
“ Engine - Clean” 79
“ Engine Oil and Filter - Change”. 84
“ Engine Air Cleaner Element - Replace” 79
“ Engine Air Cleaner Element - Replace” . . . . . .
“ Fuel System - Prime”. . . . . .
“ Fuel System - Prime”. 89
“ Fuel System Secondary Filter - Replace”. 100

Daily

“ Coolant Level - Check” 76
“ Driven Equipment - Check”. 78
“ Engine Air Cleaner Service Indicator - Inspect” . . 80
“ Engine Air Precleaner - Check/Clean” . . . . . .
“ Engine Oil Level - Check” 83
“ Fuel System Primary Filter/Water Separator - Drain” 97
“Walk-Around Inspection” 103

Every 50 Service Hours or Weekly

“ Fuel Tank Water and Sediment - Drain” 101

Every 250 Service Hours or 6 Months

“ Alternator and Fan Belts - Inspect/Adjust” 69

Every 500 Service Hours

“ Cooling System Supplemental Coolant Additive (SCA) - Test/Add”. 78
“ Fan Clearance - Check” . . . . . .
“ Engine Oil and Filter - Change”. . . . . .

Every 500 Service Hours or 1 Year

“ Battery Electrolyte Level - Check” 72
“ Engine Air Cleaner Element - Replace” . . . . . .
“ Fuel Filter (In-Line) - Replace” 88
“ Fuel System Primary Filter - Replace” 96
“ Fuel System Secondary Filter - Replace”. 98
“ Hoses and Clamps - Inspect/Replace”. 101
“ Radiator - Clean” 102

Every 1000 Service Hours

“ Alternator and Fan Belts - Replace” 70
“ Engine Valve Lash - Check” 87

Every 2000 Service Hours

“ Alternator - Inspect” 69
“ Engine Crankcase Breather - Replace” . . . . . .
“ Engine Mounts - Inspect” . . . . . .
“ Starting Motor - Inspect” . . . . . .

Every 3000 Service Hours

“ Coolant Temperature Regulator - Replace” 77
“ Fuel Injector - Test/Change” 88
“ Water Pump - Inspect”. 104

Every 3000 Service Hours or 2 Years

“ Coolant (Commercial Heavy-Duty) - Change” . . . . . .

Every 6000 Service Hours or 3 Years

“ Coolant (ELC) - Change”. . . . . .

Commissioning

“ Fan Clearance - Check” . . . . . .

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Alternator - Inspect

Perkins recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and correct battery charging. Check the ammeter (if equipped) during engine operation in order to ensure correct battery performance and/or correct performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for correct operation. If the batteries are correctly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

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Alternator and Fan Belts - Inspect/Adjust

Inspection

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

To check accurately the belt tension, a suitable gauge should be used.

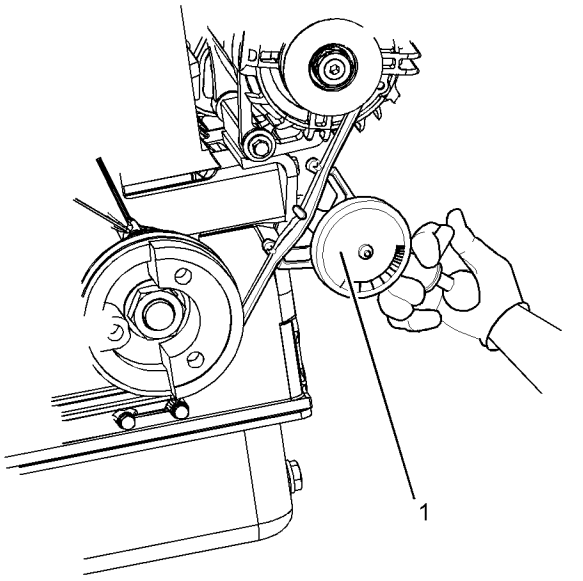


Illustration 37 g03383147

Typical example

(1) Burroughs Gauge

Install the gauge (1) at the center of the belt between the alternator and the crankshaft pulley and check the belt tension. The correct tension for a new belt is 400 N (90 lb) to 489 N (110 lb). The correct tension for a used belt that has been in operation for 30 minutes or more at the rated speed is 267 N (60 lb) to 356 N (80 lb).

If twin belts are installed, check and adjust the tension on both belts.

Adjustment

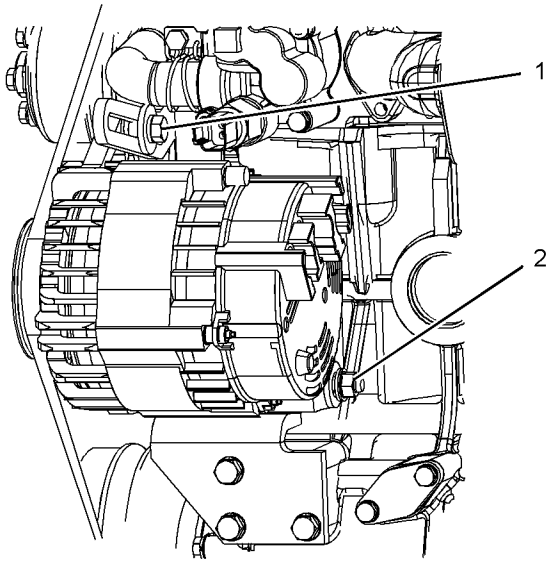


Illustration 38 g03383151

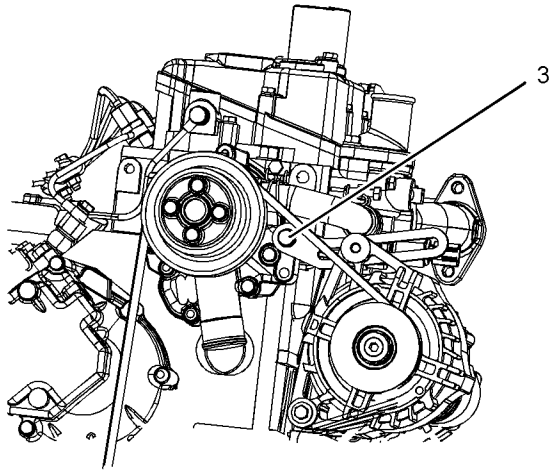


Illustration 39 g03383155

1. Loosen adjusting bolt (1) and mounting bolt and nut (2). Loosen bolt (3).

2. Move the alternator in order to increase or decrease the belt tension.

3. Tighten adjusting bolt (1) and tighten mounting bolts and nut (2). Tighten bolt (3). Tighten all fixing to a torque of 25 N·m (221 lb in)

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Alternator and Fan Belts - Replace

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

Note: When new belts are installed, check the belt tension again after 20 hours of engine operation.

Removal and Installation Procedure

Refer to the original equipment manufacture for removal and installation of the fan guards.

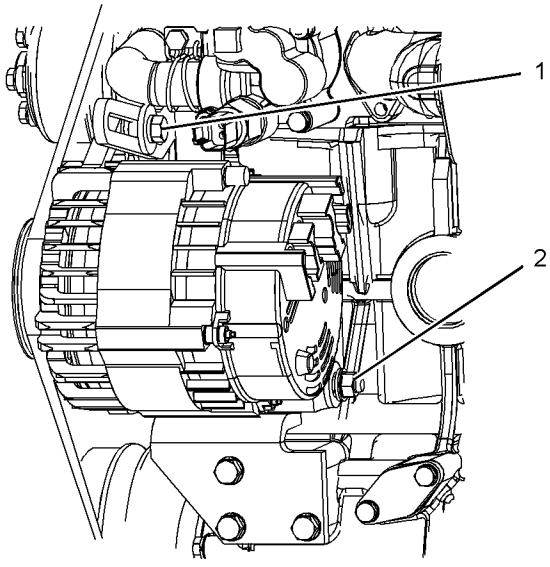


Illustration 40 g03383665

Typical example

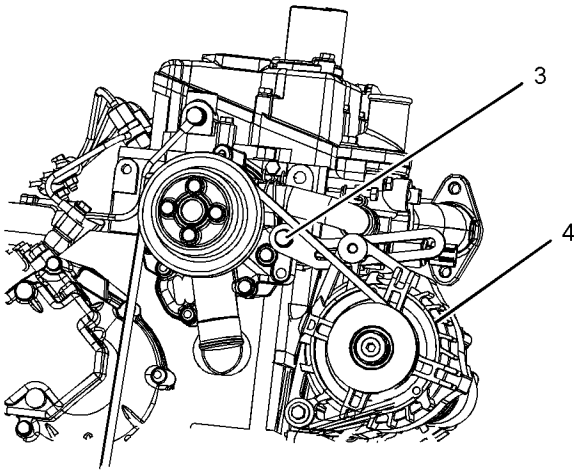


Illustration 41 g03383666
Typical example

1. Loosen adjusting bolt (1) and mounting bolt and nut (2). Loosen bolt (3).

2. Push the alternator (4) towards the engine.

Note: If the belt is to be reused, mark the belt in order to show direction of rotation.

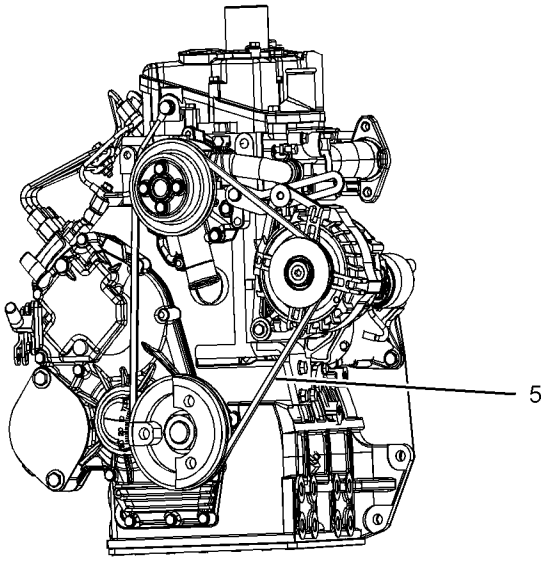


Illustration 42 g03383667
Typical example

3. Remove the belt (5).

4. Install new belt (5) and adjust the alternator to the required tension.

5. Tighten bolt (1) and tighten bolt and nut (2). Tighten bolt (3). Tighten all bolts and nuts to a torque of 25 N·m (221 lb in).

Refer to this Operation and Maintenance Manual, “Alternator and Fan Belts - Inspect/Adjust” for the tension of the belt.

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Battery - Replace

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

⚠ WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Switch the engine to the OFF position. Remove all electrical loads.

2. Turn off any battery chargers. Disconnect any battery chargers.

3. The NEGATIVE “-” cable connects the NEGATIVE “-” battery terminal to the NEGATIVE “-” terminal on the starting motor. Disconnect the cable from the NEGATIVE “-” battery terminal.

4. The POSITIVE “+” cable connects the POSITIVE “+” battery terminal to the POSITIVE “+” terminal on the starting motor. Disconnect the cable from the POSITIVE “+” battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

5. Remove the used battery.

6. Install the new battery.

Note: Before the cables are connected, ensure that the engine start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE “+” battery terminal.

8. Connect the NEGATIVE “-” cable to the NEGATIVE “-” battery terminal.

i02747977

Battery Electrolyte Level - Check

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are correctly charged, the ammeter reading should be very near zero, when the engine is in operation.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the “FULL” mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with a suitable battery tester.

3. Install the caps.

4. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- Use a solution of 0.1 kg (0.2 lb) baking soda and 1 L (1 qt) of clean water.
- Use a solution of ammonium hydroxide.

Thoroughly rinse the battery case with clean water.

i08073707

Coolant (Commercial Heavy-Duty) - Change

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to Local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. During this maintenance procedure, consider replacing the water pump, the water temperature regulator, and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

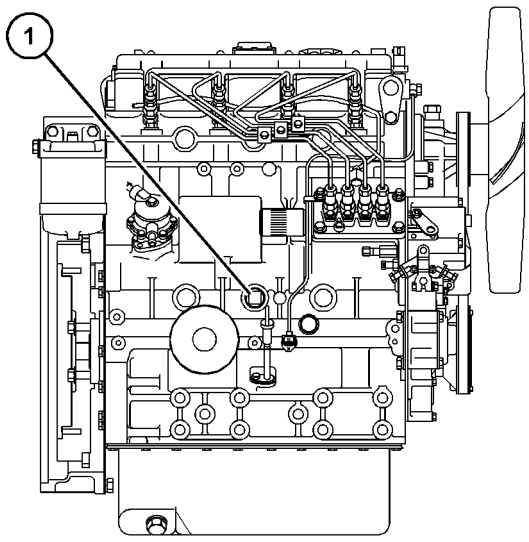


Illustration 43 g06518654
Drain plug option

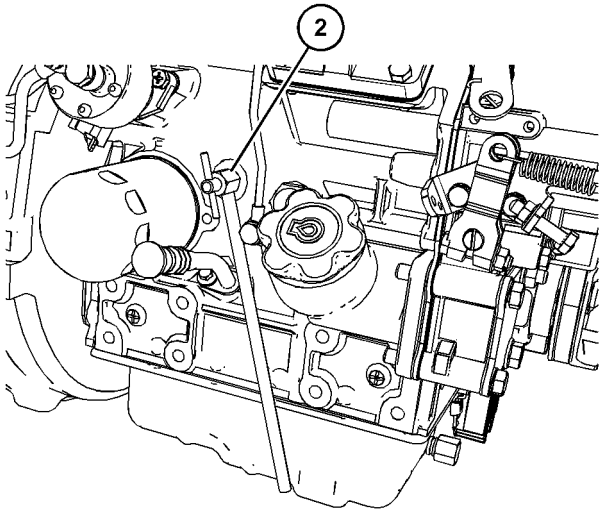


Illustration 44 g06518652
Drain tap option

2. Remove drain plug (1) or open drain tap (2) for the engine.

3. Remove the drain plug or open the drain tap on the radiator.

4. Allow the coolant to drain.

NOTICE
Dispose of used engine coolant or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Perkins to reclaim the coolant.

For information regarding the disposal and the recycling of used coolant, consult your Perkins dealer or your Perkins distributor.

Flush

1. Flush the cooling system with clean water to remove any debris.

2. Close the drain tap or install the drain plug to the engine.

3. Close the drain tap or install the drain plug on the radiator.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

4. Fill the cooling system with clean water. Install the cooling system filler cap.

5. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

6. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap. Open the drain tap or remove the drain plug on the engine. Open the drain tap or remove the drain plug on the radiator. Allow the water to drain. Flush the cooling system with clean water.

Fill

1. Close the drain tap or install the drain plug on the engine.

2. Close the drain tap or install the drain plug on the radiator.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with Commercial Heavy-Duty Coolant. Add Supplemental Coolant Additive to the coolant. For the correct amount, refer to the Operation and Maintenance Manual, “Fluid Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
4. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute to purge the air from the cavities of the engine block. Stop the engine.
5. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level in the expansion bottle (if equipped) at the correct level.
6. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a suitable pressurizing pump to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
7. Start the engine. Inspect the cooling system for leaks and for correct operating temperature.

i08073716

Coolant (ELC) - Change

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to Local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. During this maintenance procedure, consider replacing the water pump, the water temperature regulator, and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

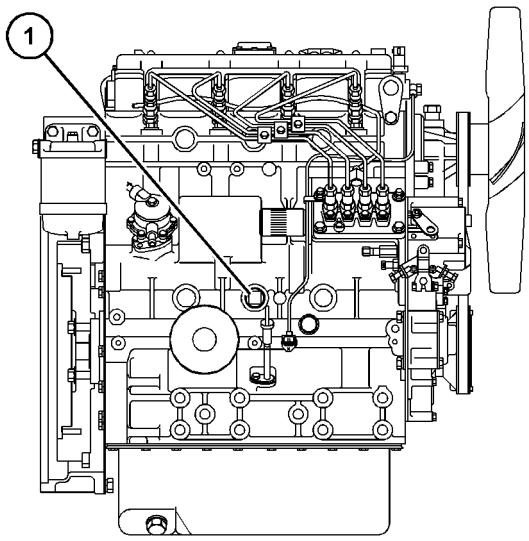


Illustration 45 g06518654

Drain plug option

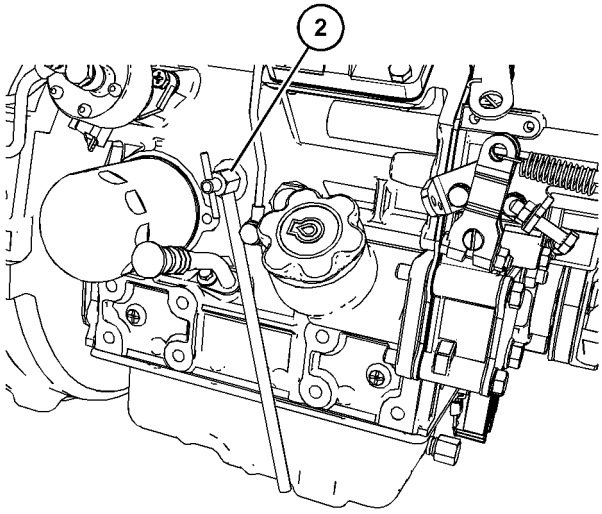


Illustration 46 g06518652

Drain tap option

2. Remove drain plug (1) or open drain tap (2) for the engine.

3. Remove the drain plug or open the drain tap on the radiator.

4. Allow the coolant to drain.

NOTICE
Dispose of used engine coolant or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Perkins to reclaim the coolant.

