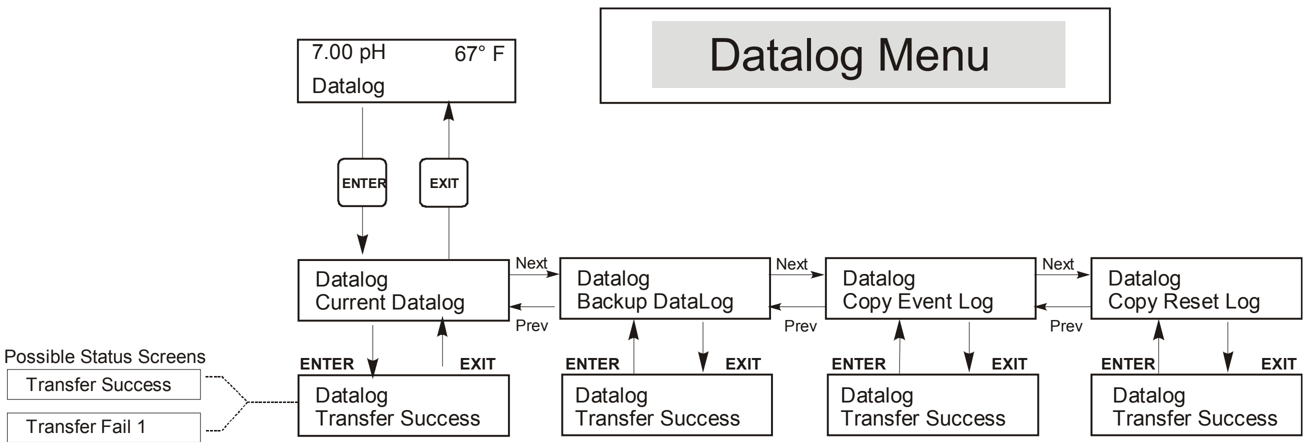


Figure 16 Datalog Menu

5.11 Config Menu

This menu allows you to export a file that contains all of the set points in the controller to a USB flash disk drive, and then later import the set points into another controller.

Export Config	Place a USB flash drive with at least 10 MB capacity into the USB port on the front panel of the controller. Press the Enter key to export the configuration file from the controller to the stick. The file name will be UCF.ini. If you are exporting files with different set points you may rename the file to something that describes it, as long as it has an ini extension. The controller will display the progress of the file download process. If the file was successfully exported to the USB disk the controller will display Transfer Success, otherwise Transfer Fail 1.	
	Transfer Success	Transfer Fail 1
Import Config	Place a USB flash drive that contains only one configuration file stored on the root directory of the stick into the USB port on the front panel of the controller. Press the Enter key to import the configuration file from the stick to the controller. The file name must have an ini extension in its name. The controller will display the progress of the file import process. If the file was successfully imported from the USB disk the controller will display one of the messages below:	
	Import Failure	Indicates that there were problems connecting to or accessing the USB stick.
	Import Success: Any key to reboot	The configuration file import succeeded and will be ready for use after reboot.
	File Open Failed	A config file could not be found on the USB stick or the USB stick file system could not be accessed.
	File Read Failed	The config file is too short (incomplete) or empty.
	Invalid CFG File	The imported file is not a valid config file.
	Invalid Model	The imported config file is not for this controller model.
	Wrong SW Version	The version of the imported config file is not compatible with this controller software version.
	Corrupt CFG File	The imported config file is corrupt. (The checksum failed.)
	Wrong file Size	The size of the imported config file is wrong.

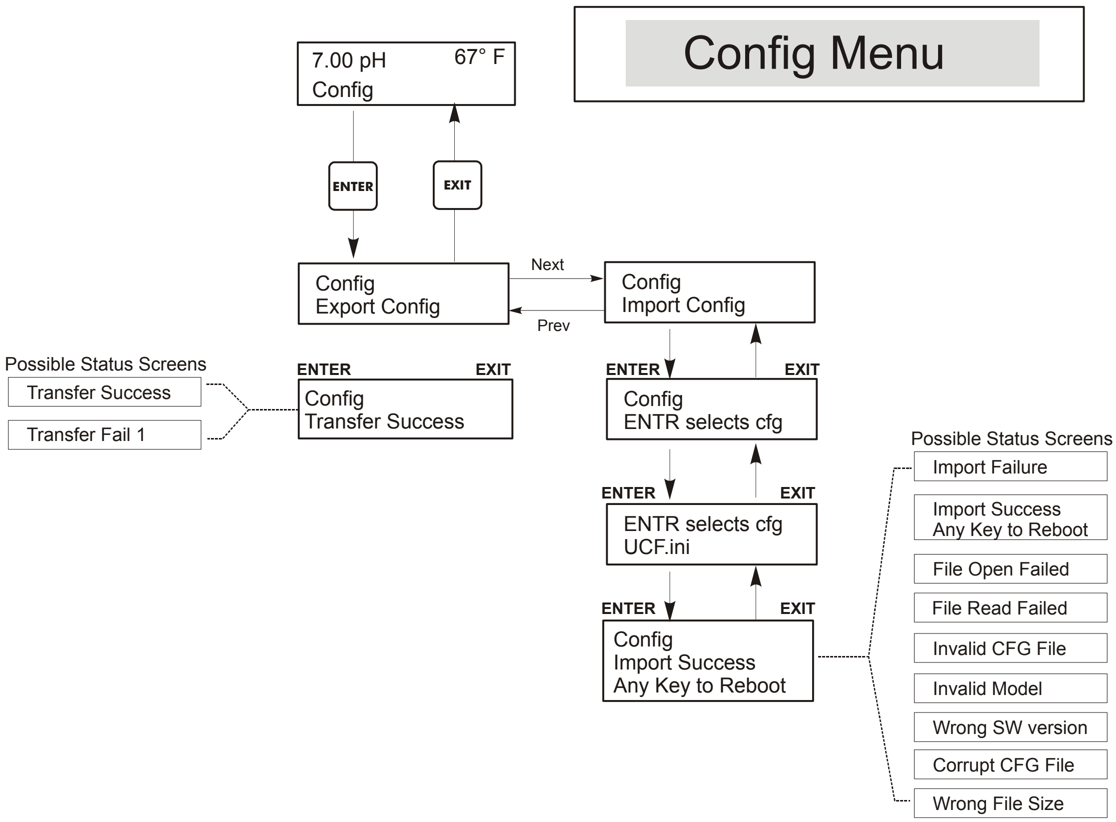


Figure 17 Config Menu

5.12 Upgrade Menu

This menu is used to upgrade the software to a newer version. If a new version of the software is available, an upgrade file will be posted on our web site. Save this file to a USB flash disk drive. It needs to be the only upgrade file stored on the root directory of the stick. Press the Enter key to import the software upgrade file from the stick to the controller.

The controller will display the progress of the file import process. If the file was successfully imported from the USB disk the controller will display Transfer Success. The controller will automatically reboot and come up with the new software installed.

Upgrade	The controller will display the progress of the file import process. If the file was successfully imported from the USB disk the controller will display Transfer Success. The controller will automatically reboot and come up with the new software installed. If the software upgrade fails, you will see one of the following messages:	
	UpgradFileInvald	The file found on the USB stick is for the wrong product, or is corrupt. Try getting the correct upgrade file and make sure it's the only upgrade file on the stick.
	No Upgrade File	There is no upgrade file stored on the stick, or the file is named incorrectly.
	CorrptUpgradFile	Try getting a new copy of the file.
	Flash Failure	The flash memory on the processor board has a problem. Repair or replace the front panel assembly.

To check that it was successful, turn off power to the controller, then press the Enter key while turning power on. The controller will show the software version, which should match the name of the upgrade file that you used.

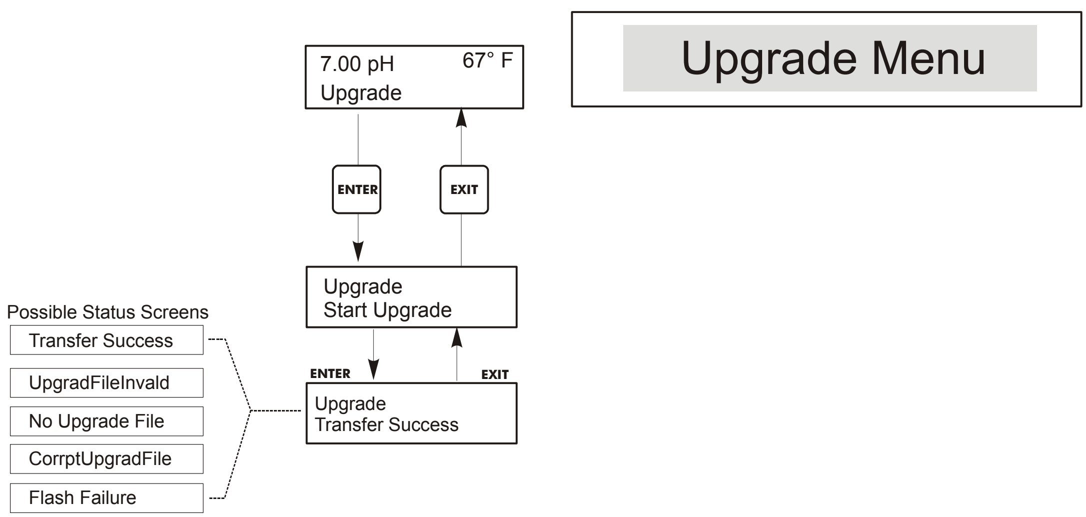


Figure 18 Upgrade Menu

6.0 MAINTENANCE

The WPH/WDP control module itself needs very little maintenance. Clean the outside of the controller enclosure with a damp cloth. Do not spray down the controller unless the enclosure door is closed and latched. "Pigtails" should be protected from spray or wash-down. Check the cords and cables for damage.

6.1 Electrode Maintenance

The pH or ORP electrodes require periodic cleaning and calibration. These electrodes are like batteries and their voltage outputs will change with time even if they are not being used. After installation, the rate of change increases, and factors such as temperature, extremes of pH, abrasion and chemical attack will increase the required frequency of calibration. If the process solution contains oils, scale or other solids, the electrode surfaces will tend to coat, its response time will slow down and cleaning will be required.

The frequency of cleaning and calibrating will vary greatly depending upon the application, the factors listed above, as well as the accuracy of control you require. The best way to determine the optimum number of days between calibrations is to remove the electrode from the process periodically (weekly in clean water applications, daily in dirty or hot applications) and check its accuracy in a buffer solution. If using manual temperature compensation, remember to change the temperature from that of the process to that of the buffer. If the accuracy of the reading is within your required tolerances, and the speed of response is good, replace the electrode in the process. If not, clean the electrode and perform a two point calibration.

The method of cleaning the electrode will depend upon the coating, as well as the materials of construction of the electrode. Do not use a solvent that will attack the electrode! Care must be taken to avoid scratching the pH electrode's glass, as this will shorten its life. An ORP electrode's platinum surface may be cleaned with 600 grit silicon carbide paper, jewelers rouge or very fine steel wool.

Oily coatings should be removed with a mild detergent or isopropyl alcohol. Hard scales such as calcium carbonate can usually be removed with a dilute hydrochloric acid solution. Soft coatings can be removed using a soft cloth or soft toothbrush.

A two point calibration should always be performed after cleaning the electrode.

Because the electrode signal is so sensitive, the condition of the cable and connectors between the electrode, preamplifier and controller is critical. Make sure that all electrical connections stay clean and dry. Never splice the cable prior to preamplification. Replace the cable if there is any sign of damage.

6.2 Replacing the Fuses

CAUTION: Disconnect power to the controller before opening front panel!

Locate the fuses on the circuit board at the back of the controller enclosure. (See figure 4.) Gently remove the old fuse from its retaining clip and discard. Press the new fuse into the clip, secure the front panel of the controller and return power to the unit.

Warning: Use of non-approved fuses can affect product safety approvals. Fuse ratings depend on controller power rating. Specifications are shown below. To insure product safety certifications are maintained, it is recommended that a Walchem fuse be used.

F1 Fuse	Walchem P/N	F2 Fuse (WPH410 & WDP410 only)	Walchem P/N
5 x 20 mm, 1.0A, 250V	103163	5 x 20 mm, 6A, 250V	102834

7.0 TROUBLESHOOTING

CAUTION: Disconnect power to the controller before opening front panel!

Troubleshooting and repair of a malfunctioning controller should only be attempted by qualified personnel using caution to ensure safety and limit unnecessary further damage. Contact the factory.

7.1 Error Messages

Output Timeout

This error message appears if one of the control outputs has been on longer than the maximum amount of time programmed in the "Time Limit" menu found in the Control menus. It is reset by answering "Yes" to the "Reset Timer" prompt that will appear or by cycling power to the controller off and back on. There are a number of possible reasons that the output could go on for longer than normal:

Possible Cause	**Corrective Action**
The process went further out of control than normal.	Increase time limit or reset timer.
The chemical supply has run out.	Replenish the chemical supply.
The pump or valve or supply line is faulty.	Repair or replace the control device.
Wrong chemical is being controlled.	Replace with correct chemical.
The electrode is not responding to changes.	Replace electrode, cable or preamplifier. Evaluate mixing or recirculation.

High Alarm

This error message appears if the pH/ORP reading exceeds the set point for one of the Control outputs that has been configured as a high alarm output. There are a number of possible causes for this condition:

Possible Cause	Corrective Action
The process went further out of control than normal.	May have to increase chemical flow rate.
The chemical supply has run out.	Replenish the chemical supply.
The pump or valve or supply line is faulty.	Repair or replace the control device.
Wrong chemical is being controlled.	Replace with correct chemical.
The electrode is not responding to changes.	Replace electrode, cable or preamplifier. Evaluate mixing or recirculation.
The pump is siphoning, valve leaking.	Repair or replace the control device or re-route tubing.
Control output has been left in "HAND" mode.	Switch back to "AUTO".
It may be a normal part of the process.	None required.

Probe Error

This error message appears if the pH/ORP input signal is outside of the normal range. This usually indicates that the electrode has been disconnected or is faulty. It could appear under normal conditions if the pH is outside of the operating range of -2 to 16pH, or if the ORP is outside of the normal range of ±1500 mV.

Possible Cause	Corrective Action
Controller is faulty; fails self test (see section 5.2)	Re-check pH self test with preamp disconnected. If it still fails, send controller back for repair. If it passes, preamp is faulty.
Preamplifier has no power to it.	If battery powered preamp, replace battery. If preamp is powered by our controller, check +5V, -5V terminals vs COM terminal. Should read +5VDC ±5% and -4.6 VDC ±-5%.
Preamplifier is faulty.	Indicated if ±5VDC power out of spec w/preamp attached, but in spec without preamp attached. Repair or replace preamp.
Electrode is faulty.	Replace electrode.

Interlock

This error message indicates that control has been stopped because the closed contact signal from a flow switch or level switch is now open and one or more control outputs have been programmed to interlock.

Possible Cause	Corrective Action
Flow has stopped, level too low.	May be a normal condition, otherwise restore flow or level.
Flow, level switch disconnected.	Reconnect.
Flow, level switch faulty.	Verify that switch closes using an ohmmeter. If not, repair or replace.
Controller faulty.	Verify that error message disappears if controller flow switch input is shorted. If not, repair controller.

Calibration Time

This message appears to prompt you to perform the routine maintenance of cleaning and calibrating the electrode. It does not appear based upon any analysis of the condition of the electrode. The frequency of calibration is set by the user in the "Days Between Cal" menu found in the "Sensor" menu. If you do not want to be prompted to perform a calibration, set this menu to "0".

Low Alarm

As above for "High Alarm", except that the pH/ORP reading is below the set point of one of the Control outputs that has been set up as a low alarm output. Refer to the possible causes and corrective actions listed above for the "High Alarm" error message.

Out Range Alarm

This error message appears if the pH/ORP reading is outside of the range selected for one of the Control outputs that has been programmed as an "Out of Range Alarm". Refer to the possible causes and corrective actions listed above for the "High Alarm" error message.

In Range Output

This error message appears if the pH/ORP reading is inside of the range selected for one of the Control outputs that has been programmed as an "In Range Alarm". Refer to the possible causes and corrective actions listed above for the "High Alarm" error message.

Temp Sensor Err

This error message appears if the signal from the automatic temperature compensation element disappears during operation. It is usually caused by a failure of the platinum RTD, or by a problem with the cabling or connections of the cable.

The Pt1000 RTD should read 1000 ohms at 0°C and 3.85 ohms/degree C above zero. At 25°C it should read 1096.25 ohms ±1%. A higher reading or open circuit (infinite resistance) may indicate a bad connection. A lower reading may indicate a shorted cable.

Measure the resistance at each connection between the sensor and the controller to determine if the sensor, cabling or connections are faulty.

Check Set Points

This is a normal display if you have changed the choice of sensor from pH to ORP or vice versa. The default set points for each choice is different, and will not match what you need for your application. Always select the sensor type before setting the control output set points.

8.0 SERVICE POLICY

The WPH/WDP Series pH/ORP Controller has a 2-year warranty on electronic components and a 1-year warranty on mechanical parts (keypad, terminal strip and relays).

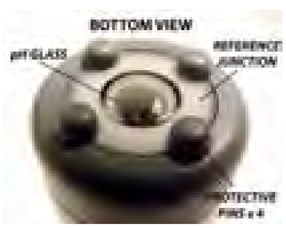
We stock circuit boards for immediate exchange after we have isolated the cause of the problem.

Factory authorized repairs that are received by next-day-air will be returned within 24 hours. Normal priority for returns is two weeks.

Out of warranty repairs or circuit board exchanges are done on a flat fee basis after the warranty is expired.

Flat-Surface, Self-Cleaning pH and ORP Electrodes

Insertion/wet-tap pH and ORP electrodes, assemblies and cables



S656CD

S656CD-ORP

Quick disconnect design saves time and money

Installs in seconds, no tools necessary

Flat-surface design resists coating

CPVC or PVDF construction

Available with or without ATC elements

Protective tip reduces pH glass breakage (S656CD)

Without the need for system shutdown for electrode maintenance, the insertion assembly allows pH measurements to be made in pressurized tanks and main lines. The assembly's adjustable insertion depth allows it to be placed in a turbulent flow region, enabling it to operate in the self-cleaning mode.

In abrasive applications, the electrode is best positioned flush with the pipe wall or tank wall. High suspended solids and viscous liquid pH measurements are simple with the insertion assembly and electrode pair. The specially designed internal makes the electrode mountable in virtually any direction, including inverted. A 1" full-port ball-valve (Sensorex BV-1) is recommended for installation.

New part number S656CD has four protective pads to reduce pH glass breakage. The S656CD replaces the 970283 which is now obsolete. In addition to the protective pad feature, the S656CD also includes our high performance acrylamide gel that provides longer life in many applications.

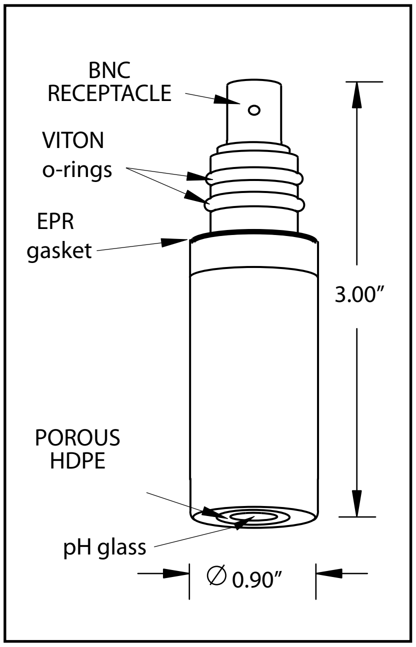
Specifications

Range	0-14pH (0-12pH without Na+ error) +/- 2000mV for ORP
Wetted Materials Body/Junction: CPVC/HDPE ("-CD" models) PVDF/ Porous PVDF ("-KD" models) Measuring Surface: pH glass (pH), Platinum or Gold (ORP)	
Temperature/Pressure Range (all models ending in "-CD") = 0C* - 75C (0-100psig), 80C (0-85psig) (all models ending in "-KD") = 0C* - 100C (0-100psig) **Note:** From 0 to 10C, electrodes will exhibit slower response time.	
Reference Type	Ag/AgCl, Sealed Double Junction
Installation	Any direction

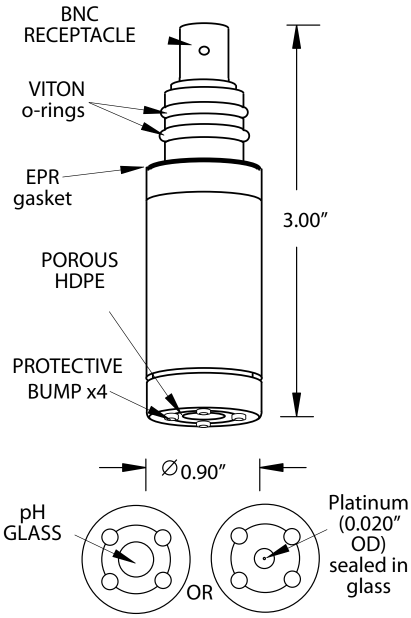
Parts covered by this product data sheet include:
S675, S676, S677, S675TC, S676TC, S677TC, S656CD, S655CD-ORP, S656CD-ORP, S675K, S675TK, S655KD, S655KD-HT, S655KD-ORP, S655KD-ORP-HT

CPVC and KYNAR ELECTRODES

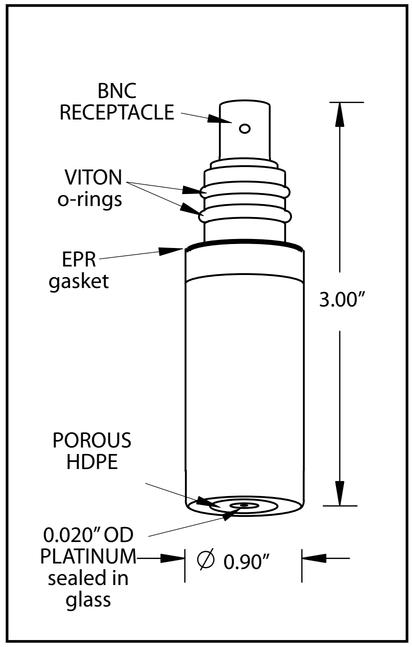
pH - S655CD, S655CD-HT, S655KD, S655KD-HT



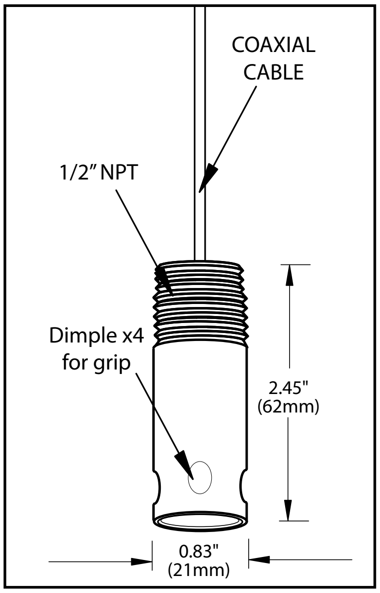
S656CD and S656CD-ORP



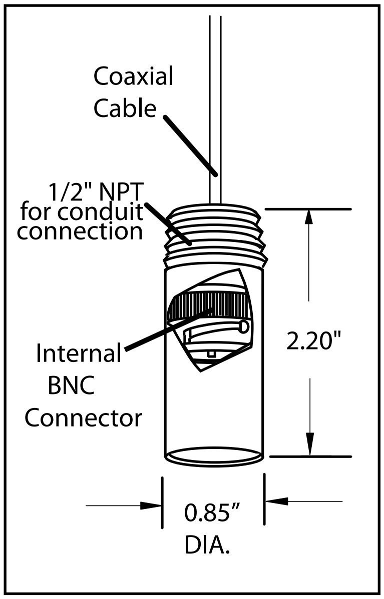
ORP-S655CD-ORP, S655KD-ORP, S655KD-ORP-HT



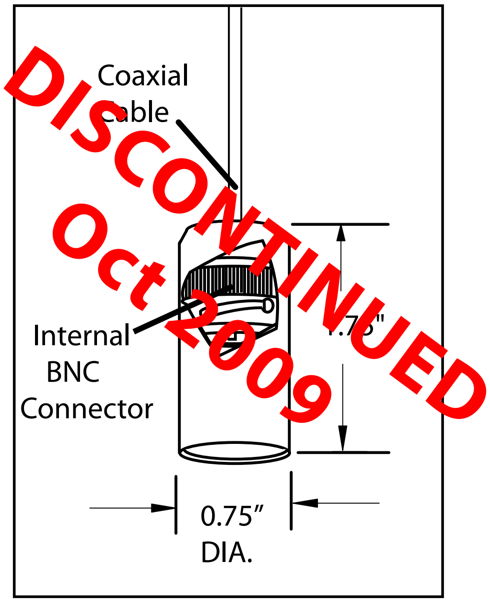
CPVC CABLES WITH CONDUIT CONNECTION (NO ATC) - S653



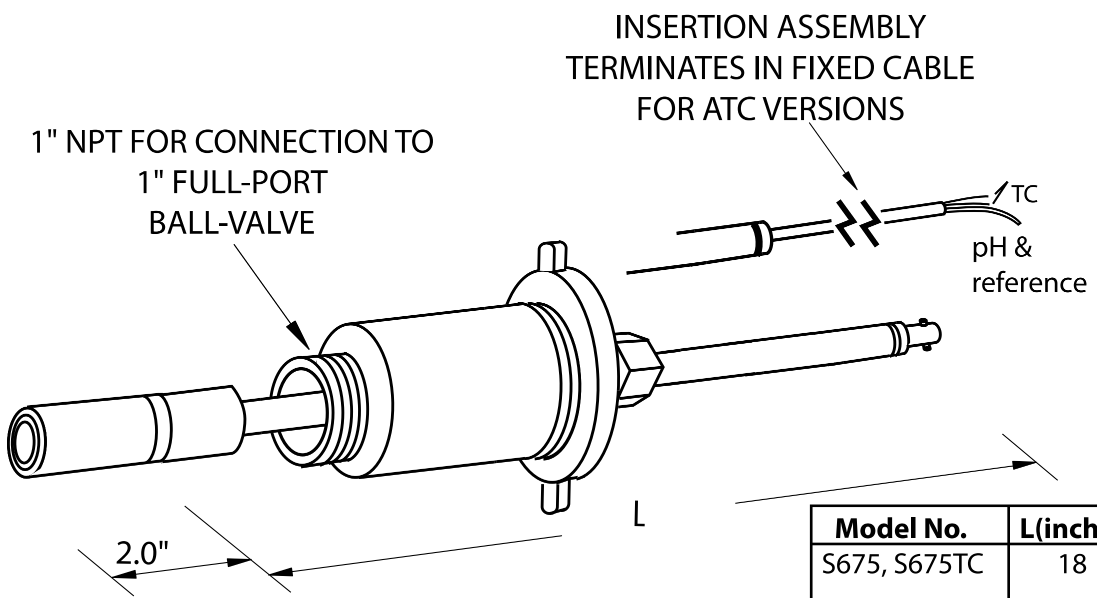
KYNAR CABLES WITH CONDUIT CONNECTION (NO ATC) - S653K



CPVC and KYNAR CABLES EXPOSED CABLE CONNECTION (NO ATC) - S648, S648K

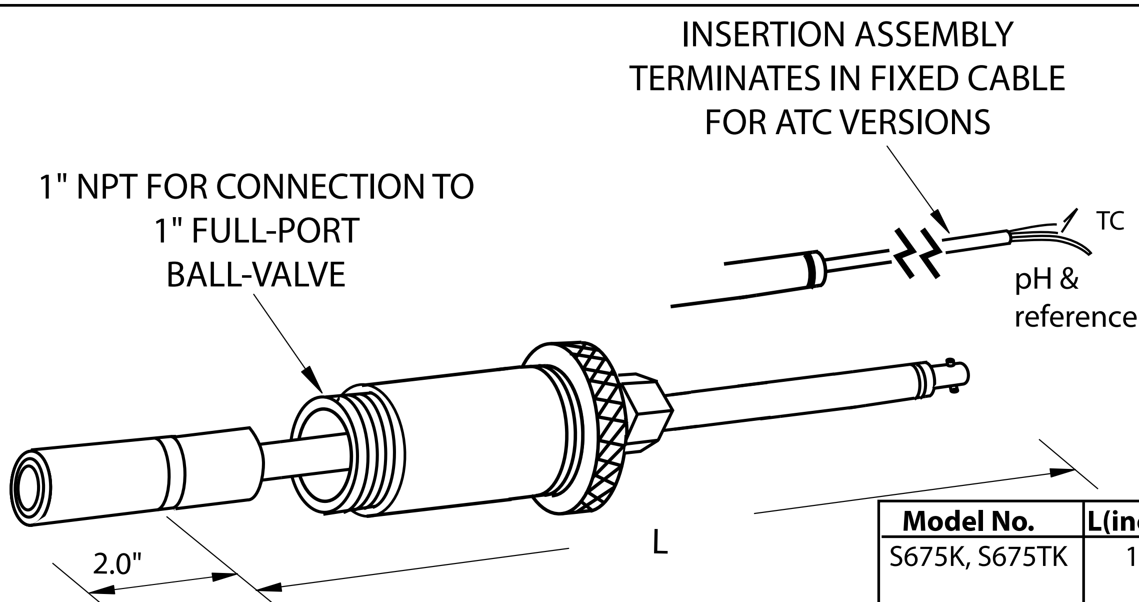


CPVC pH and ORP Insertion Assemblies (With and Without ATC) -S675, S675TC



Model No.	L(inches)
S675, S675TC	18
S676, S676TC	24
S677, S677TC	30

PVDF pH and ORP Insertion Assemblies (With and Without ATC)-S675K, S675TK



Model No.	L(inches)
S675K, S675TK	18
S676K, S676TK	24
S677K, S677TK	30

ORDERING INFORMATION

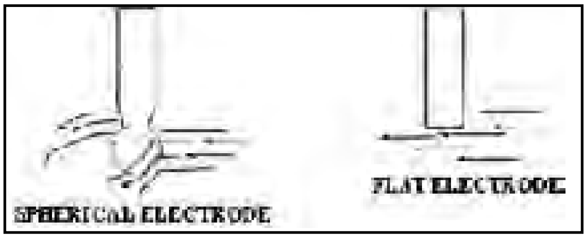
Systems without temperature compensation

ORDER 3 ITEMS	DESCRIPTION	CPVC PARTS	KYNAR (PVDF) PARTS
1. Select one insertion assembly	Insertion assembly 12" depth Insertion assembly 18" depth Insertion assembly 24" depth	S675 S676 S677	S675K N/A N/A
2. Select one electrode (pH or ORP)	pH combination electrode pH combination electrode protective tip pH combination electrode (high temp) ORP combination electrode ORP combination electrode (high temp)	S655CD S656CD S656CD S655CD-ORP S655CD-ORP-HT	S655KD N/A S655KD-HT S655KD-ORP S655KD-ORP-HT
3. Select one cable assembly	For conduit use	S653-"cable length"-"Connector"	S653K-"cable length"-"Connector"

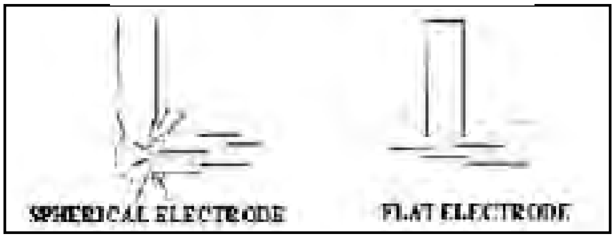
Systems with temperature compensation

ORDER 2 ITEMS	DESCRIPTION	CPVC PARTS	KYNAR (PVDF) PARTS
1. Select one insertion assembly	Insertion assembly 12" depth Insertion assembly 18" depth Insertion assembly 24" depth	S675TC-"TC TYPE"-"CABLE LENGTH"-"PH CONN"/"TC CONN" S676TC-"TC TYPE"-"CABLE LENGTH"-"PH CONN"/"TC CONN" S677TC"TC TYPE"-"CABLE LENGTH"-"PH CONN"/"TC CONN"	S675TK N/A N/A
2. Select one electrode (pH or ORP)	pH combination electrode pH combination electrode protective tip pH combination electrode (high temp) ORP combination electrode ORP combination electrode (high temp)	S655CD S656CD S656CD S655CD-ORP S655CD-ORP-HT	S655KD N/A S655KD-HT S655KD-ORP S655KD-ORP-HT