For information regarding the disposal and the recycling of used coolant, consult your Perkins dealer or your Perkins distributor.

Flush

1. Flush the cooling system with clean water to remove any debris.

2. Close the drain cock or install the drain plug in the engine. Close the drain cock or install the drain plug on the radiator.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with clean water. Install the cooling system filler cap.

4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap. Open the drain cock or remove the drain plug on the engine. Open the drain cock or remove the drain plug on the radiator. Allow the water to drain. Flush the cooling system with clean water.

Fill

1. Close the drain cock or install the drain plug on the engine. Close the drain cock or install the drain plug on the radiator.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

2. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Fluid Recommendations” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

3. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute to purge the air from the cavities of the engine block. Stop the engine.

4. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level in the expansion bottle (if equipped) at the correct level.

5. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a suitable pressurizing pump to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

6. Start the engine. Inspect the cooling system for leaks and for correct operating temperature.

i05149389

Coolant Level - Check

Engines With a Coolant Recovery Tank

Note: The cooling system may not have been provided by Perkins. The procedure that follows is for typical cooling systems. Refer to the OEM information for the correct procedures.

Check the coolant level when the engine is stopped and cool.

NOTICE
When any servicing or repair of the engine cooling system is performed, the procedure must be performed with the engine on level ground. Level ground will allow you to check accurately the coolant level. This checking will also help in avoiding the risk of introducing an air lock into the coolant system.

1. Observe the coolant level in the coolant recovery tank. Maintain the coolant level to “COLD FULL” mark on the coolant recovery tank.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

2. Loosen filler cap slowly in order to relieve any pressure. Remove the filler cap.

3. Pour the correct coolant mixture into the tank. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for information on the correct mixture and type of coolant. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for the engine cooling system capacity. Do not fill the coolant recovery tank above “COLD FULL” mark.

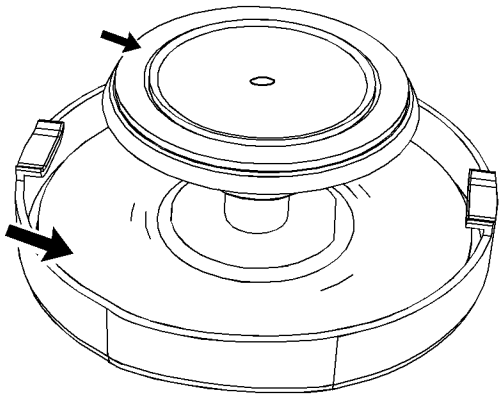


Illustration 47 g02590196
Filler cap

4. Clean the filler cap and the receptacle. Reinstall the filler cap and inspect the cooling system for leaks.

Note: The coolant will expand as the coolant heats up during normal engine operation. The additional volume will be forced into the coolant recovery tank during engine operation. When the engine is stopped and cool, the coolant will return to the engine.

Engines Without a Coolant Recovery Tank

Check the coolant level when the engine is stopped and cool.

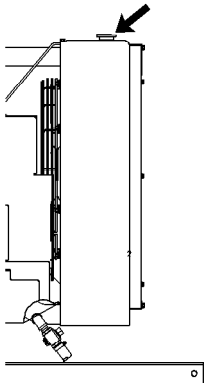


Illustration 48 g00285520

Cooling system filler cap

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level at the maximum mark that is correct for your application. If the engine is equipped with a sight glass, maintain the coolant level to the correct level in the sight glass.
3. Clean the cooling system filler cap and inspect the gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a suitable pressurizing pump in order to pressure test the filler cap. The correct pressure is stamped on the face of the filler cap. If the filler cap does not retain the correct pressure, install a new filler cap.
4. Inspect the cooling system for leaks.

i05160120

Coolant Temperature Regulator - Replace

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Perkins engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to the Disassembly and Assembly Manual, “Water Temperature Regulator - Remove and Install” for the replacement procedure of the water temperature regulator, or consult your Perkins dealer or your Perkins distributor.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i03644948

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

⚠ WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.

Test for SCA Concentration

Heavy-Duty Coolant/Antifreeze and SCA

NOTICE
Do not exceed the recommended six percent supplemental coolant additive concentration.

Use a Coolant Conditioner Test Kit in order to check the concentration of the SCA.

Add the SCA, If Necessary

NOTICE
Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

NOTICE
When any servicing or repair of the engine cooling system is performed the procedure must be performed with the engine on level ground. This will allow you to accurately check the coolant level. This will also help in avoiding the risk of introducing an air lock into the coolant system.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
3. Add the correct amount of SCA. Refer to the Operation and Maintenance Manual, “Refill Capacities and Recommendations” for more information on SCA requirements.
4. Clean the cooling system filler cap and inspect the gasket. If the gasket is damaged, discard the old filler cap and install a new filler cap. If the gasket is not damaged, use a suitable pressurizing pump in order to pressure test the filler cap. The correct pressure is stamped on the face of the filler cap. If the filler cap does not retain the correct pressure, install a new filler cap.

i02151646

Driven Equipment - Check

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i06804001

Engine - Clean

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE" .

NOTICE
Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used to prevent electrical components from being damaged by excessive water when the engine is cleaned. Do not be directed the nozzle of the cleaner at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator, the starter, and the ECM. Protect the fuel injection pump from fluids when washing the engine.

Ensure that care is taken that the safety labels, emission label, and all other information labels are not removed during engine cleaning.

i07091080

Engine Air Cleaner Element - Replace
(1000 Hour Service for Certain Engines Only)

S/N: EJ11–Up

Engine model 403F-11 with prefix EJ can be configured to operate with an extended air filter service. The extended air filter service is 1000 hours. The engine model is for constant speed only.

Refer to Operation and Maintenance Manual, "Engine Air Cleaner Service Indicator-Inspect".

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

A wide variety of air cleaners may be installed for use with this engine. Consult the OEM information for the correct procedure to replace the air cleaner.

i08154921

Engine Air Cleaner Element - Replace

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

Servicing the Air Cleaner Elements

Note: The air filter system may not have been provided by Perkins. The procedure that follows, is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the pre-cleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.
- The air cleaner element should be replaced at least one time per year.

Replace the dirty air cleaner elements with clean air cleaner elements. Before installation, the new air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Air Cleaners

Some application can have dual elements. The dual air cleaner contains a primary air cleaner element and a secondary air cleaner element. Both element must be replaced at the same time.

Do not replace the air cleaner filter elements in a dirty environment, as dirt can enter the air system when the elements are removed.

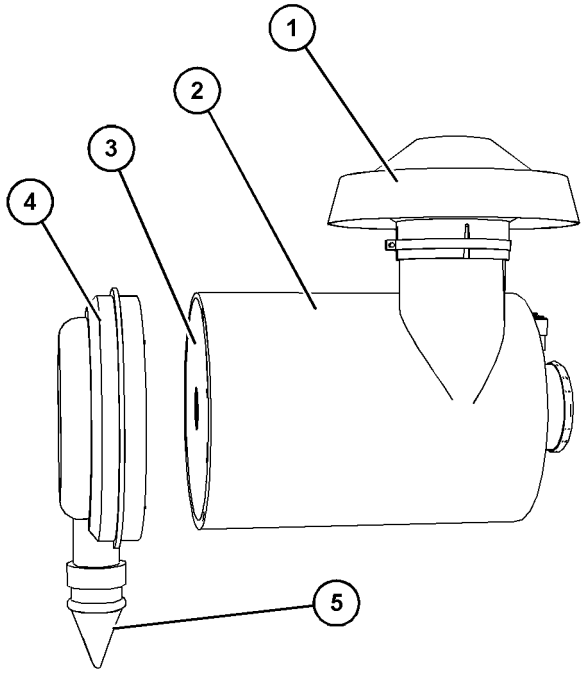


Illustration 49 g06217098

Typical example

(1) Top Cover
(2) Air Cleaner Body
(3) Primary Air Filter Element
(4) End Cover
(5) Vacuum Valve

1. Ensure that the outer body of the air cleaner to be serviced is clean and free from dirt.
2. Inspect the top cover (1) and if necessary remove top cover to clean cover. Ensure that dirt cannot enter the air cleaner system with top cover removed. If necessary, clean top cover and install.
3. Remove end cover (4) from air cleaner body (2). If necessary, clean end cover and ensure that the vacuum valve (5) is clean and free from dirt. Check the vacuum valve (5) for wear or damage, replace if necessary.
4. Remove primary air filter element (3) and if equipped, remove the secondary air filter element (Not Shown). Discard all old air filter elements.
5. If equipped, install new secondary air filter element (Not Shown) and install new primary air filter element (3).
6. Install end cover (4) to air cleaner body (2) and secure end cover. If necessary, reset the air service indicator, refer to this Operation and Maintenance Manual, Engine Air Cleaner Service Indicator - Inspect for more information.

i02335405

Engine Air Cleaner Service Indicator - Inspect

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

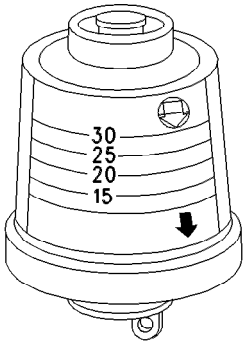


Illustration 50 g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

i07819526

Engine Air Precleaner - Check/ Clean

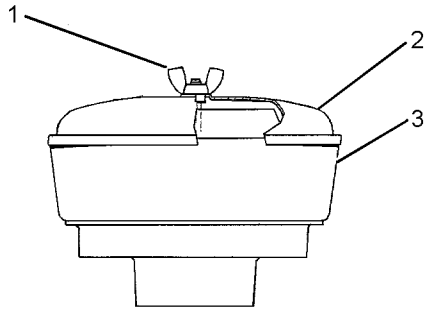


Illustration 51 g01453058

Typical engine air precleaner

(1) Wing nut
(2) Cover
(3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty conditions, more frequent cleaning is required.

Do not tap or strike the air cleaner element.

i08193629

Engine Crankcase Breather - Replace

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Naturally Aspirated Engine Crankcase Breather

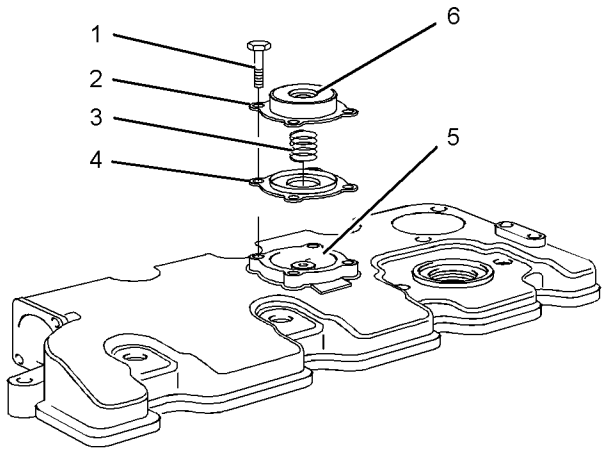


Illustration 52 g03380583

Typical example

(1) Screws for the breather cover
(2) Breather cover
(3) Spring
(4) Diaphragm and plate
(5) Cavity
(6) Vent hole

1. Loosen the screws (1) and remove the breather cover (2) from the valve mechanism cover.

2. Remove the spring (3). Remove the diaphragm and plate (4).

3. Clean the vent hole (6) and the cavity (5) in the valve mechanism cover.

NOTICE
Make sure that the components of the breather assembly are installed correctly. Engine damage may occur if the breather assembly is not working correctly.

4. Install a new diaphragm and plate (4) for the breather assembly into the cavity (5) of the valve mechanism cover.

5. Install a new spring (3).

6. Install the breather cover (2) and the four screws (1). Tighten the screws.

Turbocharged Engine Crankcase Breather

Note: Turbocharged engines have different design breather systems.

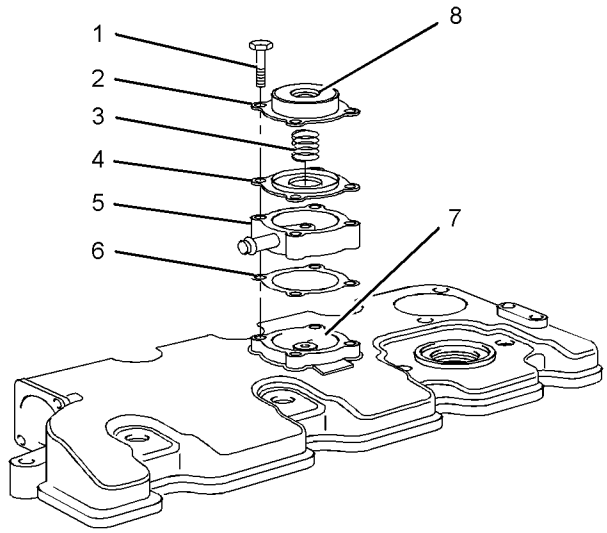


Illustration 53 g01335247

Typical example

(1) Screws for the breather cover
(2) Breather cover
(3) Spring
(4) Diaphragm and plate
(5) Spacer for turbocharged engines only
(6) Joint for turbocharged engines only
(7) Cavity
(8) Vent hole

1. Loosen the screws (1) and remove the breather cover (2) from the valve mechanism cover.

2. Remove the spring (3). Remove the diaphragm and plate (4).

3. Remove the spacer (5) and the joint (6).

4. Clean the vent hole (8) and the cavity (7) in the valve mechanism cover.

NOTICE
Make sure that the components of the breather assembly are installed correctly. Engine damage may occur if the breather assembly is not working correctly.

5. Install a new joint (6) and the spacer (5).

6. Install a new diaphragm and plate (4) for the breather assembly into the cavity (7) of the valve mechanism cover or the spacer (5) for turbocharged engines.

7. Install a new spring (3).

8. Install the breather cover (2) and the four screws (1). Tighten the screws.

i07819538

Engine Mounts - Inspect

Note: The engine mounts may not have been supplied by Perkins. Refer to the Original Equipment Manufacturer (OEM) information for further details on the engine mounts and the correct bolt torque.

Inspect the engine mounts for deterioration and for correct bolt torque. Excessive engine vibration can be caused by the following conditions:

- Incorrect mounting of the engine
- Deterioration of the engine mounts
- Loose engine mounts

Any engine mount that shows deterioration should be replaced. Refer to the OEM information for the recommended torques.

When the engine mounts are supplied by Perkins the maintenance procedure will be supplied in the Disassembly and Assembly manual for your engine.

i06812676

Engine Oil Level - Check

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

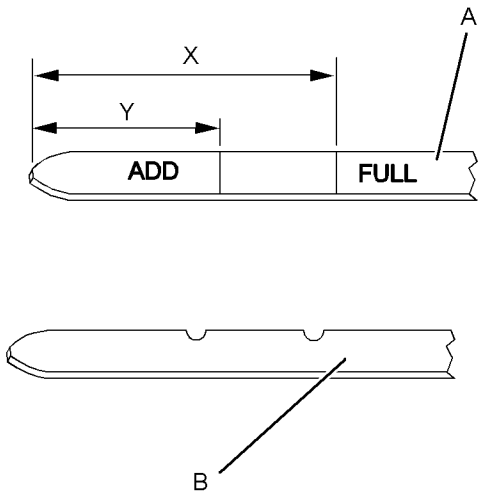


Illustration 54 g03317856
(Y) “ADD” mark. (X) “FULL” mark.
(A) Original oil level gauge
(B) Alternative oil level gauge

NOTICE
Perform this maintenance with the engine stopped.

Note: Oil gauge (A) or oil gauge (B) may be installed in the engine.

1. Maintain the oil level between “ADD” mark (Y) and “FULL” mark (X) on oil level gauge (1). Do not fill the crankcase above “FULL” mark (X).

NOTICE
Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power or engine failure.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

1000 Hour Engine Oil Level Check For Certain Engines Only

The oil level gauge (Dipstick) design is different for engines that can be serviced at 1000 hours.

The design of the dipstick can be identified by the numbers (5079476) on the dipstick.

i06804021

Engine Oil and Filter - Change (1000 Hour Service For Certain Engines Only)

S/N: EJ11–Up

The constant speed engine model 403F-11 with prefix EJ can be configured to operate with an extended oil service. The extended oil service is 1000 hours.

Oil and Filter Change

The engine oil and filter are removed and installed using the same procedure as a 500 hours service. The engine oil filter is a different design to the 500-hour oil service.

A different design oil gauge (dipstick) is used on the 1000-hour service. This dipstick can be identified by the number (5079476) on the dipstick. Checking the level of the engine oil is the same procedure as the 500-hour service.

Note: The fuel system must be configured to operate with an extended service.

i08194549

Engine Oil and Filter - Change

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained correctly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Oil and Filter Change Intervals

The standard engine oil and filter change period is 500 hours. There are several other factors that can alter the standard engine oil and filter change of 500 hours.

- If the engine is using engine oil analysis to determine oil and filter change period.
- The engine is working in a severe service environment/Load Factor
- Infrequent operation of the engine

Refer to this Operation and Maintenance Manual, “Severe Service Application” for more information on reducing the engine oil and filter change period. For severe service applications the recommended oil and filter change period is 250 hours.

If the engine is operated in severe service conditions, Perkins recommends the use of engine oil sampling. Refer to this Operation and Maintenance Manual, Fluid Recommendations, General Lubricant Information and see section Oil Analysis for more information.

If the engine is operated infrequently less than 500 hours in a 12-month period, then the engine oil and filter change should be conducted yearly.

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

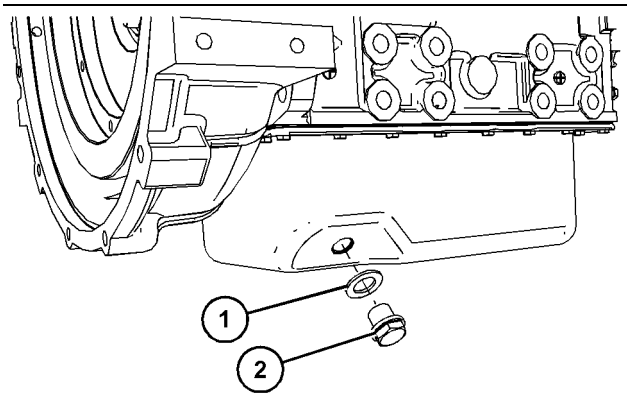


Illustration 55 g06518218

1. Remove drain plug (2) from the engine oil pan and drain the oil into a suitable container for storage or disposal.

2. Remove sealing washer (1) from the drain plug and clean the oil drain plug.

3. Install new sealing washer (1) to the drain plug.

4. Install drain plug (2) to the engine oil pan. Tighten the drain plug to a torque of 34 N·m (300.93 lb in)

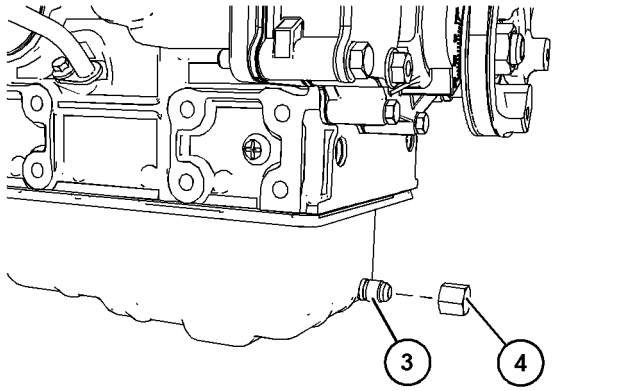


Illustration 56 g06518231

1. Remove drain cap (4) from engine oil pan outlet (3) and drain the oil into a suitable container for storage or disposal.

2. Clean the oil drain cap.

3. Install drain cap (4) to the engine oil pan outlet (3). Tighten the drain cap to a torque of 18 N·m (159.31 lb in).

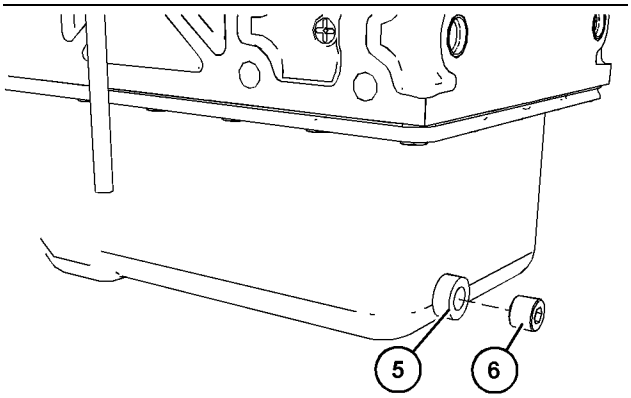


Illustration 57 g06523773

1. Remove drain plug (6) from engine oil pan outlet (5) and drain the oil into a suitable container for storage or disposal.

2. Clean oil drain plug (6).

3. Install drain plug (6) to engine oil pan outlet (5). Tighten the drain plug to a torque of 26 N·m (230.12 lb in).

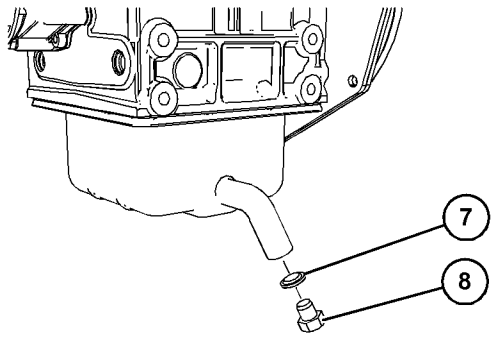


Illustration 58 g06530622

1. Remove drain plug (8) from the engine oil pan and drain the oil into a suitable container for storage or disposal.

2. Remove sealing washer (7) from the drain plug and clean the oil drain plug.

3. Install new sealing washer (7) to the drain plug.

4. Install drain plug (8) to the engine oil pan. Tighten the drain plug to a torque of 23 N·m (203.57 lb in)

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise to drain the oil. After the oil has drained, turn the drain valve knob clockwise to close the drain valve.

Replace the Oil Filter

NOTICE
Perkins oil filters are built to Perkins specifications. Use of an oil filter not recommended by Perkins could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Perkins.

1. Remove the oil filter with a suitable tool.

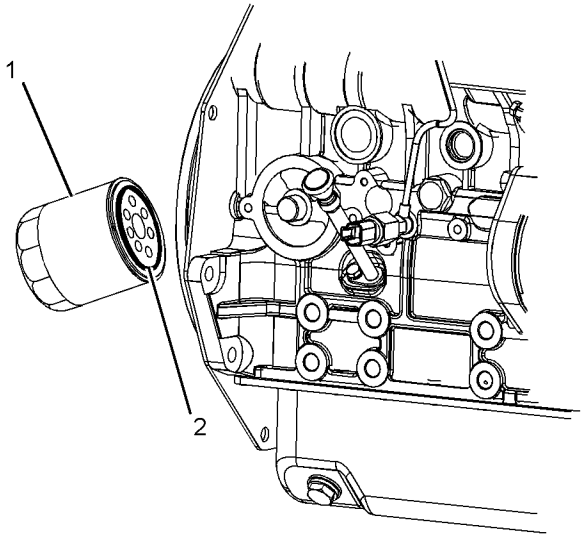


Illustration 59 g03380736
Typical example

2. Clean the sealing surface of the cylinder block or the surface of the engine oil cooler if equipped.

3. Apply clean engine oil to the new O ring seal (2).

NOTICE
Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components or engine damage.

4. Install the new oil filter (1) Spin on the oil filter until the O ring seal contacts the oil filter base. Rotate the oil filter ¾ of a full turn.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual for more information on lubricant specifications. Fill the crankcase with the correct amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at “LOW IDLE” for 2 minutes. Perform this procedure to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of 10 minutes.

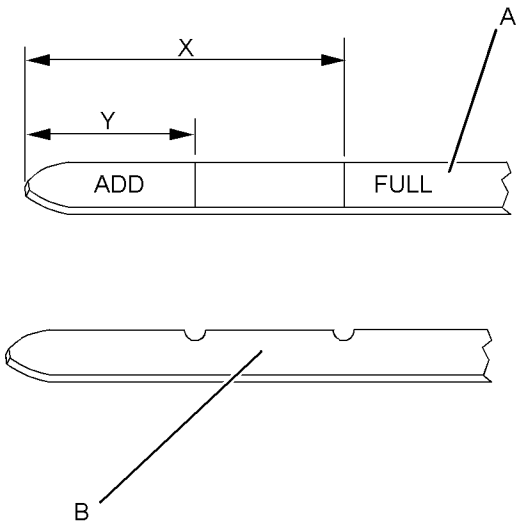


Illustration 60 g03306420

(Y) “ADD” mark. (X) “FULL” mark.

(A) Original oil level gauge
(B) Alternative oil level gauge

4. Remove the oil level gauge to check the oil level. Maintain the oil level between the “ADD” and “FULL” marks on the oil level gauge.

i05153520

Engine Valve Lash - Check

This maintenance is recommended by Perkins as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life. The maintenance for the valve lash is important in order to keep the engine compliant.

NOTICE
Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your authorized Perkins dealer or your Perkins distributor for the complete valve lash adjustment procedure.

Operation of Perkins engines with incorrect valve lash can reduce engine efficiency, and also reduce engine component life.

⚠ WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. The engine valve lash can be inspected and adjusted when the temperature of the engine is hot or cold.

Refer to Systems Operation, Testing and Adjusting, “Engine Valve Lash - Inspect/Adjust” for more information.

i07942206

Fan Clearance - Check
(Industrial Engine)

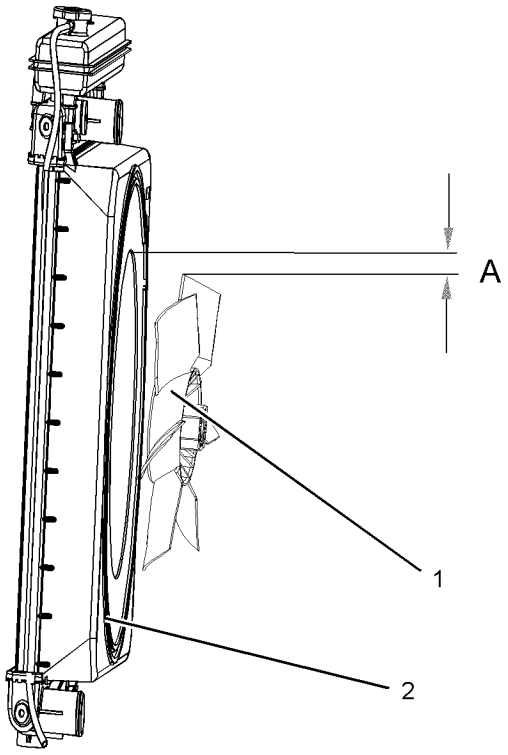


Illustration 61 g03309719

Typical example

Ensure that the engine is stopped. Ensure that the battery disconnect switch is in the OFF position. Ensure that the cooling system is full.

The clearance between the cover (2) and the fan (1) will require checking. The gap between the edge of the cover and the tip of the fan blade (A) must be checked in four equally spaced positions. The fan blade should be as central as possible in the cover.

The minimum fan tip clearance is 2 mm (0.07874 inch). If it is not possible to achieve the minimum fan tip clearance, inspect the radiator mounts. Refer to this Operation and Maintenance Manual, “Engine Mounts - Inspect” for further information.

i05161054

Fuel Filter (In-Line) - Replace

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

The location of the in-line fuel filter will depend on the application that the engine has been installed.

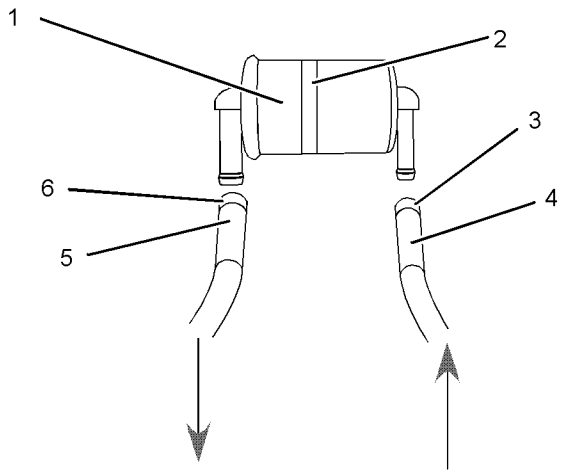


Illustration 62 g03315616
Arrows show fuel flow

Note: The in-line fuel filter is an off engine part.

1. Turn the fuel supply valve (if equipped) to the OFF position. Remove clamp (3) and remove clamp (6).
2. Remove inlet hose (4) and remove outlet hose (5) from in-line filter (1).
3. If installed, remove clamp (2) and remove in-line filter (1) from application.
4. Install new in-line filter (1) and install clamp (2).
5. Install inlet hose (4) and install clamp (3). Install outlet hose (5) and install clamp (6).
6. Turn the fuel supply valve (if equipped) to the ON position. Prime the system, refer to this Operation and Maintenance Manual, “Fuel System - Prime”.

i02154268

Fuel Injector - Test/Change

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

⚠ WARNING

Make sure that you wear eye protection at all times during testing. When fuel injection nozzles are tested, test fluids travel through the orifices of the nozzle tip with high pressure. Under this amount of pressure, the test fluid can pierce the skin and cause serious injury to the operator. Always keep the tip of the fuel injection nozzle pointed away from the operator and into the fuel collector and extension.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Regular maintenance of the fuel injectors is recommended by Perkins. The fuel injectors must be removed and tested by an authorized agent. The fuel injectors should not be cleaned as cleaning with incorrect tools can damage the nozzle. The fuel injectors should be renewed only if a fault with the fuel injectors occurs. Some of the problems that may indicate that new fuel injectors are needed are listed below:

- The engine will not start or the engine is difficult to start.
- Not enough power
- The engine misfires or the engine runs erratically.
- High fuel consumption
- Black exhaust smoke
- The engine knocks or there is vibration in the engine.
- Excessive engine temperature

For further information on the removal and the installation of the fuel injectors, refer to the Disassembly and Assembly manual.

For further information on the testing of fuel injectors, refer to the Testing and Adjusting manual.

Identification of a suspect Fuel Injector

⚠ WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

NOTICE
If your skin comes into contact with high pressure fuel, obtain medical assistence immediately.

NOTICE
If a fuel injector is suspected of operating outside of normal parameters it should be removed by a qualified technician. The suspect fuel injector should be taken to an authorised agent for inspection.

Operate the engine at a fast idle speed in order to identify the faulty fuel injector. Individually loosen and tighten the union nut for the high pressure pipe to each fuel injector. Do not loosen the union nut more than half a turn. There will be little effect on the engine speed when the union nut to the faulty fuel injector is loosened.

Consult your authorized Perkins dealer or your Perkins distributor for further assistance.

i06946788

Fuel System - Prime
(For 1000 Hours Service on Certain Engine Only)

S/N: EJ11–Up

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Use the following procedure to prime the fuel system:

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low-pressure fuel lines are disconnected.
- A leak exists in the low-pressure fuel system.
- The fuel filter is replaced.

Primary Filter

Ensure that the air is removed from the primary filter before you prime the fuel filter. Refer to illustration 63 .

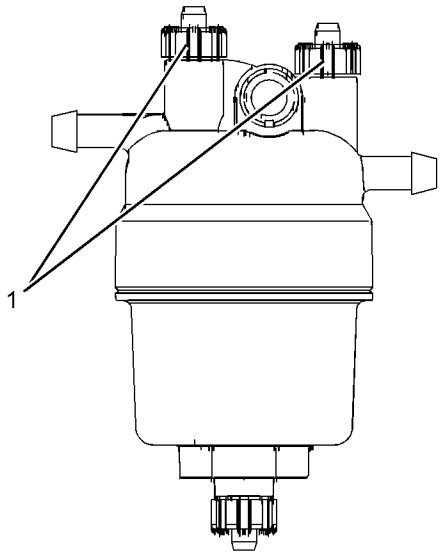


Illustration 63 g01316878

This filter may not be installed on the engine.

(1) Vent screws

1000 Hour Fuel Filter

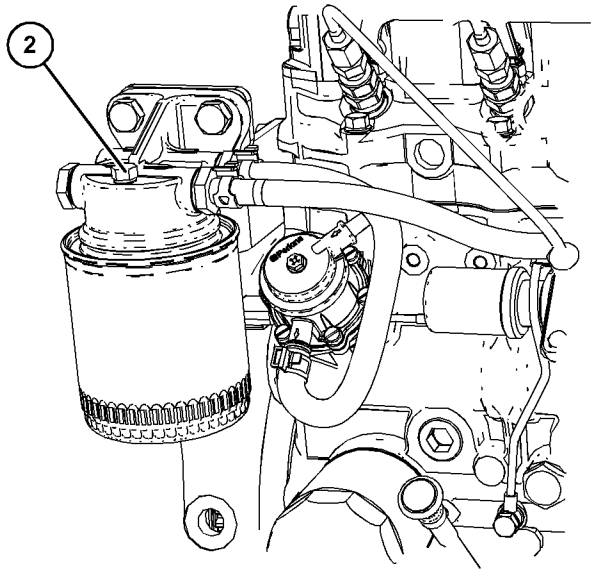


Illustration 64 g06119733

(2) Vent screw

Priming the system

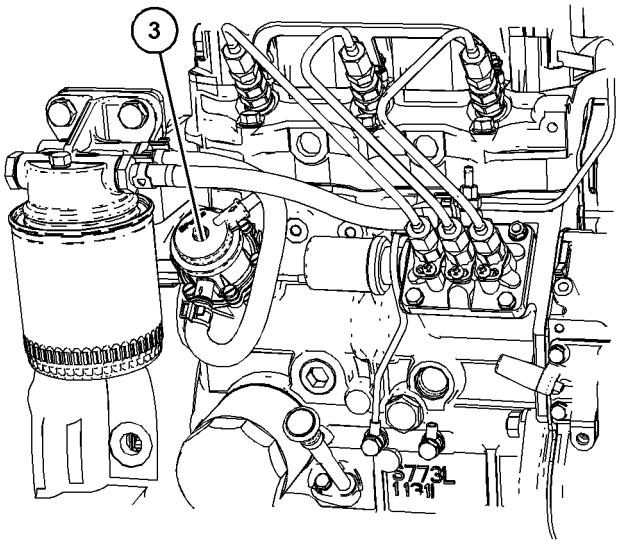


Illustration 65 g06119738

1. Ensure that the air is removed from the primary filter. Loosen vent screws (1). The primary fuel filter is a gravity feed system. When fuel free from air comes from the vent screws (1), close the vent screws. Use hand pressure only.

2. Open vent screw (2) and operate the fuel priming pump. To operate fuel priming pump, (3) you must operate the starting motor. Do not operate the starting motor for more than 15 seconds. After 15 seconds, stop and wait for 30 seconds before operating the starting motor.