SELF-CLEANING OPERATION



ABRASION-FREE OPERATION

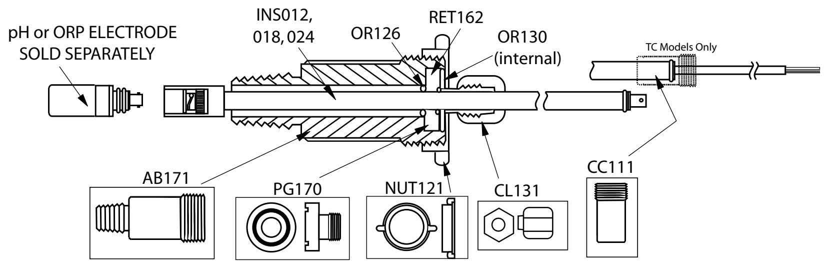


VISCOUS MATERIAL OPERATION

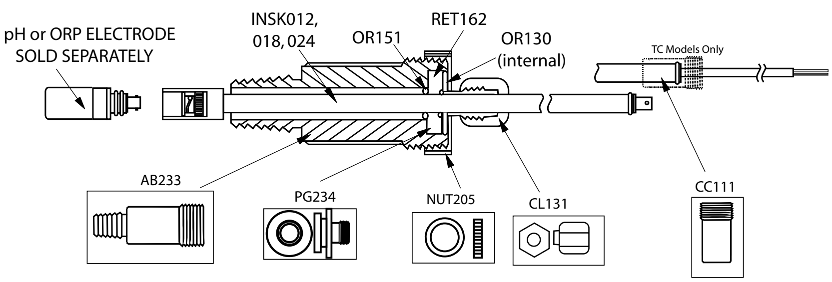
PRODUCT SPECIFICATION SHEET

ORDERING INFORMATION - REPLACEMENT PARTS

S675 INSERTION ASSEMBLY CUT AWAY
VIEW SHOWING REPLACEMENT PARTS



S675K INSERTION ASSEMBLY CUT AWAY
VIEW SHOWING REPLACEMENT PARTS



Description	CPVC Parts	KYNAR (PVDF) Parts
Insertion tube 12" depth (18" length)*	INS012	INS012K
Insertion tube 18" depth (24" length)**	INS018	INS018K
Insertion tube 24" depth (30" length)***	INS024	INS024K
Insertion tube 12" depth*, with ATC	INS012TC	INS012TK
Insertion tube 18" depth**, with ATC	INS018TC	INS018TK
Insertion tube 24" depth***, with ATC	INS024TC	INS024TK
Packing gland sliding seal, O-ring	OR130	OR130
Packing gland	PG170	PG234
Adapter Body	AB171	AB233
Retainer Nut	NUT121	NUT205
O-ring face seal (Large ring on PG170 and PG234)	OR126	OR131
Compression Nut and Ferrule	CL131	CL131
Steel Retainer Ring	RET162	RET162
Cable connection (1/2" NPT)	CC111	CC111

Sensorex
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Garden Grove, CA 92841 USA
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Fax: 714-894-4839
E-mail: info@sensorex.com
www.sensorex.com

Insertion/Wet-Tap pH and ORP Assembly (No ATC)

Product Instructions

Description of Parts

S675 Insertion assembly with 12" insertion depth, 18" total length.

S676 Insertion assembly with 18" insertion depth, 24" total length.

S677 Insertion assembly with 24" insertion depth, 30" total length.

Mechanical Installation

1. Unscrew the hex nut from the adapter body and retract rod into body until you hear a "CLICK" (FIG 1)

2. Unscrew the white or black nut from the adapter body and pull out the insertion tube and the parts mounted on it as shown in FIG. 2.

3. Thread body assembly into 1" full-port ball-valve (user supplied) as shown in FIG. 3. Be sure and seal threads with Pipe Thread Sealing Tape.

4. Install electrode into rod assembly by pushing electrode into large end of rod and rotate to align connector as shown in FIG. 4. Apply liberal amount of 0-ring grease to o-rings on electrode. After engaging connectors, rotate 1/4 run to lock electrode in place. ***DO NOT INSERT INSERTION ROD ASSEMBLY INTO SOLUTION WITHOUT ELECTRODE ATTACHED!!!***

5. Insert rod into body assembly until o-ring face seal seals against body. Then slide white nut over rod from back side and tighten onto body. (FIG. 5)

6. Open ball valve then loosen hex nut and push rod into desired position. Tighten nut to hold position. (FIG. 6)

7. Push cap cable assembly into insertion rod and rotate to align tabs of BNC receptacle on rod with grooves of BNC in cap.

CAUTION: MAKE SURE ELECTRODE IS ORIENTED AS SHOWN IN FIG 4. OR WITH GLASS POINTED DOWNWARD WHEN INSTALLING OR REMOVING SO THAT LIQUID CANNOT FLOW BACK INTO THE INTERNAL CONNECTOR!

Parts covered by this product data sheet include:
S675, S676, S677

FIG. 1

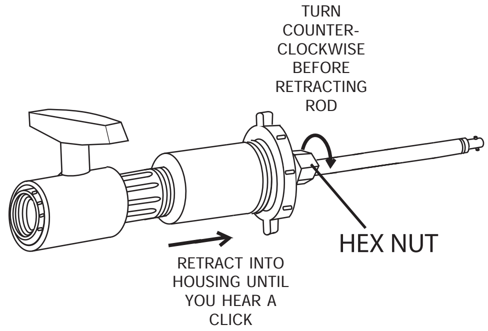


FIG. 2

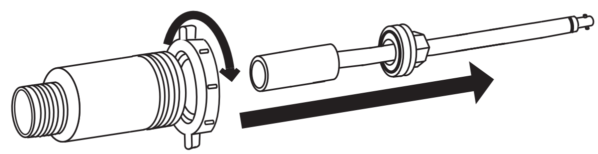


FIG. 3

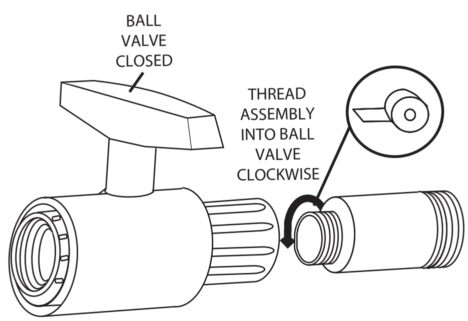
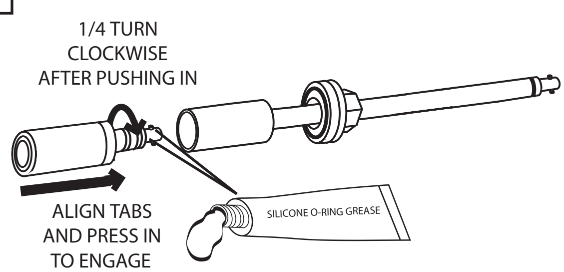


FIG. 4



Grease all o-ring seals before installation

Insertion/Wet-Tap pH and ORP Assembly (No ATC)

Product Instructions

Mechanical Removal

1. Remove cable assembly. This is reverse of step 7 (FIG. 7) in Mechanical Installation.

2. Loosen the hex nut and retract rode into body until you hear a "CLICK"

3. Remove the large white nut by turning counterclockwise and remove rod assembly with electrode attached as shown in FIG. 9.

4. Remove electrode by grasping rod in one hand and rotating the electrode cartridge 1/4 turn. Then pull the electrode and rod assembly apart as shown in FIG. 10.

Electrical Connections

The cable assembly connects the electrode to the pH pre-amplifier, transmitter or meter. It is usually supplied with connector(s) to match those of the pH meter.

FIG. 5

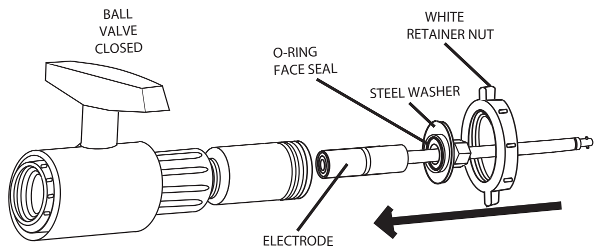


FIG. 6

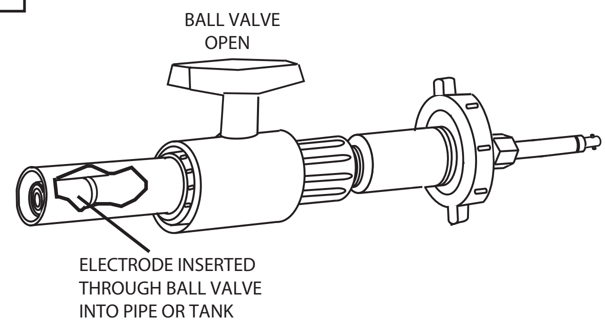


FIG. 7

S653 cap cable

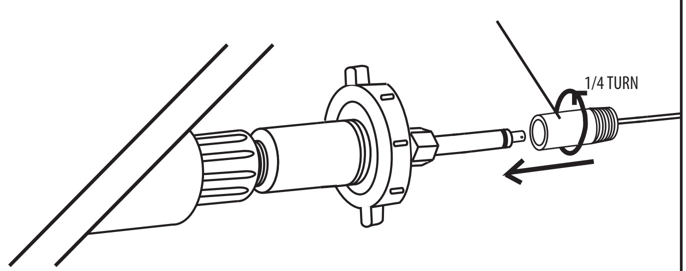
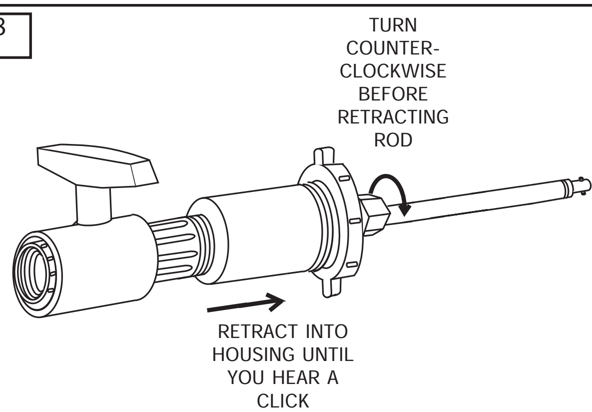


FIG. 8



Parts covered by this product data sheet include:
S675, S676, S677

Insertion/Wet-Tap pH and ORP Assembly (No ATC)

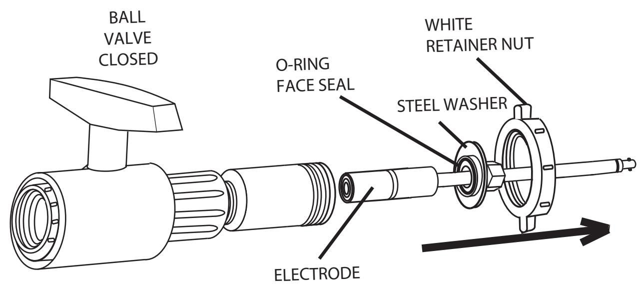
Product Instructions

Cable Considerations

To install the cable in conduit, a threaded cable cap assembly should be used (S653). Before the main rigid conduit a length of flexible conduit (at least 6"longer than the insertion rod should be used so that the insertion rod can completely clear the adapter body (large body with 1" NPT that threads into ball valve) for removal or the electrode.

Part number	Minimum Length Flexible Conduit
S675	24"(61cm)
S676	30" (76cm)
S677	36" (91cm)

FIG. 9

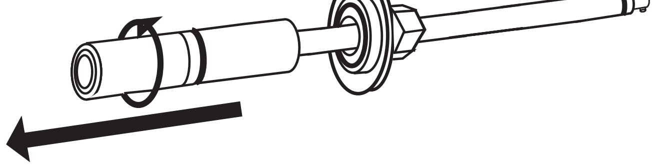


CAUTIONS:

1) DO NOT INSERT INSERTION ROD ASSEMBLY INTO SOLUTION WITHOUT ELECTRODE ATTACHED!!!
2) MAKE SURE ELECTRODE IS ORIENTED AS SHOWN IN FIG 4. OR WITH GLASS POINTED DOWNWARD WHEN INSTALLING OR REMOVING SO THAT LIQUID CANNOT FLOW BACK INTO THE INTERNAL CONNECTOR!

FIG. 10

1/4 TURN AND
PULL TO REMOVE



Parts covered by this product data sheet include:
S675, S676, S677

WEL Series

Walchem's WEL Series electrodes are cost-effective differential pH and ORP electrodes for industrial applications. They are modular in design with a rugged CPVC housing that contains the electronics; pH and ORP cartridges can easily be connected or replaced in minutes without tools. The cartridges feature a unique threaded interlock connection and a double o-ring seal, ensuring a watertight fit and secure seating at all times.

The optional differential preamplifier and temperature compensation element are in the housing, and are not thrown away when the electrode needs replacement. The electrode is powered by the controller it is connected to, so the signal is always preamplified and there are no batteries to go dead. A titanium solution ground rod integral to the housing enables the differential measuring technique. This results in prolonged electrode life and reliable measurement, resistance to stray voltages and currents or ground loop problems.

Summary of Key Benefit

- Differential preamp
- Universal mounting
- Easily replaceable electrode cartridges
- Electronics are not discarded with the electrode
- Optional ATC
- Easy to install
- Cartridge Styles:
  - Flat Surface
  - Bulb / Rod
  - HF Resistant
- Resistant to electronic noise, ground loops
- CE Performance & Safety Certifications

ORDER INFORMATION

WEL ☐ — ☐ ☐

cartridge housing mounting style

CARTRIDGE

PHF = Flat surface pH
PHB = Bulb pH
PHH = HF resistant pH
MVF = Flat surface ORP
MVR = Rod style ORP
PHLI = Flat pH, if sample is between 10 and 100μS

HOUSING

1 = Housing with preamplifier and PT1000 ATC, 20' cable with tinned leads
2 = Housing with preamplifier, 20' cable with tinned leads
3 = Housing with PT1000 ATC, 20' coaxial cable with BNC connector
4 = Housing, 20' coaxial cable with BNC connector

SPECIFICATIONS

pH/ORP Electrode

Range	0 to 14 pH (0 to 12 without sodium ion error ±1999 mV (ORP)
Response	95% in less than 5 seconds
Impedance:	
Cartridge	Not to exceed 1000mΩ over temp range
Housing	100Ω, preamplified versions Not to exceed 1000mΩ over temp range non-preamplified versions
Operating Pressure	100 psig

Temperature Range

Housings with preamplifier	32 to 158°F (0 to 70°C)
Housings without preamplifier	32 to 212°F (0 to 100°C)
PHF, MVF, MVR & PHLI	50 to 212°F (10 to 100°C)
PHB cartridges	32 to 212°F (0 to 100°C)
PHH cartridges	32 to 122°F (0 to 50°C)

Note: Electrode life is drastically reduced when used at temperatures above 122°F (50°C).

Wetted Materials of Construction

Electrode body	CPVC
Electrode reference	HDPE
O-rings	FKM
Electrode	Glass (pH) or platinum (ORP)

The WEL Series electrodes are in compliance with CE EMC standards.

MOUNTING STYLE

1 = Submersion mounting
2 = In-line mounting (3/4" NPTF tee)
3 = Metric in-line mounting (G 1¼ male adapter)

W A L C H E M
IWAKI America Inc.

HIGH PRESSURE & HIGH TEMPERATURE pH & ORP ELECTRODES

The 102029 pH electrode and 102963 ORP electrode are designed to function where other electrodes cannot. In room temperature water, they can handle up to 500 psi. In low pressure installations, they can handle up to 275°F (135°C) without melting.

In all cases, pH/ORP electrode life will be maximized by operating at room temperature, and the expected life span at temperatures above 140°F (60°C) will be short. But if low temperature operation is impossible, these electrodes will fit the bill.

Summary of Key Benefit

- Higher temperature rating
- Steam sterilizable
- High operating pressure
- Booted BNC, waterproof cable

ORDER INFORMATION

102027 Mounting Gland, SS, 3/4" NPT, High Temperature/Submersion (pH/ORP)
102028 Mounting Gland, SS, 3/4" NPT, High Temperature/In-line (pH/ORP)
102029 Electrode, pH, High Temperature, 10 ft. cable
102963 Electrode, ORP, High Temperature, 10 ft. cable

SPECIFICATIONS

Reference cell	Double junction, Na2SO4 + KCl / Ag - Ag - AGCl
Cable lead	10 FT. (3.05 m) length with BNC connector
Membrane impedance (pH)	150 megaohms at 78°F (25°C)
Zero potential (pH)	0 mV ±12 @ pH 7
Operating Temperature	23° to 275°F (-5° to 135°C) @ 200 PSI (1.38 MPa)
Operating Pressure	500 PSI (3.45 MPa) @ 77°F (25°C)
Range	0 to 14 pH, -1000 to 1000 mV
Output voltage (pH)	58.7 ±0.3 mV per pH unit
Drift	Less than 2 mV per week
Sodium error (pH)	Less than 0.5 pH unit typical in 0.1 Na+ @ 12.8 pH

Dimensions
5" (127 mm) length x 0.47" (12 mm) diameter
Gland thread size 3/4" NPTM (3/4" G)

Materials of Construction
PFA junction
Glass membrane (pH and ORP)
Platinum (ORP)
Polymer body
SS mounting gland

pH/ORP PREAMPLIFIER

The Walchem preamplifier offers a watertight way to extend the cable of any conventional combination pH/ORP electrode as far as 1000 feet (305 meters). Simply connect the electrode to the BNC connector, the optional ATC cable to the terminal block inside and run cable to the controller.

Walchem controllers provide the ±5VDC power required to operate the preamp. For connection to controllers that have only a BNC connector for the sensor input, specify the 190829 version, which includes a male BNC to connect to the controller end of the cable.

Summary of Key Benefit

- NEMA 4X, epoxy coated, die-cast aluminum wall mount enclosure
- Boosts signal for reliable transmission up to 1,000 ft (305 m) via 22 AWG wire
- No temperature simulation resistor required when used with Walchem controllers

SPECIFICATIONS

Power	±5 VDC, 5mA maximum
Input Impedance	1 x 1013 ohms
Connections	BNC for pH/ORP Screw terminals
Overall Dimensions	4 7/8" (L) x 3 1/8" (W) x 2 1/4"(H)
Mounting Dimensions	4 7/16" (L) x 2 1/16" (H)
Enclosure	Grey epoxy coated Aluminum NEMA 4X

ORDER INFORMATION

190783 pH/ORP Preamplifier
190829 pH/ORP Preamplifier with additional BNC connector for controller connection
100084 Four conductor cable for use with manual temperature compensation
102535 Six conductor cable for use with automatic temperature compensation

WALCHEM

IWAKI America Inc.

WEL pH/ORP Electrodes Instruction Manual

Five Boynton Road   Hopping Brook Park   Holliston, MA 01746   USA

TEL: 508-429-1110   FAX: 508-429-7433   WEB: www.walchem.com

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Notice

5 Boynton Road, Holliston, MA 01746 USA
(508) 429-1110

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Statement of Limited Warranty

WALCHEM warrants equipment of its manufacture, and bearing its identification to be free from defects in workmanship and material for a period of 24 months for electronics and 12 months for mechanical parts and electrodes from date of delivery from the factory or authorized distributor under normal use and service and otherwise when such equipment is used in accordance with instructions furnished by WALCHEM and for the purposes disclosed in writing at the time of purchase, if any. WALCHEM's liability under this warranty shall be limited to replacement or repair, F.O.B. Holliston, MA U.S.A. of any defective equipment or part which, having been returned to WALCHEM, transportation charges prepaid, has been inspected and determined by WALCHEM to be defective. Replaceable elastomeric parts and glass components are expendable and are not covered by any warranty.

THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, EITHER EXPRESS OR IMPLIED, AS TO DESCRIPTION, QUALITY, MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE OR USE, OR ANY OTHER MATTER.

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Oct 2012

Table of Contents

1.0 Operation

The number of parts required and the installation will vary with the model ordered. The electrode consists of a replaceable pH or ORP electrode cartridge, an electrode housing which may also contain a temperature compensation element and/or a reliable differential - type preamplifier with solution ground, and a mounting nut and adapter for in-line mounted models.

Electrode Cartridges:
There are four pH electrode cartridge choices. Each is best suited for specific applications:

WEL-PHF-NN is a flat surface glass pH electrode which will function well in almost any application, and will perform especially well if the solution tends to coat an electrode with solids or oils.

WEL-PHB-NN is a bulb-type glass pH electrode which will function well in clean chemical applications.

WEL-PHH-NN is a flat surface glass pH electrode which is highly resistant to attack by acidic fluoride solutions that would quickly etch the glass of a standard pH electrode.

WEL-PHLI-NN is a flat surface glass pH electrode with a special gel suitable for use in low ionic strength water, with conductivity between 10 and 100 µS/cm.

There are two choices of ORP electrode cartridge.
The WEL-MVF-NN is a flat surface platinum electrode which will work in almost any application.
The WEL-MVR-NN uses a platinum rod and is used where the oxidizer level is below 0.25 mg/l.

Electrode Housings:
There are six housings available, which are selected based upon the type of electrode cartridge used, and the type of instrument to be connected:

The 102581 housing contains a Pt1000 automatic temperature compensation (ATC) element and differential preamplifier with solution ground. This housing is specified in pH applications when the error due to changing temperature is significant to your process (see table below), and the instrument that the electrode will connect to either does not have an integral preamplifier (such as the WPH or WNI series) or if the distance between the instrument and the electrode will exceed 20-30 feet. It should not be specified for ORP applications, since no ATC is used. It is supplied with a 20 ft. cable with tinned leads.

The 102758 housing is identical to the 102581 housing except it uses a Pt100 ATC element.

The 102606 housing contains only the differential preamplifier with solution ground, and does NOT contain the Pt1000 ATC element. This housing is specified when the error due to temperature is insignificant to your process, and the instrument you will attach does not have a preamplifier in it (such as the WPH or WNI series), or is more than 20-30 feet away. It would also be used with an ORP cartridge, since there is no ATC used in ORP applications. It is supplied with a 20 ft. cable with tinned leads.

The 102582 housing contains only the Pt1000 ATC element with solution ground, but does NOT contain the preamplifier. This is used in pH applications where the error due to temperature is significant to your process, and the instrument to be attached contains an integral preamplifier (such as the W-250/260 or W-130/230 series), and will be located within 20-30 feet of the electrode. It should not be used in ORP applications. It is supplied with a 20 ft. cable with a BNC connector for the pH signal and tinned leads for the ATC and solution ground signals.

The 102759 housing is identical to the 102582 housing except it uses a Pt100 ATC element.

The102607 housing contains neither an ATC element, nor the preamplifier. It should be used in pH or ORP applications where the error due to temperature is insignificant to your process, and the instrument to be attached contains an integral preamplifier (such as the W-250/260 or W-130/230 series), and will be located within 20-30 feet of the electrode. It is supplied with a 20 ft. coax cable with a BNC connector.

pH Temperature Error Table:

°C	2	3	4	5	6	7	8	9	10	11	12
5	.30	.24	.18	.12	**.06**	0	**.06**	.12	.18	.24	.30
15	.15	.12	**.09**	**.06**	**.03**	0	**.03**	**.06**	**.09**	.12	.15
25	0	0	0	0	**0**	0	**0**	0	0	0	0
35	.15	.12	**.09**	**.06**	**.03**	0	**.03**	**.06**	**.09**	.12	.15
45	.30	.24	.18	.12	**.06**	0	**.06**	.12	.18	.24	.30
55	.45	.36	.27	.18	.09	0	.09	.18	.27	.36	.45
65	.60	.48	.36	.24	.12	0	.12	.24	.36	.48	.60
75	.75	.60	.45	.30	.15	0	.15	.30	.45	.60	.75
85	.90	.72	.54	.36	.18	0	.18	.36	.54	.72	.90

Mounting Adapters:
For in-line applications, included will be the mounting adapter that fits into a standard 1¼" NPT tee, and the nut that secures the housing to the adapter.

For submersion applications, all that is required is a standard 1" NPTF threaded coupling and the appropriate length of 1" pipe. These parts are supplied by the user.

2.0 Installation

General Guidelines
Note: After removing the electrode from the soaker bottle, be sure to remove the large o-ring from the electrode. This o-ring prevents soaker solution from leaking out of the bottle and is not part of the electrode.

Instructions for mounting the electrode into the process solution will vary greatly with the type of electrode and the circumstances that are encountered in your application. Here are some general guidelines to assist you. Refer also to the typical installation drawings.

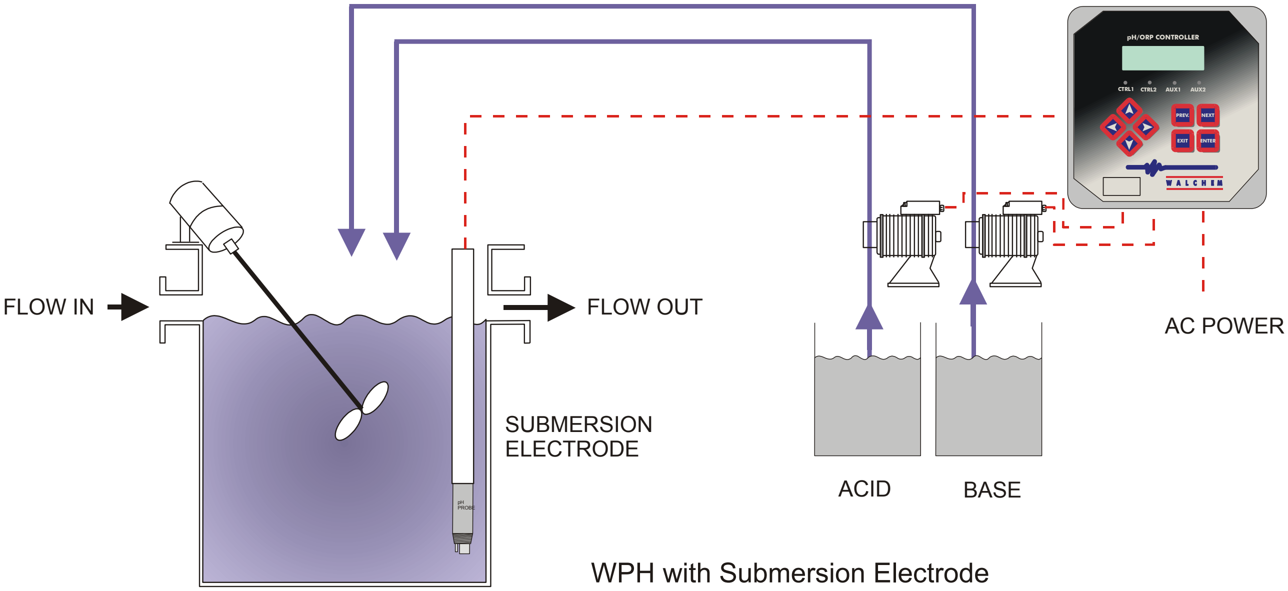
The electrode should be mounted such that the measuring surfaces will always stay wet. If the electrode dries out, it will respond slowly to changing pH/ORP values for 24 hours, and if dried out repeatedly, will fail prematurely.

For submersion applications, mount the electrode below the minimum solution level. If the tank will be completely drained, plan on removing the electrode and storing it in tap water (NOT DI water) or pH 4 buffer solution while the tank is empty. If this is undesirable, a recirculation loop may be installed and the electrode mounted in-line.

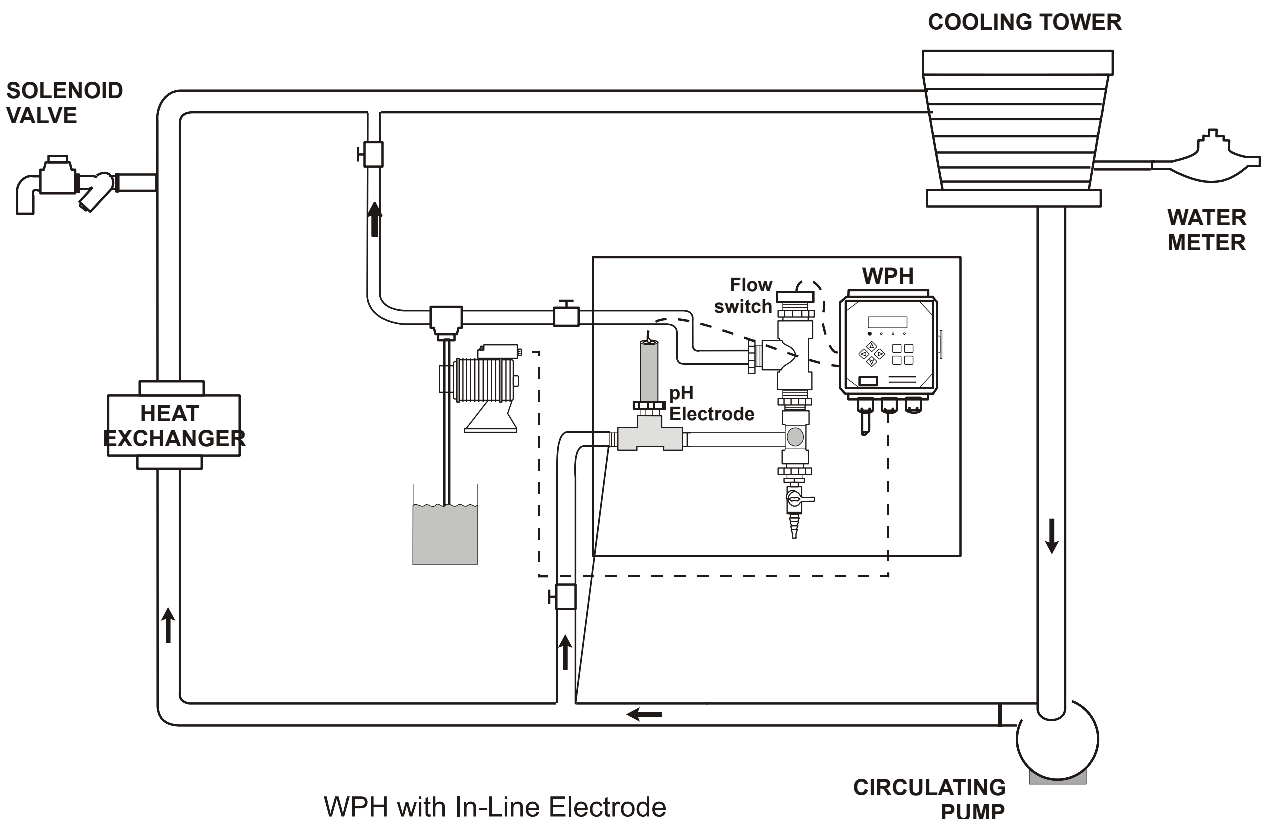
For in-line applications, where the electrode is installed in a pipe, the electrode should be placed on the discharge side of the pump (under positive pressure). A "U" trap should be installed so that if the flow stops, the electrode is still immersed in the solution. If the flow through the pipe can not be stopped to allow for cleaning and calibration of the electrode, then the electrode should be placed in a by-pass line with isolation valves to allow for electrode removal. Install the electrode vertically, with the measuring surface pointing down, at least 5 degrees above horizontal. (Refer to Installation drawings)

The electrode should be installed in an area where there is good solution movement and where it will respond rapidly to chemical additions. The placement of the electrode relative to the placement of chemical replenishment, along with the quality of the mixing, and the replenishment pump flow rate are all critical to accurate process control.

WPH Installation



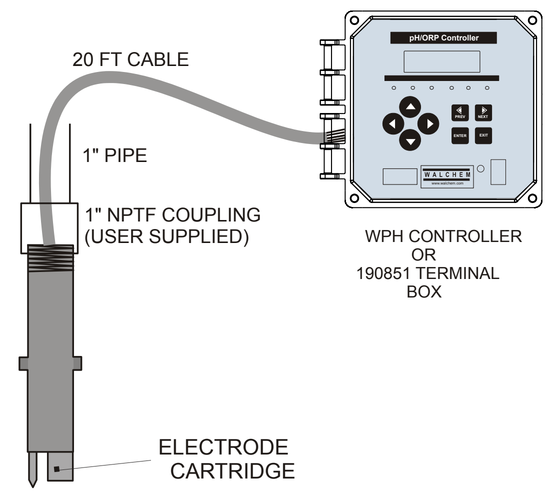
WPH with Submersion Electrode



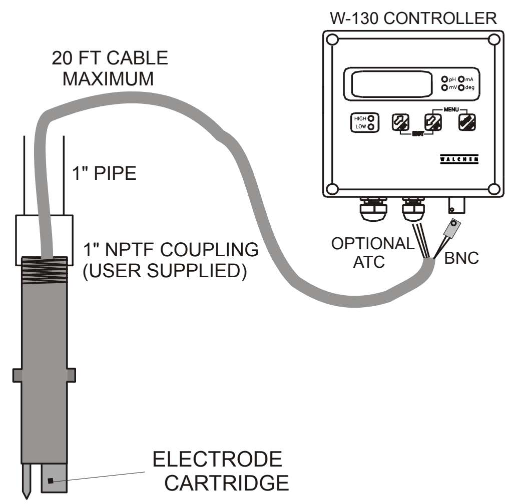
WPH with In-Line Electrode

Electrode Assembly

For submersion applications, attach the threaded end of the housing to a 1” NPTF coupling and appropriate length of 1” pipe. This should be sealed to prevent the solution from contacting the electrode housing cable. Remove the protective cap from the end of the electrode cartridge, and thread the cartridge into the housing until it is hand tight. The o-ring should seat against the housing.