3. When fuel free from air flows from the vent screw (2) tighten the vent screw to a torque of 7 N·m (62 lb in).

i08193365

Fuel System - Prime

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Use the following procedure to prime the fuel system:

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- The low-pressure fuel lines are disconnected.
- A leak exists in the low-pressure fuel system.
- The fuel filter is replaced.

Mechanical Priming Pump

Primary Filter

Ensure that the air is removed from the primary filter before you prime the secondary fuel filter. Refer to illustration 66 .

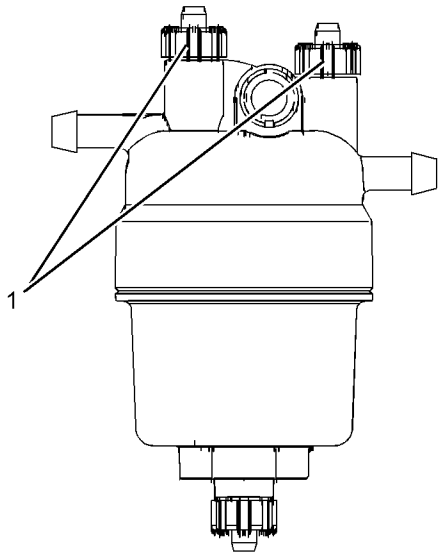


Illustration 66 g01316878

This filter may not be installed on the engine.

(1) Vent screws

Priming the Primary Fuel Filter

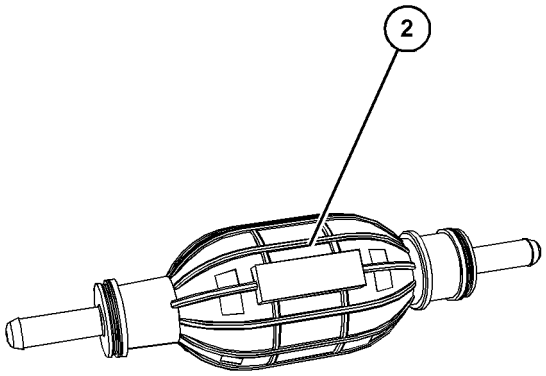


Illustration 67 g06221845

1. If equipped, operate the hand priming pump (2) until fuel free from air comes from the vent screw (1). Then close vent screw (1) by hand.

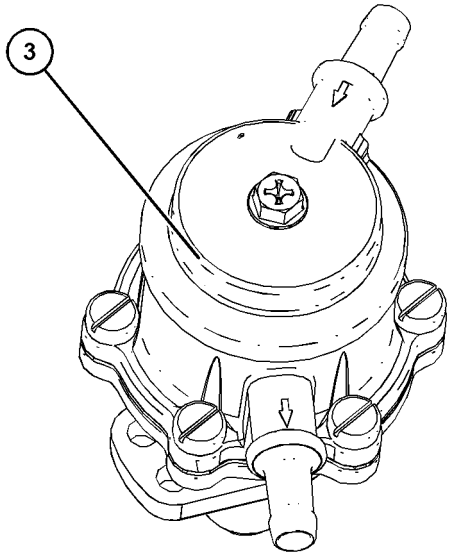


Illustration 68 g06221885

2. If the hand priming pump is not installed, operate the starting motor to crank the engine. Crank the engine to operate the transfer pump (3). Do not operate the transfer pump for more than 15 seconds. After 15 seconds, stop and wait 30 seconds before operating the starting motor.

3. When fuel free from air comes from the vent screw (1) close vent screw (1) by hand.

Secondary Fuel filters

There are three types of fuel filter that may be installed on the engine.

- Element
- Canister
- Spin-on filter with fuel priming pump

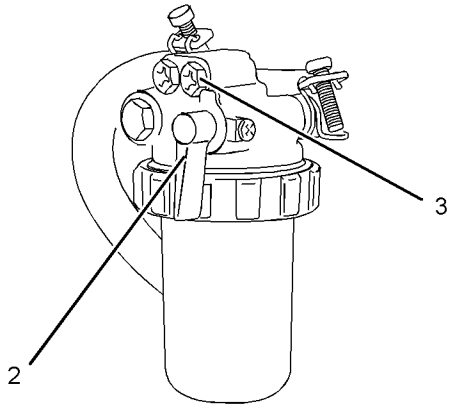


Illustration 69 g01327360

Element

(2) Fuel valve
(3) Vent screw

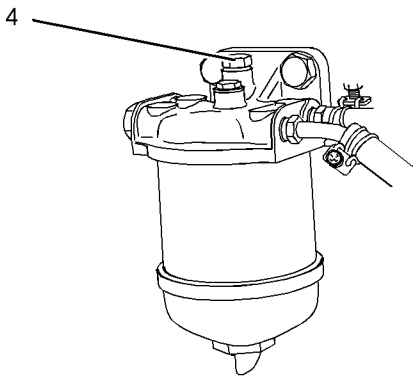


Illustration 70 g01327361

Canister

(4) Vent screw

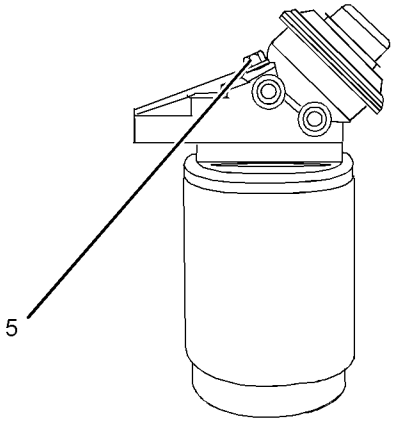


Illustration 71 g01327363

Spin-on filter with fuel priming pump

(5) Vent screw

Vent screw (3) is installed on the filter that has an element. Vent screw (4) is installed on the fuel filter that has a canister. Vent screw (5) is installed on the spin-on filter.

Priming the system

Note: Some fuel system will use gravity to prime the primary fuel filter. When gravity is used to deliver the fuel, ensure that the fuel tank is full and that all stop valves in the fuel line are open.

There are four different types of systems that can be installed on the engine to prime the fuel system. Refer to illustration 72 .

- Hand priming pump
- In-line hand priming pump
- Electrical priming pump
- Transfer pump that is operated by the starting motor

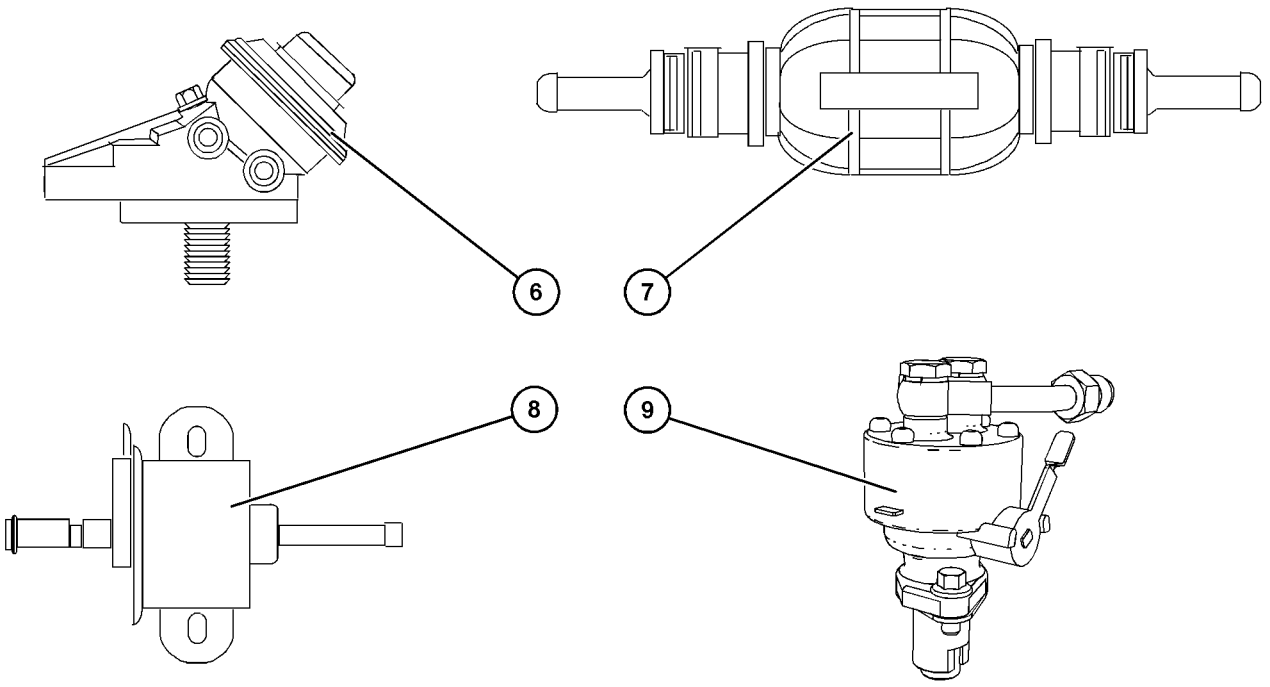


Illustration 72 g06523817

(6) Hand priming pump
(7) In-line priming pump
(8) Electrical priming pump
(9) Fuel transfer pump with hand priming

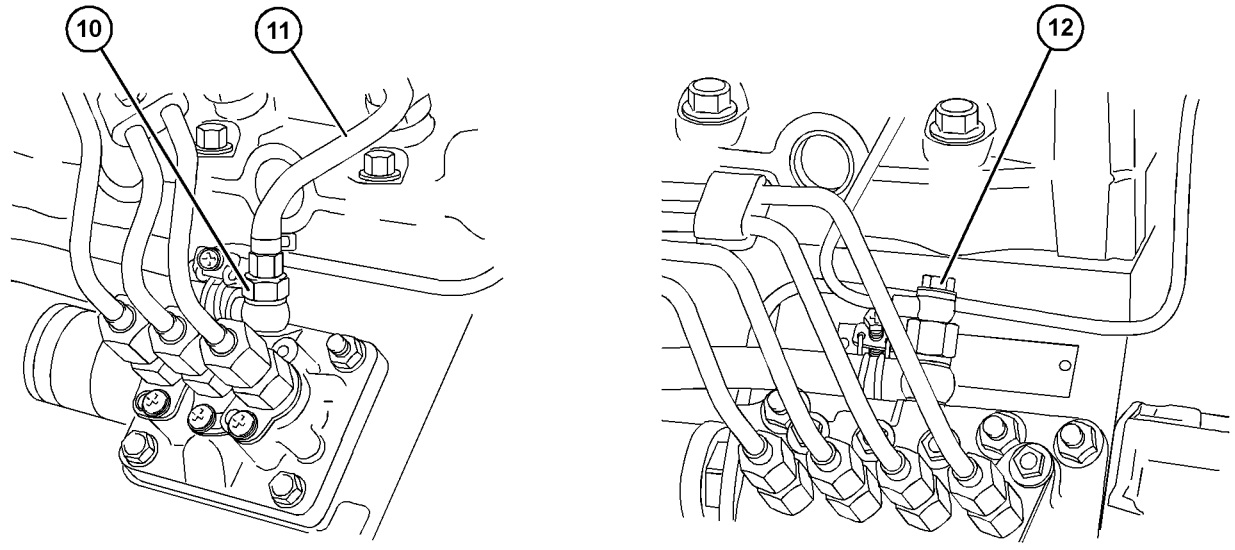


Illustration 73 g06523835

(10) Connector bolt
(11) Fuel return line
(12) Connector bolt

Hand Priming Pump 6

To identify the hand priming pump, refer to illustration 72 .

1. Ensure that fuel valve (2) for the fuel filter that has an element is in the ON position. Refer to illustration 69 .

2. Loosen vent screw (3, 4 or 5) on the fuel filter.

3. Operate hand priming pump (6). When fuel free from air flows from the vent screw tighten the vent screw.

4. Loosen connection (10 or 12) at the fuel injection pump. Refer to illustration 73 .

Note: Fuel return line (11) may need to be removed to prime the fuel system.

5. Operate the hand priming pump. When fuel free from air flows from the connections tighten the connecting bolt.

6. The engine should now be able to start. Operate the starting motor to start the engine.

Note: Do not operate the starting motor for more than 15 seconds. If the engine does not start after 15 seconds, stop and wait for 30 seconds before trying again.

In-line Priming Pump 7

To identify the in-line priming pump, refer to illustration 72 .

1. Ensure that fuel valve (2) for the fuel filter that has an element is in the ON position. Refer to illustration 69 .

2. Loosen vent screw (3, 4 or 5) on the fuel filter.

3. Operate in-line priming pump (7). When fuel free from air flows from the vent screw tighten the vent screw.

4. Loosen connection (10 or 12) at the fuel injection pump. Refer to illustration 73 .

Note: Fuel return line (11) may need to be removed to prime the fuel system.

5. Operate the in-line priming pump. When fuel free from air flows from the connections tighten the connecting bolt.

6. The engine should now be able to start. Operate the starting motor to start the engine.

Note: Do not operate the starting motor for more than 15 seconds. If the engine does not start after 15 seconds, stop and wait for 30 seconds before trying again.

Electrical Priming Pump 8

To identify the electrical priming pump, refer to illustration 72 .

Turn the keyswitch to the ON position for 2 minutes to prime the fuel system. Turn keyswitch to OFF position, then turn on again. The engine is primed and ready to start.

If the engine fails to start, follow Step (1) through Step (6).

1. Ensure that fuel valve (2) for the fuel filter that has an element is in the ON position. Refer to illustration 69 .

2. Loosen vent screw (3, 4 or 5) on the fuel filter.

3. Operate electrical priming pump (8). When fuel free from air flows from the vent screw tighten the vent screw. Switch off the electrical priming pump.

4. Loosen connector bolt (10 or 12) at the fuel injection pump. Refer to illustration 73 .

Note: Fuel return line (11) may need to be removed to prime the fuel system.

5. Operate the electrical priming pump (8). When fuel free from air flows from the connections tighten the connector bolt. If removed, install fuel return line (11).

6. The engine should now be able to start. Operate the starting motor to start the engine.

Note: Do not operate the starting motor for more than 15 seconds. If the engine does not start after 15 seconds, stop and wait for 30 seconds before trying again.

Fuel Transfer Pump 9

To identify the fuel transfer pump, refer to illustration 72 .

Note: If the transfer pump is not equipped with a manual priming lever and the engine is not equipped with any other priming option, you must operate the starting motor to prime the fuel system. Do not operate the starting motor for more than 15 seconds continuously. After 15 seconds, stop and wait for 30 seconds before operating the starting motor again.

1. Ensure that fuel valve (2) for the fuel filter that has an element is in the ON position. Refer to illustration 69 .

2. Loosen vent screw (3, 4 or 5) on the fuel filter.

3. Operate fuel transfer pump (9). When fuel free from air flows from the vent screw tighten the vent screw. Stop the fuel transfer pump.

4. Loosen connection (10 or 12) at the fuel injection pump. Refer to illustration 73 .

Note: Fuel return line (11) may need to be removed to prime the fuel system.

5. Operate the fuel transfer pump. When fuel free from air flows from the connections tighten the connecting bolt. Stop the transfer pump.

6. The engine should now be able to start. Operate the starting motor to start the engine.

Note: Do not operate the starting motor for more than 15 seconds. If the engine does not start after 15 seconds, stop and wait for 30 seconds before trying again.

i05337705

Fuel System Primary Filter - Replace

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

Remove the Element

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.

2. Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.