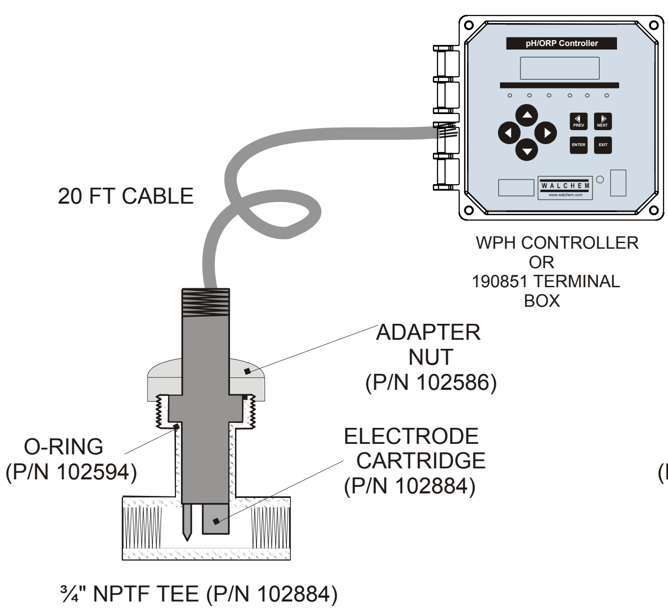


ELECTRODE HOUSING WITH PREAMP
SUBMERSION MOUNT

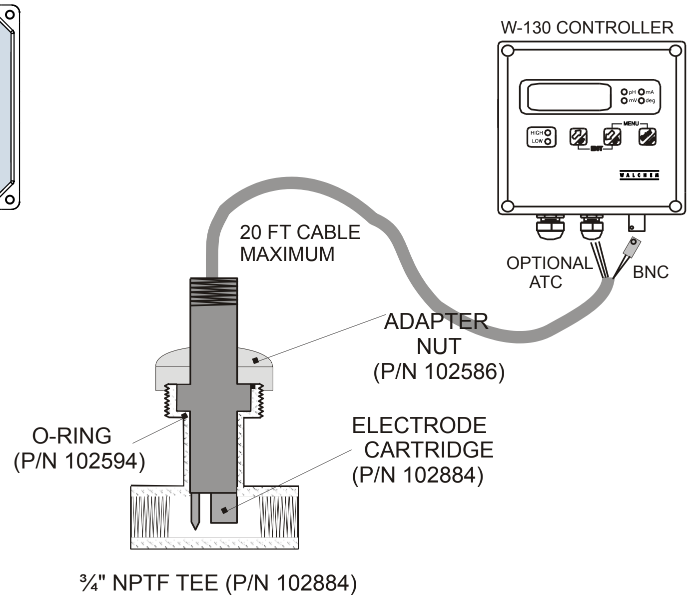


ELECTRODE HOUSING WITHOUT PREAMP
SUBMERSION MOUNT

For in-line applications, feed the electrode housing cable through the adapter nut. Remove the protective cap from the end of the electrode cartridge, and thread the cartridge into the housing until it is hand tight. The o-ring should seat against the housing. Place the large o-ring into the mounting adapter groove, then place the electrode housing into the tee, and thread the adapter nut onto the tee until it is hand tight.



ELECTRODE HOUSING WITH PREAMP
IN-LINE MOUNT



ELECTRODE HOUSING WITHOUT PREAMP
IN-LINE MOUNT

Wiring Instructions

For housings that contain the integral preamplifier, attach the 7-conductor cable directly to the controller:

Drain:	Earth Ground
Orange:	VpH (pH +)
Wht w/Orn stripe:	Com (pH -)
Green:	TC + (optional) TC= Temperature Compensation
Wht w/Grn stripe:	TC - (optional)
Blue:	+5 VDC
Wht w/Blu stripe:	- 5 VDC

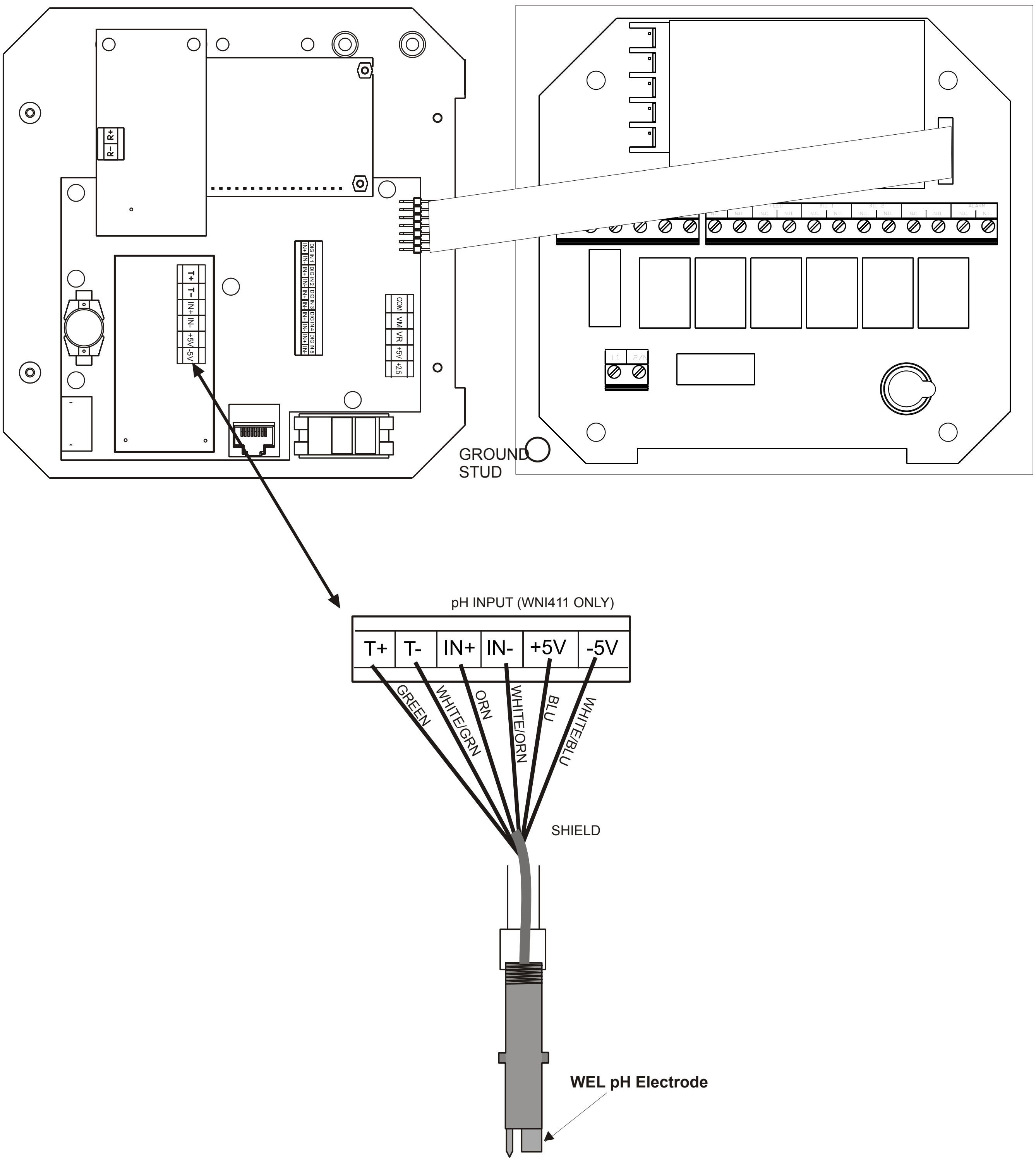
If the required cable length exceeds the 20 feet that is supplied, wire the housing to a 190851 terminal box, then use p/n 102535 cable to reach the instrument.

For housings that do not contain the integral preamplifier, attach the male BNC connector on the housing to the female BNC connector on the instrument, and the optional temperature wires to the temperature input terminal strip on the instrument:

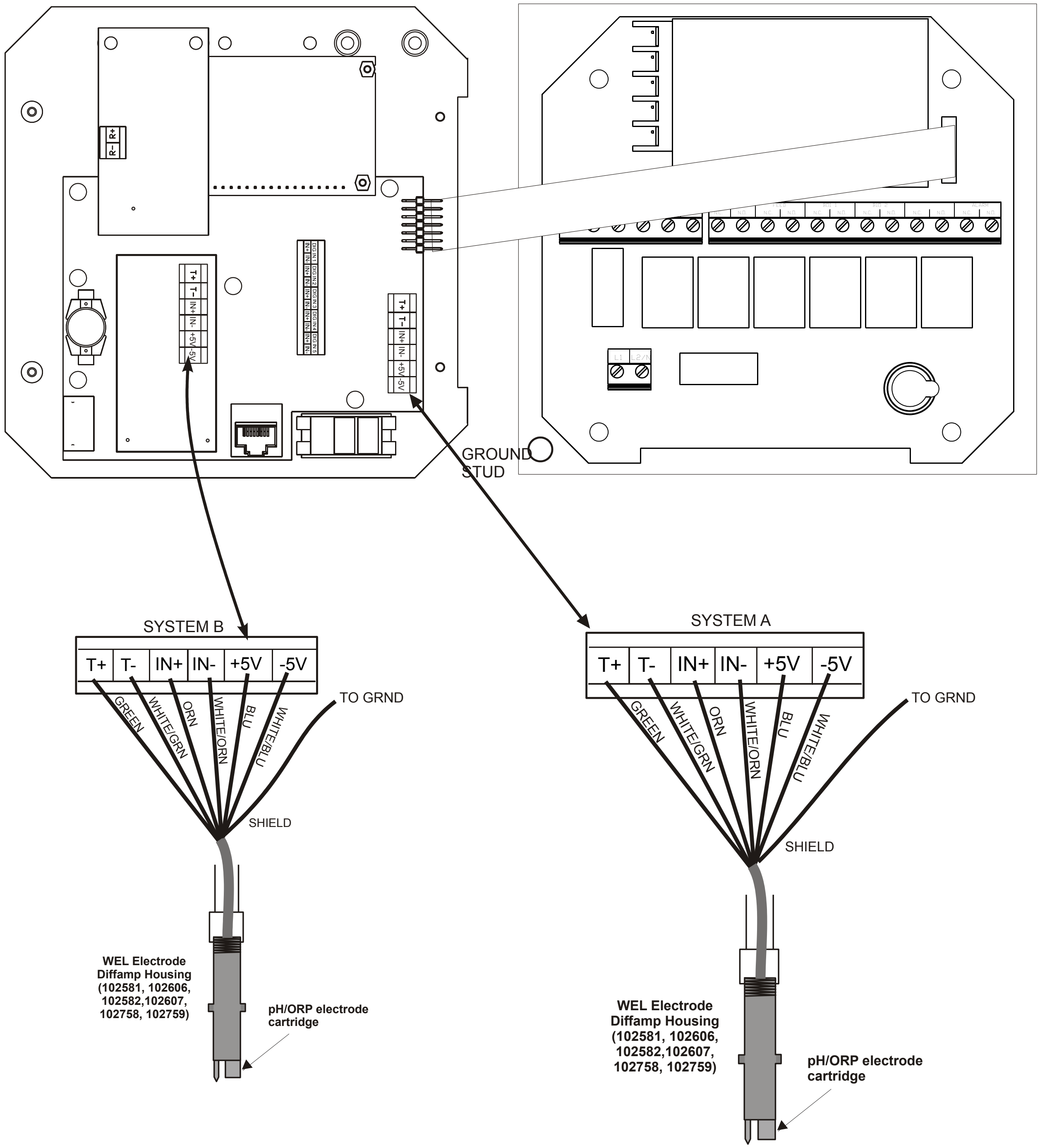
Grn:	Earth Ground
Red	TC (polarity not critical for TC)
Blk:	TC (polarity not critical for TC)
	[TC= Temperature Compensation]

The non-amplified signal is extremely sensitive! Never cut, splice or otherwise harm the integrity of the coaxial cable or BNC connector! If the distance between electrode and instrument exceeds 20 feet, use the housing that contains a preamplifier, or purchase an externally mounted preamplifier.

Wiring to a WNI411/WDT410 Series Controller



Wiring to a WPH/WDP400 Series Controller



3.0 Maintenance

The Combination pH/Reference Electrode or ORP (REDOX) Reference Electrode is ruggedly made and easy to use. Because the pH responsive glass bulb or flat surface is relatively thin, care should be taken so that the bulb does not become scratched or broken. It is also important that ORP measuring surfaces are not scratched or gouged. The suggestions in this sheet are intended to help avoid these problems.

The built-in sealed reference design of this electrode eliminates the need to add filling solutions and minimizes reference dryout. This design feature also allows the electrode to be used in pressurized systems (refer to specification sheets or consult the factory for maximum pressure/temperature limit information).

Important Considerations

1. The pH Electrode is shipped in a plastic bottle or cap containing a solution of 4 buffer and potassium chloride. ORP (REDOX) Electrodes are shipped in caps containing a piece of cotton wetted with tap water. The electrode should remain in the bottle or cap until it is used. If the electrode is used infrequently, the bottle or cap and its solution should be saved and the electrode stored in it.

2. Electrodes are a form of a battery and have limited shelf lives. Electrodes in inventory should be rotated so that older electrodes are used first.

3. Vigorous stirring brings a sample, buffer or rinse solution to the measuring surface more quickly and will improve speed of response. Care must be taken to keep the electrode's measuring surface from striking a surface and getting scratched or broken.

4. After exposure to a sample, buffer or rinse solution, carryover can be minimized by blotting - never by wiping - the electrode with a clean, non-abrasive paper or a clean cloth towel.

5. As a rinse solution, use a part of the next sample or buffer which is to be measured. This action also will minimize contamination from carryover.

6. When calibrating, use a buffer close in value to that expected from the sample for 1 point calibrations or as the first buffer for 2 point calibrations (see below). This action will minimize span errors.

7. Readings stabilize faster in some solutions than others; allow time for the reading to stabilize. In general, with new electrodes stable readings in buffers are obtained in 10-15 seconds.

8. All pH electrodes age with time. Aging is characterized by shortened span and slower speed of response. Aging is best detected by the 2 point calibration method. If the pH meter has manual or microprocessor slope (span) controls, the controls can be adjusted to compensate for electrode span errors (but will not affect the speed of the response).

9. Electrodes should be replaced when their readings cannot be corrected by the meter's controls and/or when their speed of response is too slow for the application for which they are being used. The frequency of electrode replacement is a function of the application; electrodes operating in hot liquids at very high or very low pH values will have shorter lives than those operating at neutral pH and ambient temperature.

10. Coatings on an electrode's surface prevent new liquids from contacting an electrode's measuring surface and can mimic the effects of electrode aging. Before concluding that an electrode needs replacing, check the surface for coatings.

11. Temperature affects electrode readings in two ways. First, the output of an electrode varies with temperature. For pH electrodes this effect can be corrected by manual or automatic temperature compensation (ORP/REDOX readings are not correctable for the effect of temperature changes). Second, the real pH or ORP value, independent of the electrode measuring the value or the use of temperature compensation, is temperature dependent. This fact means, for example, that the readings at 25°C and 75°C will be (and, in fact are) different.

CALIBRATION

As a rule, follow the procedure shown in the pH Meter's Instruction Manual. These procedures will vary depending on whether the meter is a simple type with manual adjustments, a micro-processor type or a pH transmitter.

FREQUENCY OF CALIBRATION

The frequency of calibration is a function of many factors. These factors include:

1. The accuracy required by the application.
2. The value of the off-specification product versus the cost of calibration.
3. The coating or abrasive nature of the application.
4. The stability of the pH Electrode and pH Meter as a system.

The frequency of calibration is really determined by experience. At a new installation, calibration might initially be checked every few hours or shift with the calibration changes noted in a log. As a pattern of longer stability is found, the time between calibration checks can be increased to once a day or once a week. Although the frequency of calibration is solely the responsibility of the user, once a week is the longest recommended interval between calibrations.