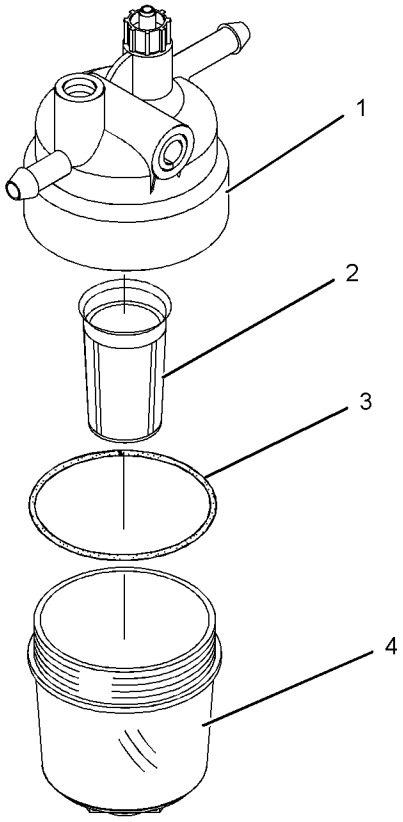


Illustration 74 g03381282
Typical example

3. Remove the filter bowl (4) from the fuel filter base (1).

4. Remove the O-ring seal (3). Discard the O-ring seal.

5. Remove the filter element (2) from the fuel filter base (1). Discard the filter element (2).

6. Clean the filter bowl (4).

Install the Element

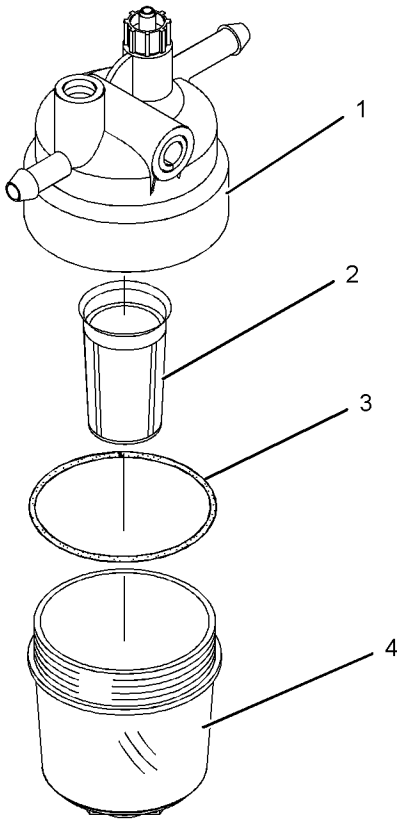


Illustration 75 g03381282
Typical example

1. Install a new filter element (2) to the fuel filter base (1).

2. Lubricate the O ring seal (3) with clean engine oil. Do NOT fill the bowl with fuel before the assembly is installed.

3. Install the filter bowl (4) to the fuel filter base (1). Tighten the filter bowl (4) by hand.

4. The secondary fuel filter must be replaced at the same time as the primary fuel filter. Refer to the Operation and Maintenance Manual , “Fuel System Secondary Filter - Replace”.

i07023784

Fuel System Primary Filter/ Water Separator - Drain

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

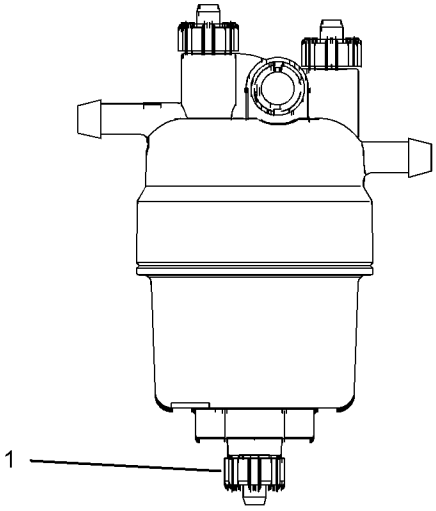


Illustration 76 g01316965
Typical example

1. Open drain (1). Catch the draining fluid in a suitable container. Dispose of the drained fluid correctly.

2. Close drain (1).

i05337334

Fuel System Secondary Filter - Replace

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Note: The primary filter element must be replaced at the same time as the secondary filter element. Refer to Operation and Maintenance Manual, “Fuel System Primary Filter (Water Separator) Element - Replace”.

Fuel Filter with Canister

1. Close the fuel supply valve.

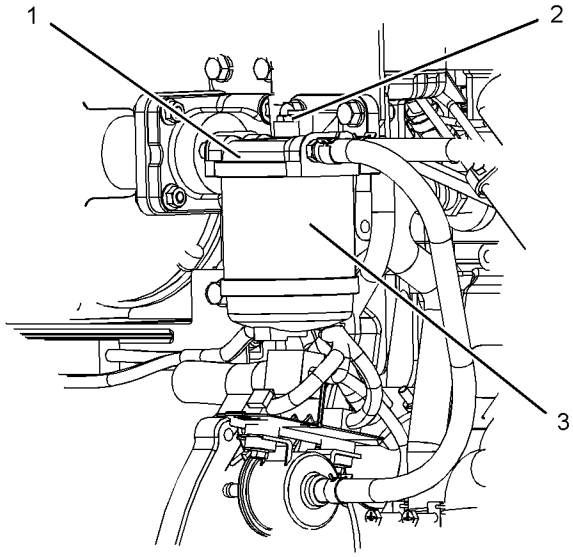


Illustration 77 g03317866
Typical example

2. Clean the outside of the fuel filter assembly (1).

3. Remove setscrew (2).

4. Remove the canister (3). Ensure that any fluid is drained into a suitable container.

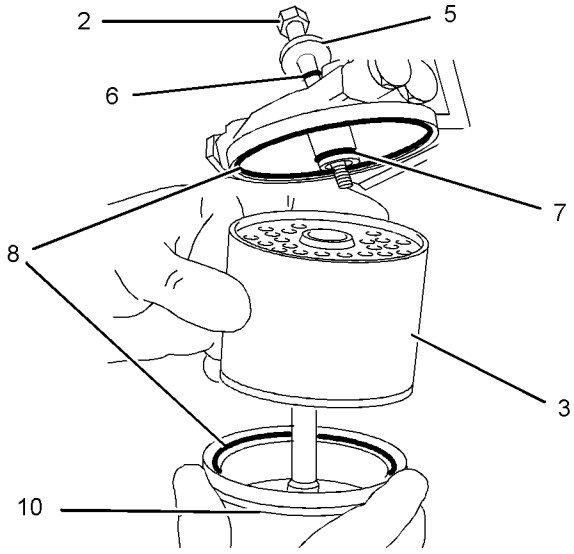


Illustration 78 g02710378
Typical example

5. Assemble the following items: seals (8), seal (7), canister (3) and bowl (10). Place washer (5) and seal (6) on setscrew (2).

6. Fasten the assembly to the fuel filter base with setscrew (2).

The fuel system will need to be primed after the new filter is installed. Refer to this Operation and Maintenance Manual, “Fuel System - Prime”.

Fuel Filter with Element

1. Close the fuel supply valve (1).

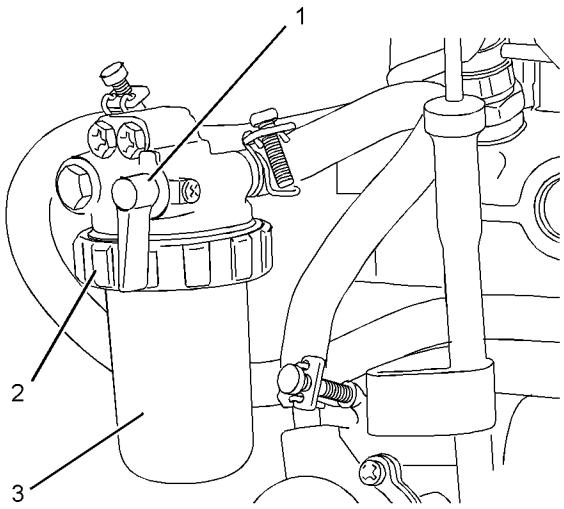


Illustration 79 g01334893
Typical example

2. Clean the outside of the fuel filter assembly.

3. Loosen the locking ring (2).

4. Remove the casing (3) for the filter and the element. Ensure that any fluid is drained into a suitable container.

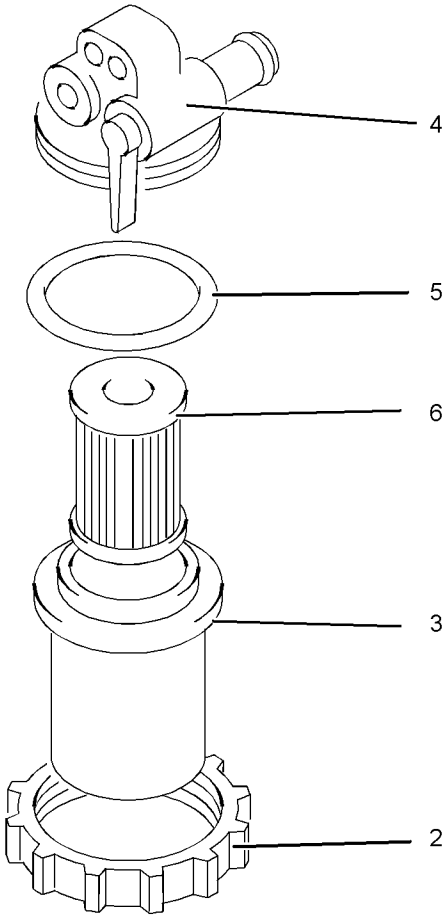


Illustration 80 g01334895
Typical example

Note: Do not fill the fuel filter with fuel. The fuel will not be filtered and the fuel could be contaminated. Contaminated fuel can damage your fuel system.

5. Assemble the following items: seal (5), filter element (6) and casing (3).

6. Install the assembled items to the filter base (4).

7. Install the locking ring (2) to the filter head. Rotate the locking ring in order to lock the assembly.

The fuel system will need to be primed after the new filter is installed. Refer to Operation and Maintenance Manual, “Fuel System - Prime”.

i06804036

Fuel System Secondary Filter - Replace
(1000 Hour Service For Certain Engines Only)

S/N: EJ11–Up

The constant speed engines model 403F-11 with prefix EJ with prefix GJ can be configured to operate with an extender fuel service. The extended fuel service is for 1000 hours.

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

Fuel Filter Replace

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.

2. Place a suitable container under the fuel filter to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.

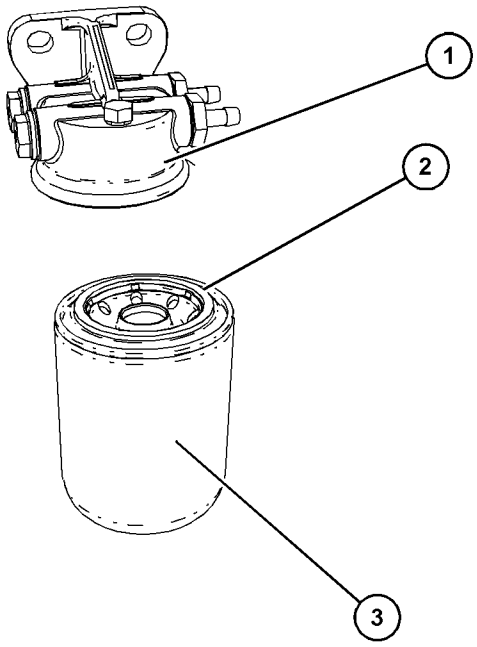


Illustration 81 g06117038

3. Using a suitable tool, remove the fuel filter (3) from the fuel filter base (1).

4. Ensure that the sealing surface on the fuel filter base (1) is clean and free from dirt.

5. Apply clean engine oil to O ring seal (2) on the new fuel filter.

6. Install the fuel filter, spin on the fuel filter until the O ring seal contacts the fuel filter base. Then, rotate the fuel filter ¾ of a full turn, by hand only.

7. Turn the fuel supply valve (if equipped) to the ON position and remove any container.

8. The Primary filter element must be replaced at the same time as the secondary filter element. Refer to the Operation and Maintenance Manual, “Fuel System Primary Filter- Replace”.

9. Prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information.

Note: The oils system must be configured to operate with an extended service.

i02335436

Fuel Tank Water and Sediment - Drain

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system.

Water can be introduced into the fuel tank when the fuel tank is being filled.

Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Allow five minutes after the fuel tank has been filled before draining water and sediment from the fuel tank.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank at the following intervals:

- Weekly
- Service intervals
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i02813964

Hoses and Clamps - Inspect/ Replace

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE
Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque. Do not clip any other item to the high pressure lines.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut

- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The coolant system and the hoses for the coolant system are not usually supplied by Perkins. The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.
7. Install the hose clamps with a torque wrench.

Note: For the correct coolant, see this Operation and Maintenance Manual, “Fluid Recommendations”.

8. Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
10. Start the engine. Inspect the cooling system for leaks.

i02335774

Radiator - Clean

The radiator is not usually supplied by Perkins. The following text describes a typical cleaning procedure for the radiator. Refer to the OEM information for further information on cleaning the radiator.

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: Damaged fins, corrosion, dirt, grease, insects, leaves, oil and other debris. Clean the radiator, if necessary.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction to the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the radiator fins. Slowly move the air nozzle in a direction that is parallel with the radiator tube assembly. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

If the radiator is blocked internally, refer to the OEM Manual for information regarding flushing the cooling system.

After cleaning the radiator, start the engine. Allow the engine to operate at low idle speed for three to five minutes. Accelerate the engine to high idle. This will help in the removal of debris and the drying of the core. Slowly reduce the engine speed to low idle and then stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: Welds, mounting brackets, air lines, connections, clamps and seals. Make repairs, if necessary.

i07888480

Starting Motor - Inspect

Perkins recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, “Electric Starting System - Test” for more information on the checking procedure and for specifications consult your Perkins dealer or your Perkins distributor for assistance.

i02177973

Walk-Around Inspection

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE
For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE
Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, “Engine - Clean” for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of the water pump and the installation of water pump and/or seal, refer to the Disassembly and Assembly Manual, “Water Pump - Remove and Install” for more information or consult your Perkins dealer or your Perkins distributor.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the rocker cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps and/or tie-wraps.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from the fuel tank on a daily basis in order to ensure that only clean fuel enters the fuel system.

- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that can not be calibrated.

i01907756

Water Pump - Inspect

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Note: The water pump seal is lubricated by the coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and parts contract.

Visually inspect the water pump for leaks. Renew the water pump seal or the water pump if there is an excessive leakage of coolant. Refer to the Disassembly and Assembly Manual, “Water Pump - Remove and Install” for the disassembly and assembly procedure.

Warranty Section

Warranty Information

i05341027

Emissions Warranty Information

This engine may be certified to comply with exhaust emission standards and gaseous emission standards that are prescribed by the law at the time of manufacture. This engine may be covered by an Emissions Warranty.

For a full warranty statement contact your Perkins dealer or your Perkins distributor. For customers that have a valid user name and password, for perkins.com. Login then go to TIPSS, and the warranty information can be accessed.

Reference Information Section

Reference Materials

i04224089

Engine Protection Plans
(Extended Service Contract)

Extended Service Contracts-purchased in minutes, protected for years.

Extended Service Contracts (ESC) protect you from the stress that unexpected repair work brings to your life by covering the cost of getting your engine up and running again. Unlike other extended warranties, Perkins Platinum ESC protects you against all component part failures.

Purchase peace of mind from only £0.03 / $0.05 / euro 0.04 a day and let an ESC make your dreams a reality.

Why buy an Extended Service Contract?

1. No surprises - total protection from unexpected repair cost (parts, labor, and travel).

2. Enjoy longer lasting product support from Perkins global network.

3. Genuine Perkins parts ensure continued engine performance.

4. Highly trained technicians carry out all repairs.

5. Transferable coverage should you sell your machine.

Flexible coverage provides the right level of protection for your Perkins Engine. Coverage can be extended to 2 years/ 1,000 hours right up to 10 year/ 40,000

You can buy an ESC at any time during standard warranty - even the last day!

Each Perkins Distributor has highly trained and experienced Perkins Product Support Service Technicians. The Support Service are equipped, and available around the clock to get your engine running again with the minimum of downtime. Buying an ESC means that you get all this for free.

To purchase an Extended Service Contract, is quick and simple! Contact your local Perkins Distributor now and the distributor can provide you with a quote in minutes. You can locate your nearest Perkins Distributor by visiting:

www.perkins.com

NOTICE
Dependant upon engine type and application.

Index

A

After Starting Engine 40
After Stopping Engine 47
Alternator - Inspect 69
Alternator and Fan Belts - Inspect/Adjust 69
  Adjustment 70
  Inspection 69
Alternator and Fan Belts - Replace 70
  Removal and Installation Procedure 70

B

Battery - Replace 71
Battery Electrolyte Level - Check 72
Before Starting Engine 13, 39
Burn Prevention 10
  Batteries 11
  Coolant 11
  Diesel Fuel 11
  Oils 11

C

Cold Weather Operation 43
  Hints for Cold Weather Operation 43
  Idling the Engine 44
  Recommendations for Coolant Warm Up 44
  Recommendations for the Coolant 43
  Viscosity of the Engine Lubrication Oil 43
Coolant (Commercial Heavy-Duty) - Change 72
  Drain 72
  Fill 73
  Flush 73
Coolant (ELC) - Change 74
  Drain 74
  Fill 75
  Flush 75
Coolant Level - Check 76
  Engines With a Coolant Recovery Tank 76
  Engines Without a Coolant Recovery Tank 77
Coolant Temperature Regulator - Replace 77
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 78
  Add the SCA, If Necessary 78
  Test for SCA Concentration 78
Crushing Prevention and Cutting Prevention .. 13

D

Diagnostic Flash Code Retrieval 36
Diagnostic Lamp 36
Driven Equipment - Check 78

E

Electrical System 14
  Grounding Practices 15
Emergency Stopping 47
Emissions Certification Film 28
Emissions Warranty Information 105
Engine - Clean 79
Engine Air Cleaner Element - Replace 79
  Servicing the Air Cleaner Elements 79
Engine Air Cleaner Element - Replace (1000 Hour Service for Certain Engines Only) 79
Engine Air Cleaner Service Indicator - Inspect 80
  Test the Service Indicator 81
Engine Air Precleaner - Check/Clean 81
Engine Crankcase Breather - Replace 81
  Naturally Aspirated Engine Crankcase Breather 82
  Turbocharged Engine Crankcase Breather 82
Engine Diagnostics 36
Engine Mounts - Inspect 83
Engine Oil and Filter - Change 84
  Drain the Engine Oil 84
  Fill the Engine Crankcase 86
  Oil and Filter Change Intervals 84
  Replace the Oil Filter 86
Engine Oil and Filter - Change (1000 Hour Service For Certain Engines Only) 84
  Oil and Filter Change 84
Engine Oil Level - Check 83
  1000 Hour Engine Oil Level Check For Certain Engines Only 83
Engine Operation 42
  General Engine Operation 42
Engine Protection Plans (Extended Service Contract) 106
Engine Starting 14, 39
Engine Stopping 14, 47
Engine Valve Lash - Check 87