SYSTEM CALIBRATION CONCEPTS

The pH Electrode and the pH Meter should always be calibrated as a system. Electronic calibration of a pH Meter with a pH signal simulator checks the meter only and does not correct for imperfections of the pH Electrode. Even if perfect when new, the performance of pH electrodes varies with time, usually in an unpredictable way. When changing electrodes or connecting an electrode to a different pH meter, re-calibration must be performed.

SINGLE POINT CALIBRATIONS

Single point calibrations involve the use of one pH buffer. They are the easiest to make but can provide misleading results. They should only be used for quick checking from time to time.

TWO POINT CALIBRATIONS
As their name implies, 2 point calibrations use 2 pH buffers: for example, buffers 7.00 and 4.00 or buffers 7.00 and 10.00. Two point calibrations correct for the pH electrode's offset and span errors. Since both the offset and span vary with time, the 2 point method is the preferred one.

GRAB SAMPLE CALIBRATIONS
The Grab Sample Calibration method is used when it is difficult or undesirable to remove an electrode from a system. This method involves obtaining a sample of the liquid being measured and noting the meter's reading at that time. The sample's reading is obtained by use of a calibrated lab or portable meter and that reading is compared to that of the on-line meter. The on-line meter is adjusted by the difference between the readings. It is important to use the difference between the readings because the system's reading may have changed in the intervening time. It is important that the sample being measured by the lab meter be at the process temperature or erroneous results may occur (See #11 on the previous page).

CALIBRATION PROCEDURES
Stepwise calibration procedures are noted in the pH Meter's Instruction Manual. The following suggestions will help make calibrations as accurate as possible:

1. Before placing the electrode in a new buffer, use an absorbent paper towel or clean absorbent cloth to blot, not wipe, off any liquid that clings to the electrode. This action will minimize carry-over that could contaminate the buffer.

2. Always use fresh buffers. Safely dispose of the buffers after they have been used for calibration. Do not return them to their bottles; this action could contaminate the buffers.

3. Stir the electrode in the buffer to make certain that the fresh buffer quickly reaches the electrode's measuring surface.

INTERMITTENT OPERATION
Some facilities are only operated part of the time. When out of operation, electrodes must not be allowed to be exposed to air and become dry. Electrodes should be removed from such systems and stored in their bottles and caps or in a beaker, filled, preferably with 4 buffer. In some instances, power to the meter is shut off; this condition can be harmful to the electrodes. Electrodes should be disconnected from un-powered meters.

ELECTRODE CLEANING

Coating of an electrode's measuring surface can lead to erroneous readings including shortened span and slow response times. The type of coating determines the type of cleaning technique.

Soft coatings can be removed by vigorous stirring, by use of a squirt bottle, or very carefully, by gently wiping with a soft, clean non-abrasive paper or cloth. Hard coatings should be chemically removed. The chemical used to remove the coating should be the least harsh chemical that dissolves the coating in 1 or 2 minutes and does not attack the electrode's materials of construction. For example, a calcium carbonate coating might be removed with 5% HCl (muriatic acid).

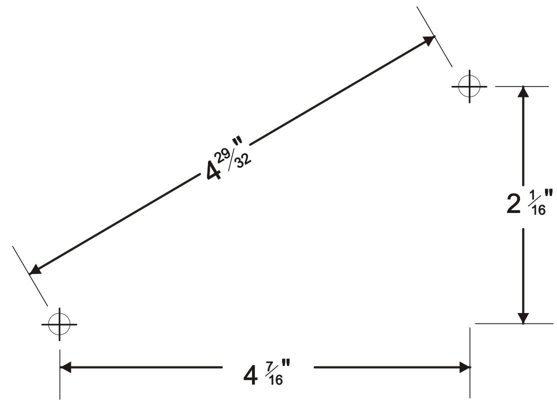
Oily or organic coatings are best removed with detergents or an appropriate solvent that does not attack the electrode's materials of construction. For example, isopropyl alcohol might be used but acetone should be avoided if the electrode's body is made of CPVC.

Note: When using chemicals or solvents, care should be taken and appropriate eye, face, hand, body and/or respiratory protection should be used.

Never abrade or sand a pH electrode's surface. However, the measuring surface of an ORP/REDOX electrode may be gently abraded by use of 600 grade wet silicon carbide paper, jewelers rouge or very fine steel wool.

WALCHEM
Iwaki America Inc.

pH/ORP PREAMPLIFIER INSTALLATION AND WIRING
P/N 190783



MOUNTING

- Two mounting holes are under enclosure cover
- Mount enclosure using two #6 screws (not provided)

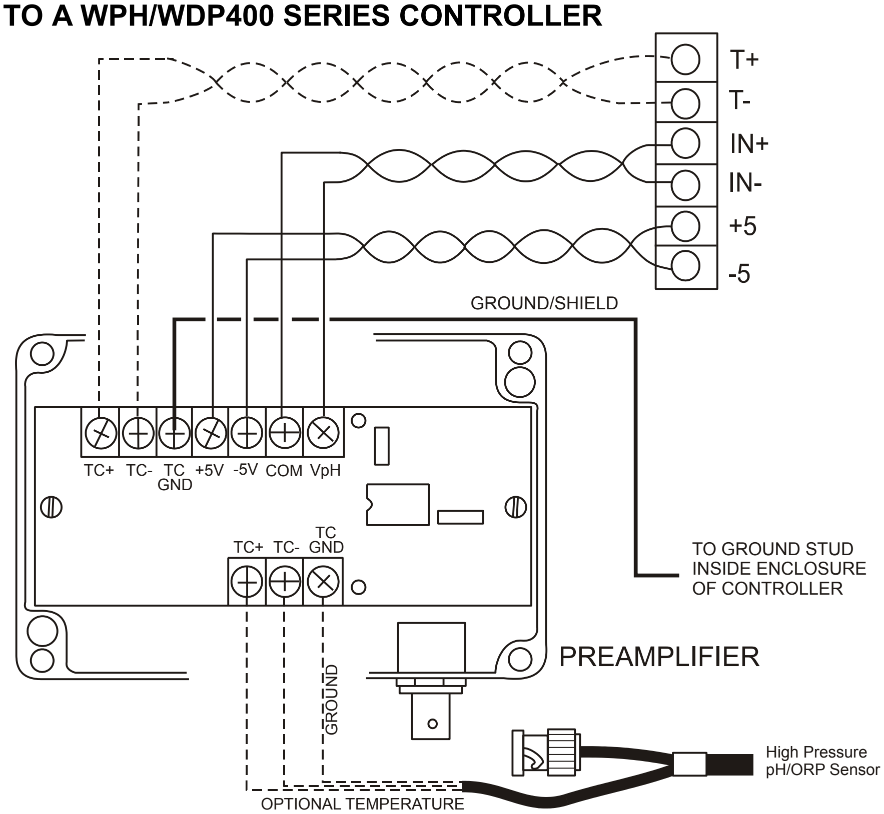
PROPER SHIELDING METHODS

Proper shielding and grounding of the signal wires is critical to obtaining a stable reading. Use only 24 AWG shield twisted pair cable to connect the preamp to the controller.

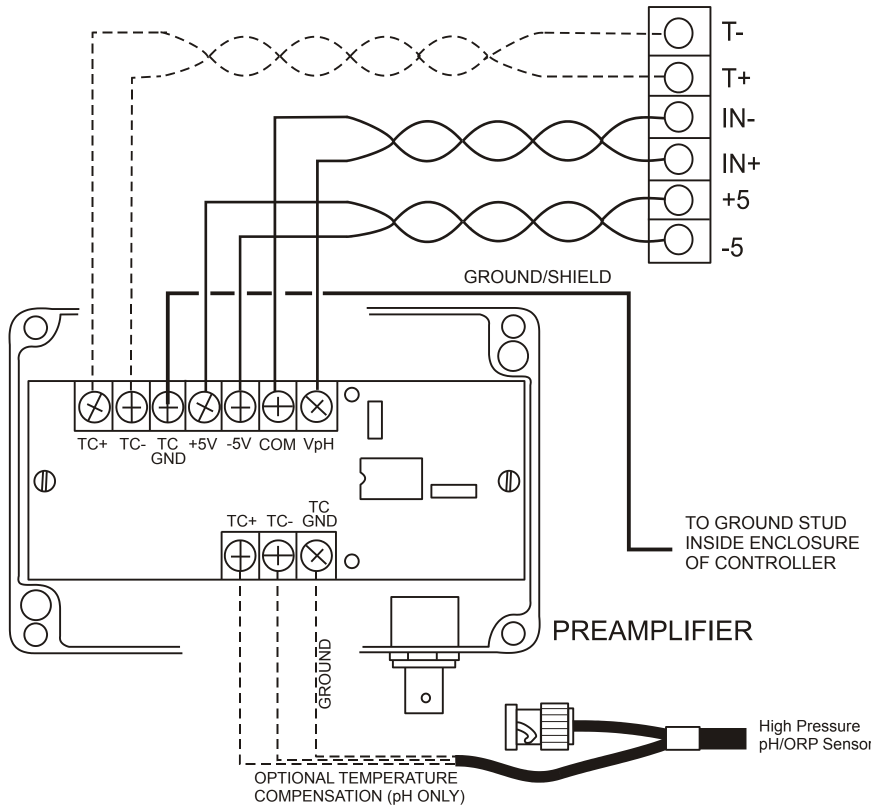
If your pH/ORP electrode does not have a solution ground wire
Or
If your pH/ORP electrode has a solution ground wire and immersed in a non-grounded solution:
Connect the shield drain wire to both the TC GND terminal in the preamp and the ground stud inside the enclosure of the controller, as shown below.

If your pH/ORP electrode has a solution ground wire and immersed in a grounded solution:
Connect the shield drain wire only to the TC GND terminal in the preamp.

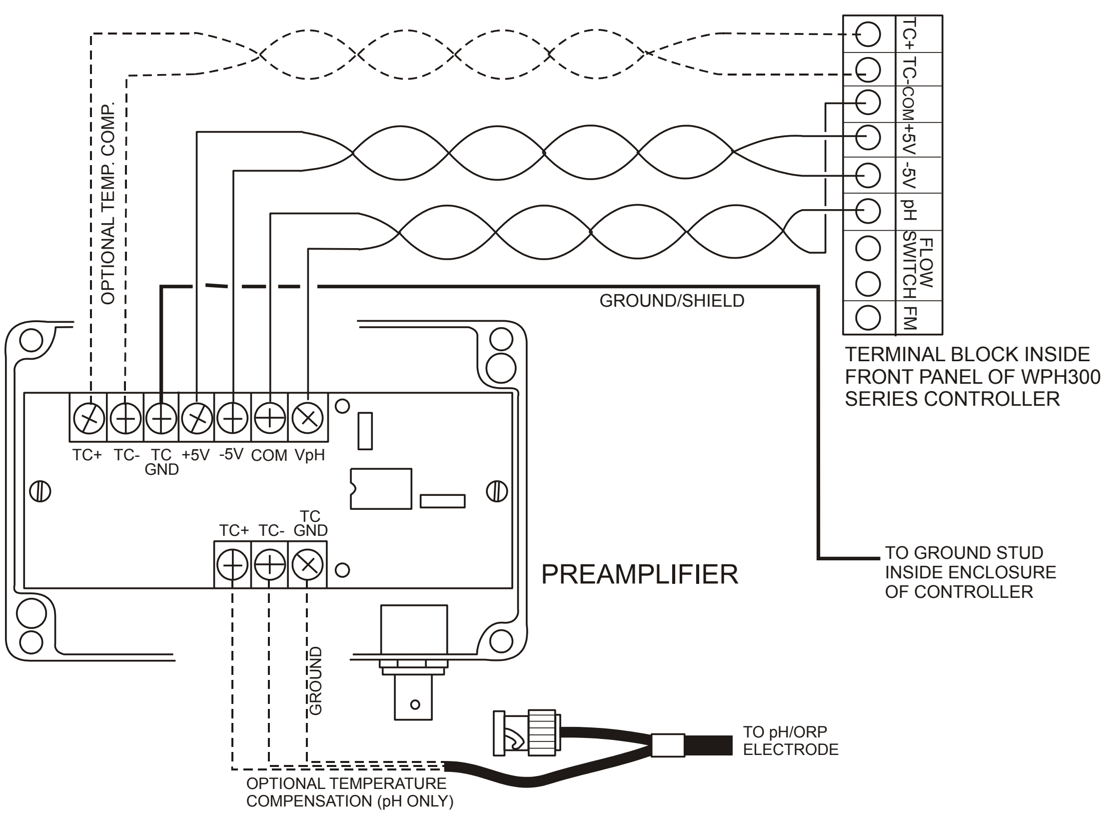
WIRING TO A WPH/WDP400 SERIES CONTROLLER



■ WIRING TO A WEBMASTER SERIES CONTROLLER



■ WIRING TO A WPH/WPD300 SERIES CONTROLLER



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SECTION 14f: PRESSURE TRANSMITTERS

P&ID: Item #: PI-0722

Unit Details: **Mercoid Pressure Transmitter 0 to 30 psi**
Model 3200G-2-FM-1-1-LCD with
Wika Diaphragm Seal Type L990.10 - Standard
Welded Diaphragm Seal
Model L990.10,1/2X1/2F,SS,SS-2,SS,SS,VI

P&ID: Item #: PI-0822

Unit Details: **Mercoid Pressure Transmitter -10 to 20 psi**
Model 3200G-1-FM-1-1-LCD with

Manufacturer: **Dwyer Instruments, Inc.**
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com

WIKA Process Solutions, Houston Facility
950 Hall Court
Deer Park, TX 77536
Phone: (800) 570-4454
Fax: (713) 475-0011
www.wika.us

Local Distributor/Contact:

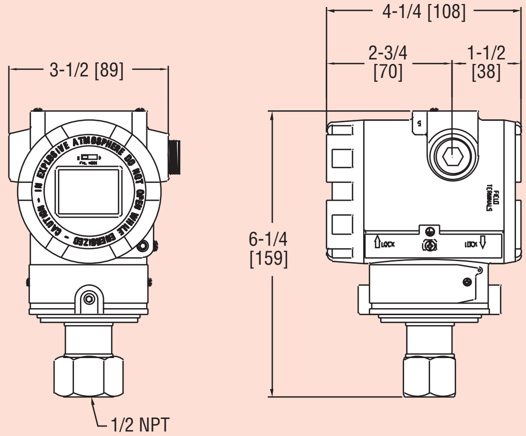
Dwyer Instruments, Inc.
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com

Colonial Instruments, Inc.
1 Chestnut Street
Nashua, NH 03060
Local: (603) 881-4040
Fax: (603) 882-7878
www.colonialgauges.com

Series 3200G

Explosion-proof Pressure Transmitter

HART®, Push Button Configuration, Rangeability (100:1)



The Mercoid® Series 3200G Smart Pressure Transmitter is a microprocessor-based high performance transmitter, which has flexible pressure calibration, push button configuration, and programmable using HART® Communication. The Series 3200G is capable of being configured with the zero and span buttons, a field calibrator is not required for configuration. The transmitter software compensates for thermal effects, improving performance. EEPROM stores configuration settings and stores sensor correction coefficients in the event of shutdowns or power loss. The Series 3200G is FM approved for use in hazardous (Classified) locations. The 100:1 rangeability allows the smart transmitter to be configured to fit any application.

FEATURES

- Completely configurable using zero/span buttons (No calibrator required)
- Rangeability (100:1)
- High accuracy (0.075%) ±0.075%
- Automatic sensor temperature compensation
- Fail-mode process function

SPECIFICATIONS

Service: Compatible gases, steam, liquids or vapors.
Wetted Materials: 316L SS.
Accuracy: ±0.075% FS (@ 20°C).
Rangeability: 100:1 turn down.
Stability: ±0.125% FSO/yr.
Temperature Limits:
Process: -40 to 248°F (-40 to 120°C);
Ambient: Without LCD -40 to 185°F (-40 to 85°C);
With LCD -22 to 176°F (-30 to 80°C).
Thermal Effect: ±0.125% span/32°C.
Power Requirements: 11.9 to 45 VDC.
Output Signal: 4 to 20 mA / HART® Communication.
Response Time: 0.12 seconds.
Damping Time: 0.25 to 60 seconds.
Loop Resistance:
Operation: 0 to 1500 Ω;
HART® Communication: 250 to 500 Ω.
Electrical Connection: Two 1/2˝ female NPT conduit, screw terminal.
Process Connections: 1/2˝ female NPT.
Display: Optional 5 digit LCD.
Enclosure Rating: NEMA 4X (IP66) and explosion proof for Class I, Div I Groups A, B, C and D.
Weight: 5.5 lb (2.5 kg).
Agency Approvals: CE, FM.

Model	Range psi (kPa)	Calibrated Span (Min. to Max.) psi (kPa)	Max. Pressure psi (bar)	LCD Display
3200G-1-FM-1-1	-14.5 to 21 (-100 to 150)	0.22 to 21 (1.5 to 150)	58 (4)	No
3200G-2-FM-1-1	-14.5 to 217 (-100 to 1500)	2 to 217 (15 to 1500)	580 (40)	No
3200G-3-FM-1-1	0 to 725 (0 to 5000)	7.25 to 725 (50 to 5000)	2000 (138)	No
3200G-4-FM-1-1	0 to 3600 (0 to 25000)	36 to 3600 (250 to 25000)	10000 (690)	No
3200G-1-FM-1-1-LCD	-14.5 to 21 (-100 to 150)	0.22 to 21 (1.5 to 150)	58 (4)	Yes
3200G-2-FM-1-1-LCD	-14.5 to 217 (-100 to 1500)	2 to 217 (15 to 1500)	580 (40)	Yes
3200G-3-FM-1-1-LCD	0 to 725 (0 to 5000)	7.25 to 725 (50 to 5000)	2000 (138)	Yes
3200G-4-FM-1-1-LCD	0 to 3600 (0 to 25000)	36 to 3600 (250 to 25000)	10000 (690)	Yes

Contact factory for custom calibration.

ACCESSORIES

A-630, Stainless steel angle type bracket with SS bolts
A-631, Stainless steel flat type bracket with SS bolts

NEW PRODUCT!

HART® is a registered trademark of Hart Communication Foundation.

1041

Example	3200G	2	FM		1	LES	S2	A1	05	S	2	05	LCD	3200G-2-FM-3-1-LESS2A105S2-05-LCD
Series	3200G			3										3200G Explosion-Proof Pressure Transmitter
Range		1												-14.5 to 21 psig
		2												-14.5 to 217 psig
		3												0 to 725 psig
		4												0 to 3600 psig
		5												0 to 8500 psig
Approval			FM											FM approved
			WP											NEMA 4X/IP66 (Only available with 316 SS housing)
Process Connection				1										1/2˝ FNPT
				3										Diaphragm seal
Electrical Connection					1									1/2˝ NPT
Diaphragm Seal Type						LED								1 extended diaphragm seal direct mount
						LES								1 extended diaphragm seal capillary type high
						LFD								1 flush diaphragm seal direct mount
						LFS								1 flush diaphragm seal capillary type
Mounting Flange							S2							2˝ (50 mm) 316 L SS
							S3							3˝ (80 mm) 316 L SS
Mounting Flange Rating								A1						ANSI class 150#
								A2						ANSI class 300#
								D1						DIN PN 10/16
								D2						DIN PN 25/40
								J1						JIS 10 K
								J2						JIS 20 K
Extension Length									00					No extension/standard for flush mount
									05					2˝ extension
									10					4˝ extension
									15					6˝ extension
Diaphragm Material										S				316 L SS diaphragm
										P				PTFE and 316 L SS diaphragm
										H				Hastelloy C-276 diaphragm
										T				Tantallum diaphragm
Fill Fluid											2			Silicon oil (-40 to 400°F)
Capillary Length												XX		0 to 20 feet
Options													LCD	5 digit LCD
													SSH	316 SS housing (Only available with WP approval)
													NIST	NIST calibration
													CC	Custom calibration

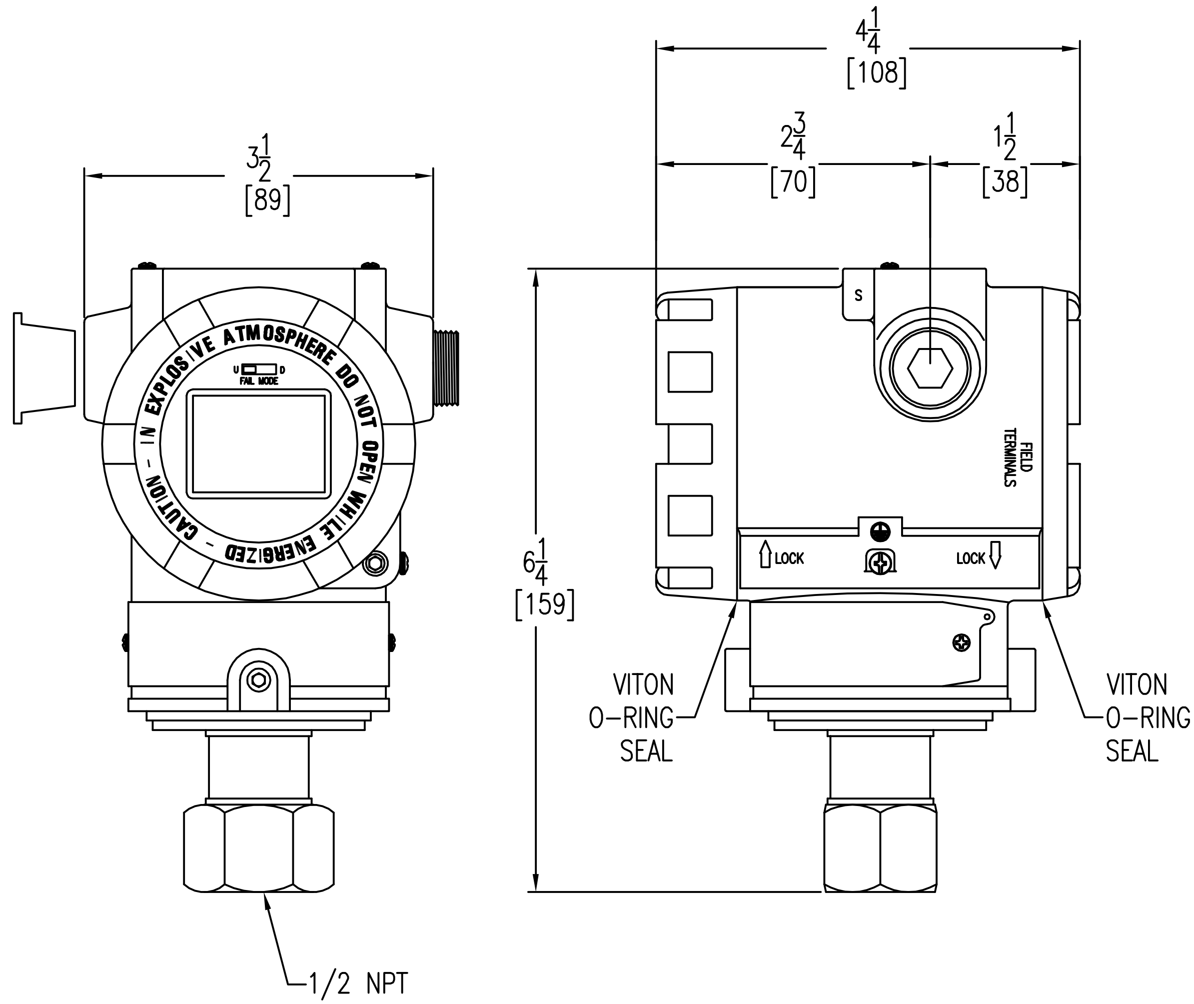
Custom Calibration Values

Primary Units	in H_2O, ft H_2O, mm H_2O, in Hg, psig, g/cm^2, kg/cm^2, Pa, kPa, bar, mbar, Torr, Atm, mm Hg
Upper Range Limit	20 mA value
Lower Range Limit	4 mA value
Damping Time	0 to 60 seconds
Display Mode	Primary unit, %, mA, rotate

3200G Direct Mount

3200G Capillary Type

Extended Diaphragm Seal



MODEL WITH OPTIONAL LCD DISPLAY

CD = CRITICAL DIMENSION
STANDARD TOLERANCES UNLESS NOTED:
ALL DECIMAL DIMENSIONS ± .005
ALL ANGLES ± 1°

SCALE 1:2

NO.	CHANGES	BY/DATE		
			DATE	
1043			DWN BY	
			CHKD	
			APPD	

NAME: 3200 SERIES EXPLOSION–PROOF PRESSURE TRANSMITTER

ACAD2002

MATERIAL

FINISH

DWYER INSTRUMENTS, INC.
MICHIGAN CITY, INDIANA 46360 U.S.A.

FR. NO.

3

Bulletin P-3200

Series 3200 Explosion-Proof Smart Pressure Transmitter

Specifications - Installation and Operating Instructions

DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
Phone: 219/879-8000
Fax: 219/872-9057
www.dwyer-inst.com
e-mail: info@dwyer-inst.com

Table of Contents

Chapter 1 Introduction

The 3200 Smart Pressure Transmitter is calibrated at the factory before shipping. To ensure correct and efficient use of the instrument, please read the manual thoroughly and fully understand how to operate the instrument before operation.

1. The contents of this manual are subject to change without prior notice.
2.
3. If any question arises, errors are found or if any information is missing from this manual, please inform Dwyer Instruments, Inc.
4. The specifications covered by this manual are limited to standard transmitters and do not cover custom-made instrument.
5. Please note that changes in the specifications, construction, or component parts of the instrument may not immediately be reflected in this manual at the time of change, provided that postponement of revisions will not cause difficulty to the user from a functional or performance standpoint.

1.1 Using This Manual

The operating manual provides information on installing, operating, and maintaining the Mercoid® Model 3200 Smart Pressure Transmitter. The Chapters are organized as follows.

Chapter 2 Handling Cautions

Chapter 2 provides instructions on commissioning and operating Model 3200 Smart Pressure Transmitters. Informations on software functions, configuration parameters, and on-line variables are also included.

Chapter 3 Transmitter Functions

Chapter 3 contains suggestions on handling the Model 3200 Smart Pressure Transmitters.

Chapter 4 Installation

Chapter 4 contains mechanical, environment consideration and electrical installation instructions for the Model 3200 Smart Pressure Transmitters.

Chapter 5 On-line Operation

Chapter 5 describes how to configure the parameters of the Model 3200 Smart Pressure Transmitter. See the following list for the details.

1. Regulations of circuit's Input/Output characteristics; Sensor or Output Trim
2. Changing the output characteristic; Range Configuration, Output Type, Dampening, Unit
3. Changing the general data; Tag No., Date, Message, etc.

Chapter 6 Maintenance

Chapter 6 contains hardware diagnostics, troubleshooting and maintenance task.

1.2 Overview of Transmitter

The Mercoid® Smart Pressure Transmitter is a microprocessor based pressure transmitter with a capacitance sensor optimized for draft measurement. The Model 3200 has a true draft analog range from 0 to 20 mA. This transmitter is explosion-proof, high precision accuracy, reliability and has digital communication for remote communication system.

The Model 3200 is enabled with HART® communication with Host, HHT (HART® Communicator) or PC Configurator. The transmitter's various variables in host are able to be changed, configured and calibrated by users. The HART® Communication between DC power supply and transmitter requires a 250~ 550 Ohm resistance.

1.3 Software Compatibility

The Mercoid® Smart Pressure Transmitter's software is implemented at the factory. The following functions can be configured using a HHT (HART® Communicator).

Function	Function Supports		
	ZERO/SPAN Button Rev. 58	**PC/PDA**	**HART HHT**
ZERO/SPAN	●	●	●
ZERO TRIM	●	●	●
ZERO Adj	●	●	●
Units set	●	●	●
Range set	●	●	●
Dampening set	●	●	●
LCD Decimal set	●	●	∆

● : Supported.
∆ : Supported but update required

Chapter 2 Handling Cautions

This chapter consists of cautions for transmitter handling, storage, installation, insulation and explosion structure, etc.

Step	Job	Job Details	Instrument
1	Unpacking	- Unpack transmitter packing	
2	Model and Specifications	- Make sure the transmitter nameplate matches the model number on the PO	
3	Storage	- In a dry, non-vibration and non-impact area - Ambient temperature around 77°F (25°C) and 65% relative humidity	
4	Calibration	- Configuration of the Range, Zero/Span, Unit, Tag, Dampening Time, Transfer Function, DA Trim and other parameters	- HHT -Pressure Source - Galvanometer
5	Installation Locations	- Where ambient temperature are consistant - Exposure to chemical corrosion, etc. - Where shock and vibration are minimal - Where the area classification does not exceed the exposion-proof rating - Where maintenance is easy	(Engineering)
6	Mechanical Considerations	- Where transmitter can be handled easily - Be cautious of process connections leaking	(Engineering)
7	Electrical Considerations	- 24 VDC (Power Supply is 11.9 Vdc – 45 Vdc) - For HART® communication, total resistance on transmitter terminal loop should between 250 – 550 Ohm	(Engineering)
8	Mounting and Installation	- When mounting the transmitter, an appropriate bracket should be used - The transmitter should be mounted securely to prevent swing	(Mounting and Installation)
9	Calibration on Spot	- Sensor Zero Trim should be done after ten seconds after the differential pressure stabilizes - Make sure that PV value is zero and current is 4 mA	HHT or Zero/Span button
11	Operation	- Make sure the transmitter operates properly	Eye or HHT

2.1 Unpacking
When moving the transmitter to the installation site, keep it in the original packaging. Unpack the transmitter at the installation site to avoid damage on the way.

2.2 Models and Specifications Check
The model number and specifications are indicated on the nameplate. Please check the specification and model number.

2.3 Storage
The following precautions must be observed when storing the instrument, especially for a long period.

1. Select a storage area that meets the following conditions:
   - is not exposed to rain or water.
   - minimal vibration and shock.
   - stored at normal temperature and humidity (approx. 77°F (25°C), 65% RH).

The ambient temperature and relative humidity ratings are:

Ambient Temperature:	-40 to 185°F (-40 to 85°C) (without LCD module)
	-22 to 176°F (-30 to 80°C) (with LCD module)
General Use:	-4 to 140°F (-20 to 60°C)
Relative Humidity:	5% ~ 98% RH at 104°F (40°C)

2. When storing the transmitter, repack it the way it was delivered from the factory.

3. If storing a used transmitter, thoroughly clean the diaphragm surfaces, so that no media remains. Make sure the transmitter assemblies are securely mounted before storing.

2.4 Selecting Installation Locations
The transmitter is designed to withstand severe environmental conditions. However, to ensure stable and accurate operation, the following precautions must be observed when selecting an installation location.

1. Ambient Temperature
   Avoid locations subject to wide temperature variations or a significant temperature gradient. If the location is exposed to radiant heat from plant equipment, provide adequate insulation or ventilation.

2. Ambient Atmosphere
   Avoid installing the transmitter in a corrosive atmosphere. If the transmitter must be installed in a corrosive atmosphere, there must be adequate ventilation. Precautions must be put into place to prevent intrusion or stagnation of rainwater in conduits.

3. Shock and Vibration
   Select an installation site with minimal shock and vibration (although the transmitter is designed to be relatively resistant to shock and vibration).

4. Installation of Explosion-Proof Transmitters
   Explosion-Proof transmitters can be installed in hazardous areas according to the gas types for which they are certified.

5. Select a place where transmitter can be maintenanced easily.

2.5 Calibration on Spot after Installation
1. Sensor Zero Trim should be done after transmitter is installed, because the zero point is not configured for mounting status.
2. When calibrating the Sensor Zero Trim apply a pressure of zero in advance, Sensor Zero Trim the sensor when the pressure is sufficiently stabilized (after approximately 10 seconds).
3. Sensor Zero Trimming can also be done with the Zero/Span button or a HHT (HART® Communicator), PC or PDA configurator.
4. Refer to On-line Operation for configuring other parameters.

2.6 Pressure Connections

⚠ WARNING Instrument installed in the process under pressure.

• Never loosen or tighten as it may cause dangerous spouting of process fluid. If the process fluid is toxic or otherwise harmful, take appropriate care to avoid contact or inhalation of vapors even after disconnecting the instrument from process line for maintenance.

The following precautions must be observed in order to safely operate the transmitter under pressure.
1. Never apply a pressure higher than the specified maximum working pressure.
2. Confirm the option pressure of transmitter. It is necessary to use standardized and quality-approved parts.
3. There should be isolation valves in case of leakage.

2.7 Waterproofing Cable Conduit Connections
Apply a non-hardening sealant (silicone or tape, etc.) to the threads to waterproof the transmitter cable conduit connections.

2.8 Restrictions on Use of Radio Transceivers

⚠ WARNING Although the transmitter has been designed to resist high frequency electrical noise, if a radio transceiver is used near the transmitter's external wiring, the transmitter may be affected by high frequency noise pickup. To test for such effects, bring the transceiver in slowly from a distance of several feet from the transmitter, and observe the measurement loop for noise affects. Always use the transceiver outside the area affected by noise.