F

Fan Clearance - Check (Industrial Engine)..... 87
Features and Controls..... 32
Fire Prevention and Explosion Prevention.....11
Ether 13
Fire Extinguisher..... 13
Lines, Tubes, and Hoses 13
Fluid Recommendations 57, 62
ELC Cooling System Maintenance..... 60
Engine Oil 62
General Coolant Information 57
General Lubricant Information..... 62
Fluid Recommendations (General Fuel Information) 50
Contamination Control Recommendations for Fuels 57
Diesel Fuel Characteristics..... 53
Diesel Fuel Requirements 50
General Information..... 50
Foreword 4
California Proposition 65 Warning..... 4
Literature Information 4
Maintenance 4
Maintenance Intervals 5
Operation 4
Overhaul 5
Safety..... 4
Fuel and the Effect from Cold Weather..... 45
Fuel Conservation Practices 42
Fuel Filter (In-Line) - Replace 88
Fuel Injector - Test/Change 88
Identification of a suspect Fuel Injector..... 89
Fuel Related Components in Cold Weather ... 45
Fuel Filters 46
Fuel Heaters 46
Fuel Tanks 45
Fuel System - Prime..... 91
Mechanical Priming Pump..... 91
Fuel System - Prime (For 1000 Hours Service on Certain Engine Only)..... 89
1000 Hour Fuel Filter..... 90
Primary Filter 90
Priming the system 91
Fuel System Primary Filter - Replace 96
Install the Element 97
Remove the Element 96
Fuel System Primary Filter/Water Separator - Drain 97
Fuel System Secondary Filter - Replace 98
Fuel Filter with Canister..... 98
Fuel Filter with Element 99
Fuel System Secondary Filter - Replace (1000 Hour Service For Certain Engines Only)..... 100
Fuel Filter Replace..... 100
Fuel Tank Water and Sediment - Drain 101
Drain the Water and the Sediment 101
Fuel Storage Tanks..... 101
Fuel Tank 101

G

Gauges and Indicators 32
Indicators and Lamps 32
General Hazard Information..... 7
Containing Fluid Spillage..... 8
Fluid Penetration 8
Inhalation 9
Pressure Air and Water 8
Static Electricity Hazard when Fueling with Ultra-low Sulfur Diesel Fuel 9
General Information 16

H

Hoses and Clamps - Inspect/Replace..... 101
Replace the Hoses and the Clamps..... 102

I

Important Safety Information..... 2

L

Lifting and Storage 30

M

Maintenance Interval Schedule..... 68
Commissioning 68
Daily 68
Every 1000 Service Hours..... 68
Every 2000 Service Hours..... 68
Every 250 Service Hours or 6 Months..... 68
Every 3000 Service Hours..... 68
Every 3000 Service Hours or 2 Years 68
Every 50 Service Hours or Weekly..... 68
Every 500 Service Hours..... 68
Every 500 Service Hours or 1 Year 68
Every 6000 Service Hours or 3 Years 68
When Required..... 68
Maintenance Recommendations 65
Maintenance Section..... 48
Model View Illustrations 16
402F-05 Engine View 22

403F-07 Engine View With Factory Radiator 20
403F-11 Engine View..... 18
403F-15 Engine View 16
Components for Electronic Control 25
Fuel System Components 23
Monitoring System..... 32

O

Operation Section..... 30
Overspeed..... 33

P

Plate Locations and Film Locations 28
Product Description..... 26
Engine Specifications 26
Product Identification Information 28
Product Information Section..... 16
Product Lifting 30
Product Storage 31
Condition for Storage..... 31

R

Radiator - Clean 102
Reference Information..... 29
Record for Reference 29
Reference Information Section 106
Reference Materials 106
Refill Capacities..... 48
Cooling System..... 49
Lubrication System 48

S

Safety Messages..... 6
(A) Universal Warning..... 6
Safety Section 6
Self-Diagnostics 36
Sensors and Electrical Components..... 33
Severe Service Application 66
Environmental Factors..... 66
Incorrect Maintenance Procedures 67
Incorrect Operating Procedures 67
Starting Motor - Inspect..... 103
Starting the Engine..... 39
Starting with Jump Start Cables..... 40
Stopping the Engine 47
System Pressure Release..... 65
Coolant System 65
Engine Oil 65
Fuel System..... 65

T

Table of Contents 3

W

Walk-Around Inspection 103
Inspect the Engine for Leaks and for Loose Connections..... 103
Warranty Information..... 105
Warranty Section..... 105
Water Pump - Inspect..... 104
Welding on Engines with Electronic Controls 65

Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

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APPENDIX XV

Tescom
Electro Pneumatic Nitrogen Regulator

ER3100 Series

Electropneumatic Controllers/Motors

DER311923X012

Specifications

For other materials or modifications, please consult TESCOM.

ER3100 SYSTEM

Maximum Inlet Pressure
4500 psig / 310 bar

Maximum Outlet Pressure
400, 900 psig / 27.6, 62.1 bar

Flow Capacity
C_V = 0.7, 2.0

Features and Benefits
- Captured venting
- Fast responding, high flow system
- Compact size
- Includes all the features of the ER3000 Series (0.1% accuracy, onboard PID loop, free software)

ER3110 SYSTEM

Maximum Inlet Pressure
3500 psig / 241 bar

Maximum Outlet Pressure
500 psig / 34.5 bar

Flow Capacity
C_V = 0.06, 0.15

Features and Benefits
- Venting (not captured) or non-venting
- Fast responding, low pressure, low flow system
- Suitable for both static and dynamic applications
- Includes all the features of the ER3000 Series (0.1% accuracy, onboard PID loop, free software)



ER3100 (WITH 44-4000 SERIES REGULATOR)



ER3110 (WITH 44-5200 SERIES REGULATOR)

TESCOM ER3100 Series consists of the ER3000 Series controller and a 44-4000 Series pressure reducing regulator integrated together. Inlet pressures are up to 4500 psig / 310 bar with two different outlet ranges of 400 and 900 psig / 27.6 and 62.1 bar. The ER3100 Series may be ordered with a C_V = 0.7 or a C_V = 2.0. This series offers fast accurate control in applications requiring continuous flow. Also available with the 44-5200 Series regulator (ER3110).

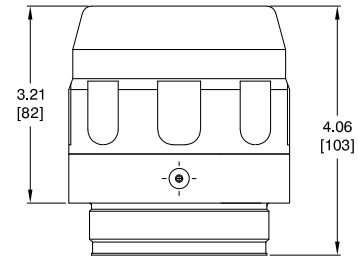
Applications

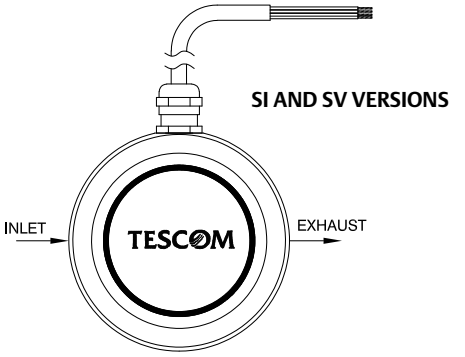
- Gas assist laser cutting
- OEM equipment

ER3100 Series Drawing

ER3100

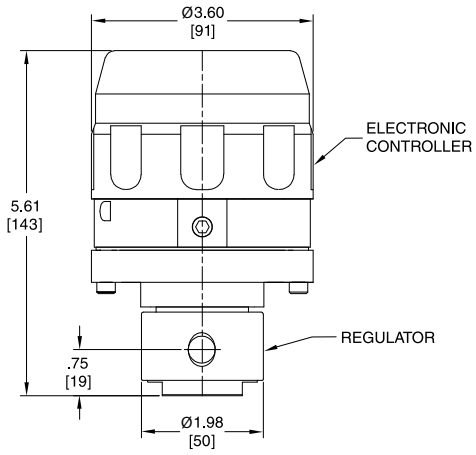
(PLEASE REFER TO THE 44-4000 SERIES DRAWING FOR COMPLETE DIMENSIONS)

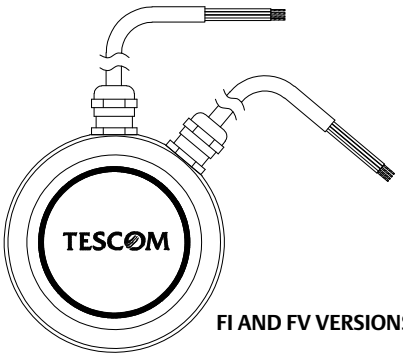




ER3110

(WITH 44-5200 SERIES REGULATOR)





All dimensions are reference & nominal
Metric [millimeter] equivalents are in brackets

ER3100 Series Part Number Selector

Repair Kits, Accessories & Modifications may be available for this product. Please contact TESCOM for more information.

Example for selecting a part number:

ER31	00	S	I	-	1
BASIC SERIES	**BASE STYLE**	**CONFIGURATION OPTIONS**	**ANALOG SIGNALS**		**MODIFICATIONS**
ER31	**00** **10**	**S -** Standard **F -** Enhanced[2]	**I -** 4-20 mA 1-5 VDC **V -** 0-10 VDC		**1 -** Standard solenoid valves **2 -** Low flow solenoid valves **1W -** Pre-wired

For ER3100 Series, order one of the following regulators:[1]

- **44-40X1XXXXER042** (Outlet: 400 psig / 27.6 bar, C_V = 0.7)
- **44-40X2XXXXER042** (Outlet: 750 psig / 51.7 bar, C_V = 0.7)
- **44-40X1XXXXER046** (Outlet: 500 psig / 34.5 bar, C_V = 2.0)
- **44-40X2XXXXER046** (Outlet: 900 psig / 62.1 bar, C_V = 2.0)

For ER3110 Series, order one of the following regulators:[1]

- **44-52X5XX4N1X34** (Non-venting, Outlet: 500 psig / 34.5 bar, C_V = 0.06)
- **44-52X5XX4N2X34** (Non-venting, Outlet: 500 psig / 34.5 bar, C_V = 0.15)
- **44-52X5XX4V1X34** (Venting, Outlet: 500 psig / 34.5 bar, C_V = 0.06)
- **44-52X5XX4V2X34** (Venting, Outlet: 500 psig / 34.5 bar, C_V = 0.15)

1. *The "X" in the regulator part number is to be finalized depending on desired soft goods and port configurations.*
2. *Enhanced models have extra analog inputs and outputs.*

WARNING! Do not attempt to select, install, use or maintain this product until you have read and fully understood the *TESCOM Safety, Installation and Operation Precautions.*

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EMERSON Process Management

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APPENDIX XVI

Wattco Circulation Heater

CIRCULATION HEATERS

immersion heaters



WATTCO™

CIRCULATION HEATERS

OVERVIEW

WATTCO™ circulation heaters are the perfect solution for generating heat and enhancing normal immersion heaters performance. They are designed to heat pressurized circulating fluids to provide effective, controlled heating to water, oil, steam and other gases.

Circulation heaters are composed of all-in-one units with a heater mounted inside an insulated tank. They are made of a flanged or a screwplug immersion heater that is inserted into a pressure vessel or a pipe body. Heaters have inlet and outlet piping where the liquid or gas goes through the tank in order to reach the desired temperature.

KEY FEATURES

- Standard sizes: 1.25" NPT screwplug size to 14" diameter
- Steel vessels fitted with 150 lb. flanges
- Thermal insulated vessels
- Custom unit sizes: up to 44" nominal pipe size
- Custom-designed to meet your specifications
- Special sizes, wattages, and materials are available upon request
- Units are available with larger vessels and heavier flanges
- Supplied with stainless steel parts and special design terminal boxes for heat protection and use in high temperature conditions

BENEFITS

- Easy to install
- Compact
- Clean
- Durable
- Highly energy efficient
- Provide fast response and even heat distribution
- Provide greater wattage in a smaller heater bundle
- Provide maximum dielectric strength
- Reduce heat loss from the vessel
- Protect and prevent thermal insulation
- Easy mounting support
- Suitable to general purpose terminal enclosures, weather or moisture resistant terminal enclosures, and unsafe or explosion proof locations
- Compatible with standard industry piping and safety standards
- Designed and built for safety



FIG. 1 – WATTCO™ Standard Unit

FACTORS

Please consider the following factors in order to select the proper circulation heater:

- Operating temperature
- Heating element watt density
- Sheath material (corrosive or non corrosive)
  - o Temperature of the corrodent
  - o Degree of aeration of exposed corrodent
  - o Velocity of the corrodent

REGISTRATION

Circulation heaters are sometimes considered as boilers or pressure vessels according to the:

- Heated fluid
- KW rating
- Size of vessel
- Operating pressure
- Outlet temperature

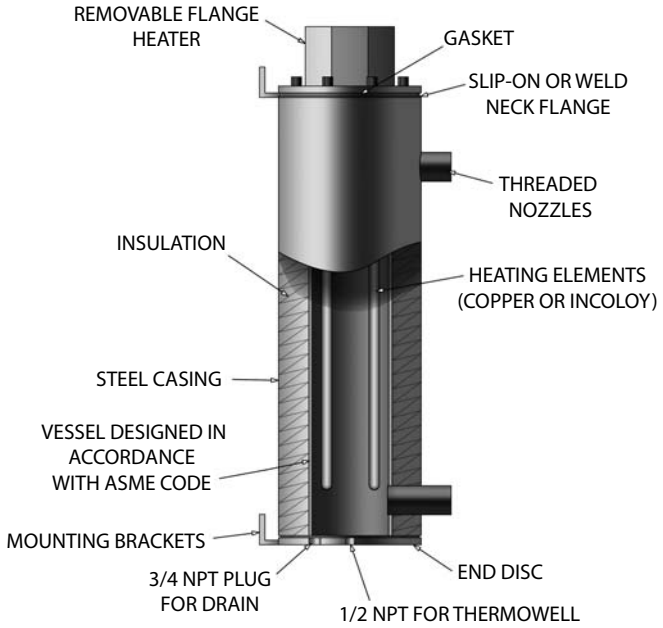
Where applicable, registration requirements are imposed by law and according to the installation location.

EXTRA FEATURES

- Available built-in high limit controls and thermostats
- Standard built-in thermostats: Single pole device limited to 240V up to 30 amps
- For heater voltage over 240V, or heater currents over 30 amps, or three-phase supply, the thermostat is used for pilot duty only and is not factory wired to the elements.

Please call us at 1.800.4WATTCO (1.800.492.8826) if you need further assistance.

FIG. 2 – CONSTRUCTION – Features and Components



GENERAL

GENERAL PRINCIPLES:

• The heat you get from an electric heater will leave the heater, as opposed to the steam or liquid heat exchanger.

• Even when the surface area in contact with the application is properly fixed, the sheath temperature of the heating element will increase until the heat achieved is similar to the heat that is transferred to the process.

• Low watt density heaters last longer than high density heaters, particularly with viscous or stagnant liquids. Low density heaters are however more expensive.

For larger systems, please call us at 1.800.4WATTCO (1.800.492.8826) for further assistance.

Warning: Selecting the wrong watt density can damage the product and control systems that are in place, and cause the heater to fail.

SELECTING

WATTCO™ CIRCULATION HEATER

When heating liquids (forced flow and natural flow heating loops):

- Make sure that the heater vessel remains totally filled when in use
- Use a circulator pump to achieve forced flow heating for heavier liquids or high temperature liquids heating purposes
- Set natural flow systems to "side arm" water heating applications
- Mount the heater in the vertical position where top of the heater is below the minimum liquid level of the tank

When heating gases (steam superheating, heating compressed air, nitrogen, ammonia):

- Make sure that there is enough flow in order to maintain the maximum allowable vessel and sheath temperatures.

NEED ASSISTANCE?

Please call us at 1.800.4WATTCO (1.800.492.8826) if you still need further assistance in selecting the circulation heater that best suits the requirements of your application.

HOW TO INSTALL:

The following figures show the proper vertical or horizontal mountings for vessels.



FIG. 3 – LIQUID HEATING or LOW TEMPERATURE GAS HEATING - **VERTICAL INSTALLATION**



FIG. 4 – GAS or LIQUID HEATING **HORIZONTAL INSTALLATION**



FIG. 5 – HIGH TEMPERATURE GAS HEATING **VERTICAL INSTALLATION**

WATTCO™ MINIATURE CIRCULATION HEATERS

- Economical heat sources for several applications
- No mounting support in stationary systems

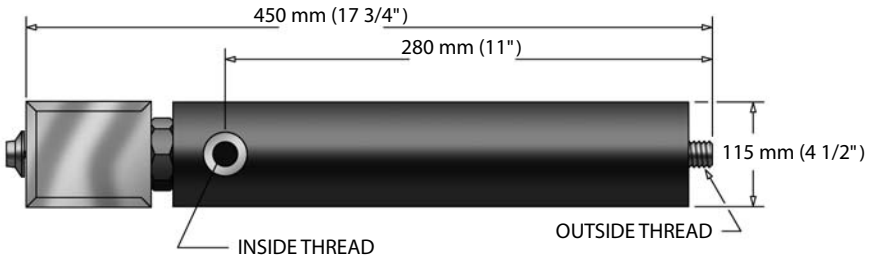
CONSTRUCTION

- Basic construction:
  - o 1" or 1 ¼" pipe fitted with a pipe "T" to fit a screwplug heater
  - o Insulated pipe with 1 ¼" – 1 ½" of insulation protected by a steel casing of 20 ga.
- Supplied units:
  - o With or without thermostats
  - o With general-purpose, moisture resistant, or explosion-proof terminal housings
- If the outlet liquid or gas temperature is above 150ºC (300ºF):
  - o Take the farthest end from the terminal box as the outlet
- If the outlet liquid or gas temperature is under 150ºC (300ºF):
  - o Take the outside threaded connection as the system inlet

EXTRA FEATURES

- Stainless steel wetted parts
- Moisture resistant or explosion-proof housings
- Special wattage (length increases when the watt density is the same)
- Special thermostat range

FIG. 1 – UNIT WITH BUILT-IN THERMOSTAT SHOWN



APPLICATIONS	SHEATH MATERIAL	SCREWPLUG or FLANGE MATERIAL	HEATER TYPE
Water Glycol water solutions Low viscosity liquids, not corrosive to brass or copper	Copper Steel	Brass Steel	MSX
Oils Low pressure steam Preheating instrument air	Incoloy®	Steel	MWHI

Note: Select lower watt density heaters for heavier liquids.
Incoloy® and Inconel® are registered trademarks of Inco Alloys International

TABLE 1
Miniature Circulation Heaters

KILO-WATTS	STANDARD VOLTAGES 1 PHASE ONLY	WATT DENSITY W/cm²	WATT DENSITY W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
TYPE MSX - COPPER SHEATH (BRASS PLUG & VESSEL WITH 1" NPT CONNECTIONS						
1.0	120, 208, 240	12.4	80	MSX110B	MSX110BT	13.2 (6)
1.5	"	12.4	80	MSX115B	MSX115BT	13.2 (6)
2.0	"	12.4	80	MSX120B	MSX120BT	13.2 (6)
3.0	208, 240	12.4	80	MSX130B	MSX130BT	13.2 (6)
TYPE MWHI - INCOLOY SHEATH (STEEL PLUG & VESSEL WITH 1 1/4" NPT CONNECTIONS						
0.6	120, 208, 240	2.3	15	MWHI206EO	MWHI206EOT	17.6 (8)
1.0	"	3.9	25	MWHI210EO	MWHI210EOT	17.6 (8)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, material to be heated, flowing or static mediums, types of controls to be applied, type of metal or alloy of the container, any extra features.

3" CIRCULATION HEATERS - GENERAL RECOMMENDATIONS - (ALSO APPLICABLE TO: 4" 5" 6" 8" 10" 12" 14" Circulation Heaters)

APPLICATIONS	SHEATH MATERIAL	HEATER TYPE
Water or aqueous solutions not corrosive to the steel vessel and copper sheath Dishwashing and rinsing Hot water storage tanks Process water	Copper	MFLC
Water (spray washing systems with chemical additives corrosive to copper)	Incoloy®	MFLI
Circulated oils Molding dies and platens Closed loop heat transfer systems Process liquids not corrosive to steel and incoloy® Compressed air or other gases	Steel	MFLO
Fluid heat transfer devices Tars High to low viscous petroleum oils Asphalt Wax Molten salt	Low Carbon Steel	MFLO
Deionized water	Stainless	MFLI

Note: When heating compressed air or gases, please verify if you need lower density heaters for high viscosity liquids or high temperature, low flow steam or gas heating systems. Call us at 1.800.4WATTCO (1.800.492.8826) for technical assistance.

HEATER DIMENSIONS IN: mm (in.)

VESSEL SIZE	A	B	C	D	E	F	G
3"	1060 (41.7)	780 (30.7)	85 (3.3)	190 (7.5)	235 (9.3)	135 (5.3)	945 (37.2)

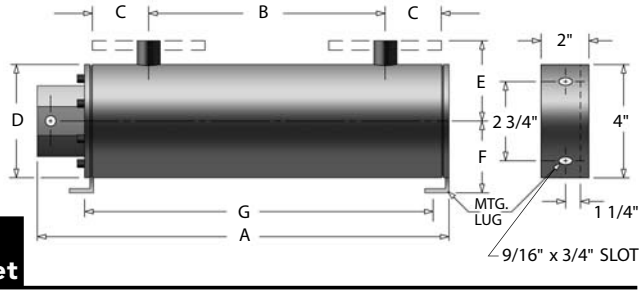


TABLE 2
3" - 150 lb. Flanged Steel Vessel with 1" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	B DIM INLET/OUTLET in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
6	780	30.7	✓	✓	✓	✓	9.3	60	MFLC306X2418	MFLC306X2418T	108.6 (47)
9	780	30.7	✓	✓	✓	✓	8.5	55	MFLC309X2426	MFLC309X2426T	105.8 (48)
12	780	30.7	✓	✓	✓	✓	8.4	54	MFLC312X2432	MFLC312X2432T	105.8 (48)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLC618X2425	MFLC618X2425T	112.4 (51)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLC624X2432	MFLC624X2432T	112.4 (51)
HIGH DENSITY - INCOLOY SHEATH											
6	780	30.7	✓	✓	✓	✓	9.3	60	MFLI306X2418	MFLI306X2418T	108.6 (47)
9	780	30.7	✓	✓	✓	✓	8.5	55	MFLI309X2426	MFLI309X2426T	105.8 (48)
12	780	30.7	✓	✓	✓	✓	8.4	54	MFLI312X2432	MFLI312X2432T	105.8 (48)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLI618X2426	MFLI618X2426T	112.4 (51)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLI624X2432	MFLI624X2432T	112.4 (51)
MEDIUM DENSITY - INCOLOY SHEATH											
3	780	30.7	✓	✓	✓	✓	4.6	30	MFLI303X2418	MFLI303X2418T	108.6 (47)
4.5	780	30.7	✓	✓	✓	✓	4.2	27	MFLI304X2426	MFLI304X2426T	105.8 (48)
6	780	30.7	✓	✓	✓	✓	4.2	27	MFLI306X2432	MFLI306X2432T	105.8 (48)
LOW DENSITY - INCOLOY SHEATH											
3	780	30.7	✓	✓	✓	✓	2.1	14	MFLI303X2432	MFLI303X2432T	105.8 (48)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

4" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)							
VESSEL SIZE	**A**	**B**	**C**	**D**	**E**	**F**	**G**
4"	1220 (48.0)	780 (30.7)	145 (5.7)	230 (9.1)	260 (10.2)	155 (6.1)	1065 (41.9)

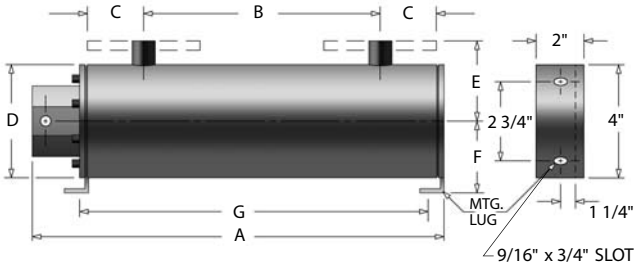




TABLE 3

4" - 150 lb. Flanged Steel Vessel with 1 1/2" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	B DIM INLET/OUTLET in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
12	780	30.7	✓	✓	✓	✓	8.4	60	MFLC612X2818	MFLC612X2818T	138.9 (63)
15	780	30.7	✓	✓	✓	✓	8.8	57	MFLC615X2822	MFLC615X2822T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLC618X2826	MFLC618X2826T	141.1 (64)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLC624X2832	MFLC624X2832T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	9.3	60	MFLC918X2818	MFLC918X2818T	147.7 (67)
27	780	30.7	✓	✓	✓	✓	8.5	55	MFLC927X2826	MFLC927X2826T	149.9 (68)
36	780	30.7	✓	✓	✓	✓	8.4	54	MFLC936X2832	MFLC936X2832T	152.1 (69)
HIGH DENSITY - INCOLOY SHEATH											
12	780	30.7	✓	✓	✓	✓	8.4	60	MFLI612X2818	MFLI612X2818T	138.9 (63)
15	780	30.7	✓	✓	✓	✓	8.8	57	MFLI615X2822	MFLI615X2822T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLI618X2825	MFLI618X2825T	141.1 (64)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLI624X2832	MFLI624X2832T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	9.3	60	MFLI918X2818	MFLI918X2818T	147.7 (67)
27	780	30.7	✓	✓	✓	✓	8.5	55	MFLI927X2826	MFLI927X2826T	149.9 (68)
36	780	30.7	✓	✓	✓	✓	8.4	54	MFLI936X2832	MFLI936X2832T	152.1 (69)
MEDIUM DENSITY - INCOLOY SHEATH											
6	780	30.7	✓	✓	✓	✓	4.6	30	MFLI606X2818	MFLI606X2818T	138.9 (63)
9	780	30.7	✓	✓	✓	✓	4.2	27	MFLI609X2826	MFLI609X2826T	143.3 (65)
12	780	30.7	✓	✓	✓	✓	4.2	27	MFLI612X2832	MFLI612X2832T	143.3 (65)
9	780	30.7	✓	✓	✓	✓	4.6	30	MFLI909X2818	MFLI909X2818T	149.9 (68)
13.5	780	30.7	✓	✓	✓	✓	4.2	27	MFLI913X2825	MFLI913X2825T	152.1 (69)
18	780	30.7	✓	✓	✓	✓	4.2	27	MFLI918X2832	MFLI918X2832T	154.3 (70)
LOW DENSITY - INCOLOY SHEATH											
6	780	30.7	✓	✓	✓	✓	2.1	14	MFLI606X2832	MFLI606X2832T	143.3 (65)
9	780	30.7	✓	✓	✓	✓	2.1	14	MFLI909X2832	MFLI909X2832T	152.1 (69)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

5" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)

VESSEL SIZE	A	B	C	D	E	F	G
5"	1220 (48.0)	780 (30.7)	145 (5.7)	255 (10.0)	270 (10.6)	170 (6.7)	1065 (41.9)

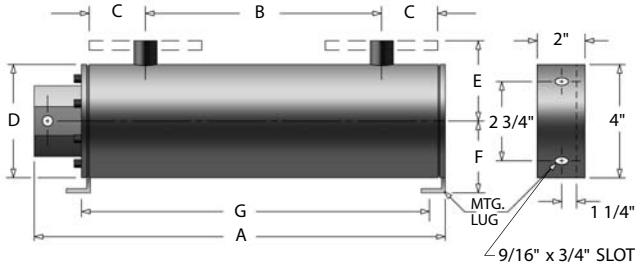




TABLE 4
5" - 150 lb. Flanged Steel Vessel with 2" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	B DIM INLET/OUTLET in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
12	780	30.7	✓	✓	✓	✓	8.4	60	MFLC612X3018	MFLC612X3018T	138.9 (63)
15	780	30.7	✓	✓	✓	✓	8.8	57	MFLC615X3022	MFLC615X3022T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLC618X3026	MFLC618X3026T	141.1 (64)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLC624X3032	MFLC624X3032T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	9.3	60	MFLC918X3018	MFLC918X3018T	147.7 (67)
27	780	30.7	✓	✓	✓	✓	8.5	55	MFLC927X3026	MFLC927X3026T	149.9 (68)
36	780	30.7	✓	✓	✓	✓	8.4	54	MFLC936X3032	MFLC936X3032T	152.1 (69)
HIGH DENSITY - INCOLOY SHEATH											
12	780	30.7	✓	✓	✓	✓	8.4	60	MFLI612X3018	MFLI612X3018T	138.9 (63)
15	780	30.7	✓	✓	✓	✓	8.8	57	MFLI615X3022	MFLI615X3022T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	8.5	55	MFLI618X3025	MFLI618X3025T	141.1 (64)
24	780	30.7	✓	✓	✓	✓	8.4	54	MFLI624X3032	MFLI624X3032T	141.1 (64)
18	780	30.7	✓	✓	✓	✓	9.3	60	MFLI918X3018	MFLI918X3018T	147.7 (67)
27	780	30.7	✓	✓	✓	✓	8.5	55	MFLI927X3026	MFLI927X3026T	149.9 (68)
36	780	30.7	✓	✓	✓	✓	8.4	54	MFLI936X3032	MFLI936X3032T	152.1 (69)
MEDIUM DENSITY - INCOLOY SHEATH											
6	780	30.7	✓	✓	✓	✓	4.6	30	MFLI606X3018	MFLI606X3018T	138.9 (63)
9	780	30.7	✓	✓	✓	✓	4.2	27	MFLI609X3026	MFLI609X3026T	143.3 (65)
12	780	30.7	✓	✓	✓	✓	4.2	27	MFLI612X3032	MFLI612X3032T	143.3 (65)
9	780	30.7	✓	✓	✓	✓	4.6	30	MFLI909X3018	MFLI909X3018T	149.9 (68)
13.5	780	30.7	✓	✓	✓	✓	4.2	27	MFLI913X3025	MFLI913X3025T	152.1 (69)
18	780	30.7	✓	✓	✓	✓	4.2	27	MFLI918X3032	MFLI918X3032T	154.3 (70)
LOW DENSITY - INCOLOY SHEATH											
6	780	30.7	✓	✓	✓	✓	2.1	14	MFLI606X3032	MFLI606X3032T	143.3 (65)
9	780	30.7	✓	✓	✓	✓	2.1	14	MFLI909X3032	MFLI909X3032T	152.1 (69)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

6" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)

VESSEL SIZE	A	B	C	D	E	F	G
6"	1220 (48.0)	780 (30.7)	145 (5.7)	280 (11.0)	290 (11.4)	180 (7.1)	1065 (41.9)
6"	1540 (60.6)	1100 (43.3)	145 (5.7)	280 (11.0)	290 (11.4)	180 (7.1)	1385 (54.5)

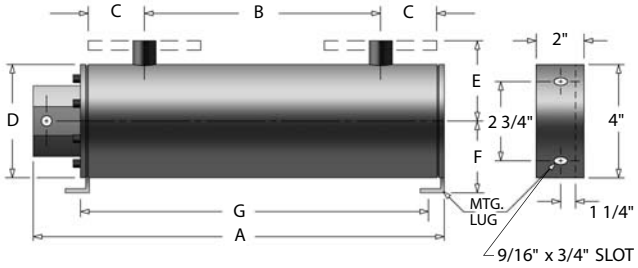


TABLE 5
6" - 150 lb. Flanged Steel Vessel with 2" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
36	780	30.7	✓	✓	✓	✓	8.5	55	MFLC1236X1026	MFLC1236X1026T	200.6 (91)
48	780	30.7	—	✓	✓	✓	8.4	54	MFLC1248X1032	MFLC1248X1032T	202.8 (92)
60	1100	43.3	—	✓	✓	✓	8.4	54	MFLC1260X1039	MFLC1260X1039T	209.4 (95)
72	1100	43.3	—	✓	✓	✓	8.2	53	MFLC1272X1047	MFLC1272X1047T	211.6 (96)
45	780	30.7	—	✓	✓	✓	8.5	55	MFLC1545X1026	MFLC1545X1026T	205.0 (93)
60	780	30.7	—	✓	✓	✓	8.4	54	MFLC1560X1032	MFLC1560X1032T	211.6 (96)
75	1100	43.3	—	✓	✓	✓	8.4	54	MFLC1575X1039	MFLC1575X1039T	240.3 (109)
90	1100	43.3	—	—	✓	✓	8.2	53	MFLC1590X1047	MFLC1590X1047T	246.9 (112)
90	1100	43.3	—	—	✓	✓	8.4	54	MFLC1890X1039	MFLC1890X1039T	246.9 (112)
HIGH DENSITY - INCOLOY SHEATH											
36	780	30.7	✓	✓	✓	✓	8.5	55	MFLI1236X1026	MFLI1236X1026T	200.6 (91)
48	780	30.7	—	✓	✓	✓	8.4	54	MFLI1248X1032	MFLI1248X1032T	202.8 (92)
60	1100	43.3	—	✓	✓	✓	8.4	54	MFLI1260X1039	MFLI1260X1039T	209.4 (95)
72	1100	43.3	—	✓	✓	✓	8.2	53	MFLI1272X1047	MFLI1272X1047T	211.6 (96)
45	780	30.7	—	✓	✓	✓	8.5	55	MFLI1545X1026	MFLI1545X1026T	205.0 (93)
60	780	30.7	—	✓	✓	✓	8.4	54	MFLI1560X1032	MFLI1560X1032T	211.6 (96)
75	1100	43.3	—	✓	✓	✓	8.4	54	MFLI1575X1039	MFLI1575X1039T	240.3 (109)
90	1100	43.3	—	—	✓	✓	8.2	53	MFLI1590X1047	MFLI1590X1047T	246.9 (112)
90	1100	43.3	—	—	✓	✓	8.4	54	MFLI1890X1039	MFLI1890X1039T	246.9 (112)
120	1100	43.3	—	—	—	✓	10.9	70	MFLI15120X1047	MFLI15120X1047T	251.3 (114)
144	1100	43.3	—	—	—	✓	10.9	70	MFLI18144X1047	MFLI18144X1047T	260.2 (118)
MEDIUM DENSITY - INCOLOY SHEATH											
18	780	30.7	✓	✓	✓	✓	4.2	27	MFLI1218X1025	MFLI1218X1025T	202.8 (92)
24	780	30.7	✓	✓	✓	✓	4.2	27	MFLI1224X1032	MFLI1224X1032T	207.2 (94)
30	1100	43.3	✓	✓	✓	✓	4.2	27	MFLI1230X1039	MFLI1230X1039T	233.7 (106)
36	1100	43.3	✓	✓	✓	✓	4.1	26	MFLI1236X1047	MFLI1236X1047T	238.1 (108)
22.5	780	30.7	✓	✓	✓	✓	4.2	27	MFLI1522X1025	MFLI1522X1025T	209.4 (95)
30	780	30.7	✓	✓	✓	✓	4.2	27	MFLI1530X1032	MFLI1530X1032T	213.8 (97)
37.5	1100	43.3	✓	✓	✓	✓	4.2	27	MFLI1537X1039	MFLI1537X1039T	240.3 (109)
45	1100	43.3	—	✓	✓	✓	4.1	26	MFLI1545X1047	MFLI1545X1047T	246.9 (112)
MEDIUM DENSITY - INCOLOY SHEATH											
12	780	30.7	✓	✓	✓	✓	2.1	14	MFLI1212X1032	MFLI1212X1032T	202.8 (92)
18	1100	43.3	✓	✓	✓	✓	2.5	16	MFLI1218X1039	MFLI1218X1039T	233.7 (106)
24	1100	43.3	✓	✓	✓	✓	2.7	18	MFLI1224X1047	MFLI1224X1047T	244.7 (111)
15	780	30.7	✓	✓	✓	✓	2.1	14	MFLI1515X1032	MFLI1515X1032T	209.4 (95)
22.5	1100	43.3	✓	✓	✓	✓	2.5	16	MFLI1522X1039	MFLI1522X1039T	242.5 (110)
30	1100	43.3	✓	✓	✓	✓	2.7	18	MFLI1530X1047	MFLI1530X1047T	253.5 (115)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

8" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)

VESSEL SIZE	A	B	C	D	E	F	G
8"	1580 (62.2)	1100 (43.3)	165 (6.5)	345 (13.6)	330 (13.0)	215 (8.5)	1425 (56.1)

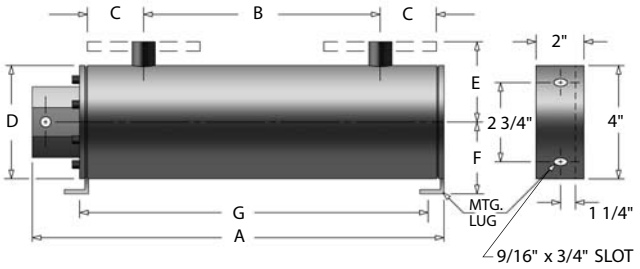


TABLE 6
8" - 150 lb. Flanged Steel Vessel with 2 1/2" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	B DIM INLET/OUTLET in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	WATT DENSITY W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
54	1100	43.3	—	✓	✓	✓	8.5	55	MFLC1854X1225	MFLC1854X1225T	233.7 (106)
72	1100	43.3	—	✓	✓	✓	8.4	54	MFLC1872X1232	MFLC1872X1232T	240.3 (109)
90	1100	43.3	—	✓	✓	✓	8.4	54	MFLC1890X1239	MFLC1890X1239T	313.6 (142)
108	1100	43.3	—	✓	✓	✓	8.2	53	MFLC18108X1247	MFLC18108X1247T	317.5 (144)
81	1100	43.3	—	✓	✓	✓	8.5	55	MFLC2781X1225	MFLC2781X1225T	326.3 (148)
108	1100	43.3	—	—	✓	✓	8.4	54	MFLC27108X1232	MFLC27108X1232T	335.1 (152)
135	1100	43.3	—	—	—	✓	8.4	54	MFLC27135X1239	MFLC27135X1239T	346.1 (157)
162	1100	43.3	—	—	—	✓	8.2	53	MFLC27162X1247	MFLC27162X1247T	352.7 (160)
HIGH DENSITY - INCOLOY SHEATH											
54	1100	43.3	—	✓	✓	✓	8.5	55	MFLI1854X12	MFLI1854X12T	233.7 (106)
72	1100	43.3	—	✓	✓	✓	8.4	54	MFLI1872X12	MFLI1872X12T	240.3 (109)
90	1100	43.3	—	✓	✓	✓	8.4	54	MFLI1890X12	MFLI1890X12T	313.6 (142)
108	1100	43.3	—	✓	✓	✓	8.2	53	MFLI18108X12	MFLI18108X12T	317.5 (144)
81	1100	43.3	—	✓	✓	✓	8.5	55	MFLI2781X12	MFLI2781X12T	326.3 (148)
108	1100	43.3	—	—	✓	✓	8.4	54	MFLI27108X12	MFLI27108X12T	335.1 (152)
135	1100	43.3	—	—	—	✓	8.4	54	MFLI27135X12	MFLI27135X12T	346.1 (157)
162	1100	43.3	—	—	—	✓	8.2	53	MFLI27162X12	MFLI27162X12T	352.7 (160)
120	1100	43.3	—	—	—	✓	10.9	70	MFLI15120X12	MFLI15120X12T	313.6 (142)
144	1100	43.3	—	—	—	✓	10.9	70	MFLI18144X12	MFLI18144X12T	319.7 (145)
168	1100	43.3	—	—	—	✓	10.9	70	MFLI21168X12	MFLI21168X12T	326.3 (148)
192	1100	43.3	—	—	—	✓	10.9	70	MFLI24192X12	MFLI24192X12T	332.9 (151)
216	1100	43.3	—	—	—	✓	10.9	70	MFLI27216X12	MFLI27216X12T	339.5 (154)
240	1100	43.3	—	—	—	✓	10.9	70	MFLI30240X12	MFLI30240X12T	346.1 (157)
MEDIUM DENSITY - INCOLOY SHEATH											
36	1100	43.3	✓	✓	✓	✓	4.2	27	MFLI1836X1232	MFLI1836X1232T	304.2 (138)
54	1100	43.3	—	✓	✓	✓	4.1	26	MFLI1854X1247	MFLI1854X1247T	319.7 (145)
63	1100	43.3	—	✓	✓	✓	4.1	26	MFLI2163X1247	MFLI2163X1247T	328.5 (149)
72	1100	43.3	—	✓	✓	✓	4.1	26	MFLI2436X1247	MFLI2436X1247T	335.1 (152)
81	1100	43.3	—	✓	✓	✓	4.1	26	MFLI2781X1247	MFLI2781X1247T	341.7 (155)
90	1100	43.3	—	✓	✓	✓	4.1	26	MFLI3090X1247	MFLI3090X1247T	348.3 (158)
LOW DENSITY - INCOLOY SHEATH											
27	1100	43.3	✓	✓	✓	✓	2.5	16	MFLI1827X1239	MFLI1827X1239T	313.6 (142)
31.5	1100	43.3	✓	✓	✓	✓	2.5	16	MFLI2131X1239	MFLI2131X1239T	317.5 (144)
36	1100	43.3	✓	✓	✓	✓	2.5	16	MFLI2436X1239	MFLI2436X1239T	321.9 (146)
36	1100	43.3	✓	✓	✓	✓	2.7	17	MFLI1836X1247	MFLI1836X1247T	321.9 (146)
40.5	1100	43.3	—	✓	✓	✓	2.5	16	MFLI2740X1239	MFLI2740X1239T	328.5 (149)
45	1100	43.3	—	✓	✓	✓	2.5	16	MFLI3045X1239	MFLI3045X1239T	335.1 (152)
54	1100	43.3	—	✓	✓	✓	2.7	17	MFLI2754X1247	MFLI2754X1247T	343.9 (156)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

10" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)							
VESSEL SIZE	**A**	**B**	**C**	**D**	**E**	**F**	**G**
10"	1650 (65.0)	1100 (43.3)	180 (7.1)	405 (16.0)	375 (14.8)	250 (9.9)	1450 (57.1)

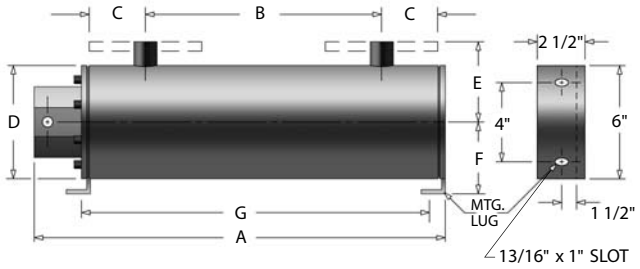




TABLE 7
10" - 150 lb. Flanged Steel Vessel with 3" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
108	1100	43.3	—	—	—	✓	9.8	63	MFLC36180X1439	MFLC36180X1439T	485.0 (220)
216	1100	43.3	—	—	—	✓	9.3	60	MFLC36216X1447	MFLC36216X1447T	498.2 (226)
252	1100	43.3	—	—	—	✓	9.3	60	MFLC42252X1447	MFLC42252X1447T	520.3 (236)
HIGH DENSITY - INCOLOY SHEATH											
180	1100	43.3	—	—	—	✓	9.8	63	MFLI36180X1439	MFLI36180X1439T	485.0 (220)
216	1100	43.3	—	—	—	✓	9.3	60	MFLI36216X1447	MFLI36216X1447T	498.2 (226)
252	1100	43.3	—	—	—	✓	9.3	60	MFLI42252X1447	MFLI42252X1447T	520.3 (236)
288	1100	43.3	—	—	—	✓	12.3	80	MFLI36288X1447	MFLI36288X1447T	498.2 (226)
336	1100	43.3	—	—	—	✓	12.3	80	MFLI42336X1447	MFLI42336X1447T	520.3 (236)
384	1100	43.3	—	—	—	✓	12.3	80	MFLI48384X1447	MFLI48384X1447T	542.3 (246)
MEDIUM DENSITY - INCOLOY SHEATH											
108	1100	43.3	—	—	✓	✓	4.6	30	MFLI36108X1447	MFLI36108X1447T	498.2 (226)
126	1100	43.3	—	—	—	✓	4.6	30	MFLI42336X1447	MFLI42336X1447T	520.3 (236)
144	1100	43.3	—	—	—	✓	4.6	30	MFLI48384X1447	MFLI48384X1447T	537.9 (244)
LOW DENSITY - INCOLOY SHEATH											
72	1100	43.3	—	✓	✓	✓	3.1	20	MFLI3672X1447	MFLI3672X1447T	498.2 (226)
84	1100	43.3	—	✓	✓	✓	3.1	20	MFLI4284X1447	MFLI4284X1447T	520.3 (236)
96	1100	43.3	—	✓	✓	✓	3.1	20	MFLI4896X1447	MFLI4896X1447T	537.9 (244)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

12" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)							
VESSEL SIZE	**A**	**B**	**C**	**D**	**E**	**F**	**G**
12"	1655 (65.1)	1100 (43.3)	180 (7.1)	480 (19.0)	410 (16.1)	290 (11.5)	1450 (57.1)

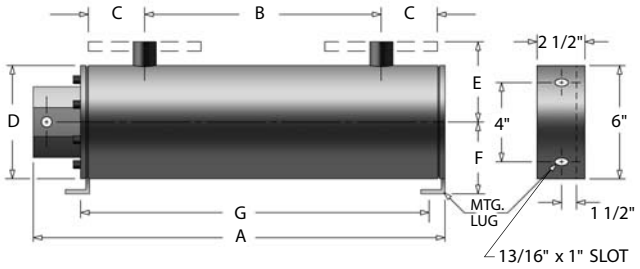




TABLE 8
12" - 150 lb. Flanged Steel Vessel with 3" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
240	1100	43.3	—	—	—	✓	9.8	63	MFLC48240X1639	MFLC48240X1639T	690.1 (313)
288	1100	43.3	—	—	—	✓	9.3	60	MFLC48288X1647	MFLC48288X1647T	709.9 (322)
324	1100	43.3	—	—	—	✓	9.3	60	MFLC54324X1647	MFLC54324X1647T	727.5 (330)
360	1100	43.3	—	—	—	✓	9.3	60	MFLC60360X1647	MFLC60360X1647T	718.7 (326)
HIGH DENSITY - INCOLOY SHEATH											
240	1100	43.3	—	—	—	✓	9.8	63	MFLI48240X1639	MFLI48240X1639T	690.1 (313)
288	1100	43.3	—	—	—	✓	9.3	60	MFLI48288X1647	MFLI48288X1647T	709.9 (322)
324	1100	43.3	—	—	—	✓	9.3	60	MFLI54324X1647	MFLI54324X1647T	727.5 (330)
360	1100	43.3	—	—	—	✓	9.3	60	MFLI60360X1647	MFLI60360X1647T	718.7 (326)
432	1100	43.3	—	—	—	✓	12.3	80	MFLI54432X1647	MFLI54432X1647T	727.5 (330)
480	1100	43.3	—	—	—	✓	12.3	80	MFLI60480X1647	MFLI60480X1647T	743.0 (337)
MEDIUM DENSITY - INCOLOY SHEATH											
144	1100	43.3	—	—	—	✓	4.6	30	MFLI48144X1647	MFLI48144X1647T	709.9 (322)
162	1100	43.3	—	—	—	✓	4.6	30	MFLI54162X1647	MFLI54162X1647T	727.5 (330)
180	1100	43.3	—	—	—	✓	4.6	30	MFLI60180X1647	MFLI60180X1647T	743.0 (337)
LOW DENSITY - INCOLOY SHEATH											
96	1100	43.3	—	✓	✓	✓	3.1	20	MFLI4896X1647	MFLI4896X1647T	709.9 (322)
108	1100	43.3	—	—	✓	✓	3.1	20	MFLI54108X1647	MFLI54108X1647T	727.5 (330)
120	1100	43.3	—	—	—	✓	3.1	20	MFLI60120X1647	MFLI60120X1647T	743.0 (337)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.

14" CIRCULATION HEATERS

Refer to **PAGE 4.4** for the **GENERAL RECOMMENDATIONS**

HEATER DIMENSIONS IN: mm (in.)							
VESSEL SIZE	**A**	**B**	**C**	**D**	**E**	**F**	**G**
14"	1680 (66.2)	1100 (43.3)	220 (7.8)	535 (21.0)	445 (17.5)	320 (12.6)	1490 (58.6)

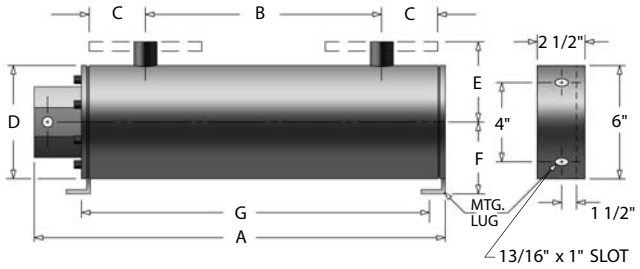




TABLE 9
14" - 150 lb. Flanged Steel Vessel with 3" Inlet and Outlet

KILO-WATTS	B DIM INLET/OUTLET mm	in.	STANDARD VOLTAGES 208 1ϕ	240 3ϕ	480 1ϕ	600 3ϕ	WATT DENSITY W/cm²	W/in.²	WITHOUT THERMOSTAT CAT. No.	WITH THERMOSTAT 10 - 120°C (50 - 250°F) CAT. No.	NET WT. LBS (KG)
HIGH DENSITY - COPPER SHEATH											
300	1100	43.3	—	—	—	✓	9.8	63	MFLC60300X1839	MFLC60300X1839T	877.4 (398)
360	1100	43.3	—	—	—	✓	9.3	60	MFLC60360X1847	MFLC60360X1847T	903.9 (410)
432	1100	43.3	—	—	—	✓	9.3	60	MFLC72432X1847	MFLC72432X1847T	934.8 (424)
504	1100	43.3	—	—	—	✓	9.3	60	MFLC84504X1847	MFLC84504X1847T	967.8 (439)
HIGH DENSITY - INCOLOY SHEATH											
300	1100	43.3	—	—	—	✓	9.8	63	MFLI60300X1839	MFLI60300X1839T	877.4 (398)
360	1100	43.3	—	—	—	✓	9.3	60	MFLI60360X1847	MFLI60360X1847T	903.9 (410)
432	1100	43.3	—	—	—	✓	9.3	60	MFLI72432X1847	MFLI72432X1847T	934.8 (424)
504	1100	43.3	—	—	—	✓	9.3	60	MFLI84504X1847	MFLI84504X1847T	967.8 (439)
576	1100	43.3	—	—	—	✓	12.3	80	MFLI72576X1847	MFLI72576X1847T	934.8 (424)
672	1100	43.3	—	—	—	✓	12.3	80	MFLI84672X1847	MFLI84672X1847T	967.8 (439)
MEDIUM DENSITY - INCOLOY SHEATH											
180	1100	43.3	—	—	—	✓	4.6	30	MFLI60180X1847	MFLI60180X1847T	903.9 (410)
216	1100	43.3	—	—	—	✓	4.6	30	MFLI72216X1847	MFLI72216X1847T	934.8 (424)
252	1100	43.3	—	—	—	✓	4.6	30	MFLI84252X1847	MFLI84252X1847T	967.8 (439)
LOW DENSITY - INCOLOY SHEATH											
120	1100	43.3	—	✓	✓	✓	3.1	20	MFLI60120X1847	MFLI60120X1847T	903.9 (410)
144	1100	43.3	—	✓	✓	✓	3.1	20	MFLI72144X1847	MFLI72144X1847T	934.8 (424)
168	1100	43.3	—	✓	✓	✓	3.1	20	MFLI84168X1847	MFLI84168X1847T	967.8 (439)

WHEN ORDERING, PLEASE SPECIFY: Quantity, catalogue number, voltage, phase, wattage, extra features, fluid to be heated, operating temperature and pressure, name and address of owner, name and address of the installation location.



APPENDIX XVII

Declaration of Conformity

Declaration of Conformity

The design, development and manufacture is in accordance with European Community guidelines

Equipment Categories..... Coolant Service Cart (CSC)
Equipment Name ..... Coolant Service Cart (CSC)
Model Number..... 1016

Malabar declares under our sole responsibility that the product described above complies with the requirements of the following European Directives:

Machinery Directive 2006/42/EC
Electromagnetic Compatibility Directive 2004/108/EC

Main standards Considered:
EN ISO 12100-1:2003/A1:2009
EN ISO 12100-2:2003/A1:2009

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Malabar International
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