2.9 Insulation Resistance Test and Dielectric Strength Test

Since the transmitter has undergone insulation resistance and dielectric strength tests at the factory, normally these tests are not required. However, if required, observe the following precautions in the test procedures.

1. Do not perform such tests more frequently than necessary. Even test voltages, that do not cause visible damage to the insulation, may degrade the insulation and reduce safety margins.
2. Never apply a voltage exceeding 500VDC for the insulation resistance test, or a voltage exceeding 500VAC for the dielectric strength test.
3. Before conducting these tests, disconnect all signal lines from the transmitter terminals. Perform the tests using the following procedure.

Insulation Resistance test

1. Short-circuit the + and - SUPPLY terminals in the terminal box.
2. Turn OFF the insulation tester. Then connect the insulation tester plus (+) lead wire to the shorted SUPPLY terminals and the minus (-) lead wire to the grounding terminal.
3. Turn ON the insulation tester power and measure the insulation resistance. The voltage should be applied briefly to verify that insulation resistance is at least 20MΩ.
4. After completing the test and being very careful not to touch exposed conductors. Disconnect the insulation tester and connect a 100kW resistor between the grounding terminal and the short-circuiting SUPPLY terminals. Leave this resistor connected at least three seconds to discharge any static potential. Do not touch the terminal while it is discharging.

Dielectric Strength Test

1. Short-circuit the + and - SUPPLY terminals in the terminal box.
2. Turn off the dielectric strength tester. Then connect the tester between the shorted SUPPLY terminal and the grounding terminal. Be sure to connect the grounding lead of the dielectric strength tester to the ground terminal.
3. Set the current limit on the dielectric strength tester to 10mA, then turn on the power and gradually increase the tester voltage from '0' to the specified voltage.
4. When the specified voltage is reached, hold it for one minute.
5. After completing this test, slowly decrease the voltage to avoid any voltage surges.

2.10 Explosion-Proof Rating

2-10-1. FM Certification

HAZARDOUS LOCATION ELECTRICAL EQUIPMENT

Equipment Rating : Explosion-Proof for use in Class I, Division 1, Groups A, B, C and D;
Dust-Ignition-Proof for Class II/III, Division 1, Groups E, F and G;
Nonincensive for use in Class I, Division 2, Groups A, B, C and D;
Suitable for use in Class II, Division 2, Groups E, F and G; and
Suitable for Class III, Division 1;
Hazardous(classified) location, indoor and outdoor (NEMA Type 4X/IP67).

2.10.2 DEKRA/ATEX Certification

ATEX Certification number : DEKRA 11ATEX0192X
CE 0344 Ex II 2 G

NOTICE **Model 3200 for potentially explosive atmosphere**

1. Ex d IIC T6...T4
2. Operating Temperature : -20°C ≤ T_{amb} ≤ +60°C
3. T6 for process ≤ 85°C;
4. T5 for process ≤ 100°C;
5. T4 for process ≤ 130°C;

NOTICE **Electrical Data**

1. Supply Voltage : 42 Vdc Max
2. Output Signal : 4 to 20 mA + HART

NOTICE **Electrical Connection : 1/2˝-14 NPT Female**

NOTICE **3200 ATEX Certification is according to the below standards**

EN 60079-0 : 2006
EN 60079-1 : 2007

NOTICE **Installation**

1. All wiring shall comply with local installation requirement.
2. The cable glands and blanking elements shall be of a certified flameproof type, suitable for the condition of use and correctly installed. Also those devices should be endured at the 130°C.
3. Housing Ground must be followed to “local electrical codes”. The most efficient ground procedure is to connect directly to the earth as least impedance.
1. How to Housing Ground:
   A. Internal Ground Connection:
      Internal ground connection screw is located in terminal in housing; the screw can be identified as ground sign.
   B. External Ground Assembly:
      This is located in the right side of housing and identified as ground sign. (Grounding with a cable lug)
2. When use tubing, stopping boxes must be connected with the wall of housing directly.
3. Tubing is installed a minimum of 5 threads.
4. Sensor is to be threaded a minimum of 7 threads and prevented from turing by tightening the housing rotation set screw.
5. Do not disassemble flameproof Joints but in an unavoidable case to disassemble it or need the specification of flameproof Joints, contact the manufacturer before doing.

NOTICE **Operation**

WARNING DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT.

1. Take care not to generate mechanical spark when access to the instrument and peripheral devices in hazardous location.

NOTICE **Maintenance and Repair**

The instrument modification or parts replacement by other than authorized representative of Dwyer/Mercoid is prohibited and will void KEMA/ATEX explosion-proof/flame-proof.

2.11 EMC Conformity Standards

EMI (Emission): EN55011
EMS (Immunity): EN50082-2

Dwyer Instruments, Inc. recommends customer use metal conduit wiring or twisted pair shield cable for signal wiring to conform with EMC regulation, when installing the Mercoid® 3200 transmitters.

Chapter 3 Transmitter Functions

3.1 Overview

This chapter contains information on operating the Model 3200. Tasks that should be performed on the bench prior to installation are explained in this chapter.

3.2 Safety Message

Procedures and instructions in this chapter may require special precautions to ensure the safety of the personnel performing the operations. Potential safety issues are indicated by a warning symbol (▲). Refer to the following safety messages before performing an operation preceded by this symbol.

3.3 Warning

⚠ WARNING Explosion can result in death or serious injury:

- Do not remove the transmitter covers in explosion environments when the circuit is powered.
- Transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠ WARNING Electrical shock can result in death or serious injury:
- Only qualified personnel can install the transmitter.

3.4 Fail Mode Alarm

Mercoid® Smart Pressure Transmitter automatically and continuously performs self-diagnostic test. If the self-diagnostic test detects a failure, the transmitter drives the output outside of the normal operation values. The transmitter will drive its output low (down) or high (up) based on the position of the failure mode alarm jumper. See Table 3.1 for output values.

Level	4~20mA Saturation	4~20mA Alarm
Low/Down	3.9 mA	≤ 3.75 mA
High/Up	20.8 mA	≥ 21.75 mA

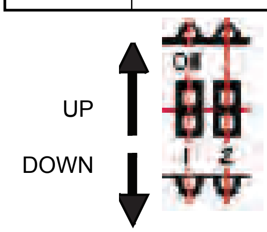
[Table 3.1 Standard Alarm and Saturation Values]

⚠ WARNING Electrical shock can result in serious injury:
• Avoid contact with the leads and terminals. High voltage, that may be present, on leads can cause electrical shock.

Fail Safe mode can be set via Jumper switches provided on the LCD module or the main CPU module. The jumper switch for an indicating transmitter, located on the LCD module, can be set to the right (fail down i.e. ≤ 3.75 mA) or left (fail up i.e. ≥ 21.75 mA). For non-indicating transmitters the jumper switch is located on the main CPU module, it can be set up (fail up to ≥ 21.75 mA) or down (fail down to ≤ 3.75 mA). Refer to Figure 3-1 for detailed summary of jumper settings for both CPU and LCD modules.

Fail Mode Selection (LCD & CPU Module)

Select Fail Mode	Both LCD Module and CPU Module		Only CPU Module
	CPU Module	LCD Module	CPU Module
Fail Down	Down	D	D
Fail Up	Down	U	U
	Up	U or D	



1. WR_EN (EEPROM Write Enable)
   DOWN : ENABLE
   UP : DISABLE
2. Fial Mode (Alarm)
   DOWN : LOW
   UP : HIGH

Fail Mode for LCD Module Selection Jumper Switch

U	O	O	O		O	O	O	D		O	O	O	D
(If Down)					FAIL MODE					(If Up)			

Figure 3-1. Fail Mode and EEPROM-Write Selection Jumper Switch

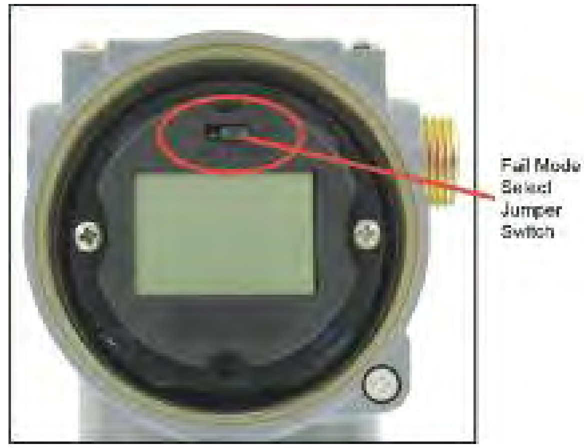


Figure 3-2 Fail Mode Selection Jumper Switch for LCD Module

3-5 EEProm-Write Enable / Disable Mode Switch

EEPROM (Electrically Erasable Programmable ROM), included on the CPU module, is used by the transmitter to save/restore configuration variables. To protect the transmitter from any unauthorized changes, a hardware lockout feature can be implemented by using the Write-Protect mode jumper switch provided on the main CPU Module. This Jumper switch is designated as “EEP-Write DIS/EN” on the CPU Module. If the jumper switch is connected to DIS, this disables writing/changing of any data saved in the EEPROM. On the other hand, if the jumper switch is set to “EN”, changes can be made to the configuration data stored in the EEPROM. The factory default setting is “EN” (Enable) for all transmitters. The location of the Wire Protect Jumper Switch can be seen in Figure 3-3.

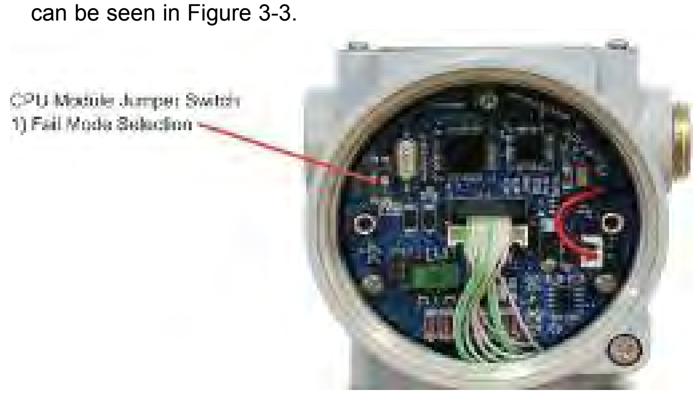


Figure 3-3. CPU Module Fail Mode, EEPROM-Write Selection Jumper Switch

The 3200 has two security settings.
1. Security Jumper: the transmitter configuration parameters are protected.
2. Physically removing Zero and Span Magnetic Buttons: you are unable to regulate zero and span locally.

3.5.1 Security Jumper (EEPROM Write Protect)

Prevents the transmitter’s configured parameters from being changed.

3.5.2 Zero and Span Buttons

By removing the Magnetic Buttons, you can't configure the transmitter using the Zero and Span locally.

3.6 Configuration of Alarm and Security Jumper Procedures

Changing jumper position.
1. If the transmitter is installed, cutoff power.
2. Open the front cover. If the transmitter is powered, don't open the cover.
3. Move the jumper to the preferred position.
4. Close the front housing cover. You must fully engage the cover to meet explosion-proof requirements.

3.7 Configuration of Zero and Span Procedures

The ZERO and SPAN buttons are under the transmitter's nameplate. The ZERO, SPAN, ZERO TRIM, ZERO ADJ, Units, Range, Dampening, LCD and decimal set functions are configurable using the ZERO / SPAN buttons.

Zero/Span Configuration Process

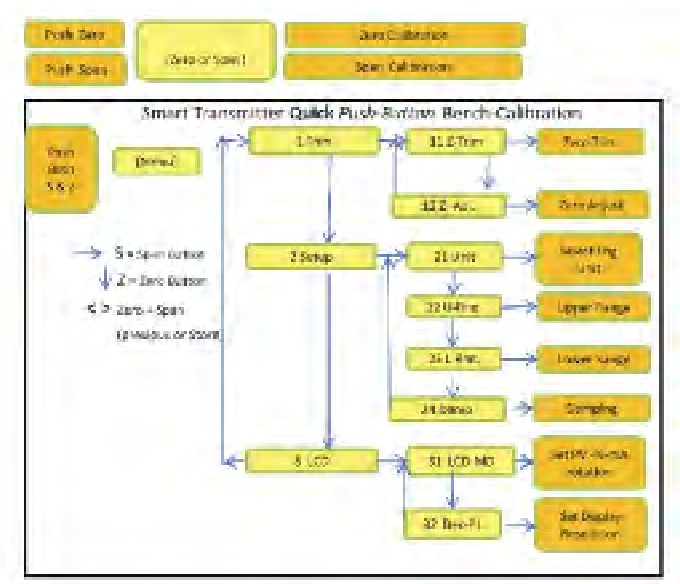
Remove both name plate screws on the upper part of transmitter. Remove top name plate to access the Zero and Span Buttons. (following Figure 3-4)

1. Zero Configurations
Set the current process value for Lower Range Value (4 mA). Apply zero differential pressure for 10 seconds and push the Zero Button for 5 seconds. The LCD should display "Zero". Push the Zero button for 3 seconds, after 1 second the LCD should display "-ZE-". This message means the zero configuration is finished. If the zero configuration failed, the LCD will display "SPEr" or "SEtE", try repeating the zero configuration steps.

2. Span Configurations
Apply the desired pressure for 10 seconds and push the Span Button for 5 seconds. The LCD should display "Span". Push the Span button for 3 seconds, after 1 second the LCD should display "-SP-". This message means that the span configuration is finished. If the span configuration failed the LCD will display "SPEr" or "SEtE", try repeating the span configuration steps.

• Please refer to Appendix 1 for the button error and LCD display message.

The other functions supported by the ZERO / SPAN Buttons are below.



Menu Tree for Zero+Span Button Function

1. Moving between menus: Zero
2. Enter or moving to sub menu: Span
3. Moving to top menu: Zero+Span

- Press the button for 3 seconds to execute each function. After 3 seconds press the Zero+Span buttons, the LCD display will change from Menu to Trim. To see the next menu, press the Zero button for 3 seconds. Use the Zero button to move down the directory.
- Use the Span button to select the displayed menu. The same procedure will be used for the sub menus.

CAUTION 30 seconds without any action, the button function menu will return to normal operation.

4. How to select a numerical value
- Functions use numerical values: 12 Zero Adjustment, 22 Change Upper Range Value, 23 Change Lower Range Value, 24 Dampening Second
- How to select numerical value: First, select an increasing rate (10n), then change each decimal value to increase or decrease as wanted. For example, select 3810 : Select increasing rate 1000 -> Increase 3 times -> Select increasing rate 100 -> Increase 8 times -> Select increasing rate as 10 -> Increase 1 time
- To select the increase / decrease steps : SelInc message will be displayed on the bottom of the LCD. Select parameter and press the Zero button : The decimal value will be changed when the Zero button is pressed. After set, press the span button to execute the parameter.
- To set the required values using the Zero/Span buttons: VALUE message will be displayed on the bottom of the LCD.
    1. Press the Zero button, the menu will increase 1 item.
    2. Press the Span button, the menu will decrease 1 item.
    3. After setting, save the parameter by pressing the Zero+Span buttons.
- To set the final value, repeat 3 and 4.
- After setting the final parameter, exit the menu by pressing the Zero+Span buttons.

5. Exercises for each function

- ZERO TRIM
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the sub directory using the Span button until the 1 TRIM message appears on the display.
  3. Change the Zero Trim Function by using the Span button until the 11 Z-TRIM message appears on the display.
- ZERO ADJUSTMENT : Change the PV value to 14
  1. Exit the menu by pressing the Zero+Span button.
  2. Moving thru the sub directory using the Span button until 1 TRIM message appears.
  3. Moving thru the sub directory using the Zero button until 11 Z-TRIM message appears.
  4. Access the Zero Adjustment function by pressing the Span button until the 12 Z-ADJ messages appears.
  5. When the SelInc message appears, press the Zero button repetitively until the 10.0 message appears on the LCD. Set the value by pressing the Span button.
  6. When the VALUE message appears, change the LCD value to 10.0 and press the Zero button, then press the Zero+Span buttons.
  7. When SelInc message appears, change the LCD value to 1.0 and press the Zero button, then set the value and press the Span button. Press the Zero+Span buttons after the LCD value changes to 14.0.
  8. To save the settings, press the Zero+Span buttons until the SelInc message appears.
- CHANGE UNITS
  1. Access the menu by pressing the Zero+Span buttons.
  2. Moving to next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Moving thru the sub directory press the Span button until the 2 SETUP message appears.
  4. Press the Span button to access 21 UNIT, press Span again to access Change Unit.
  5. Save the values by pressing the Span button when the desired value is displayed on the LCD.
- CHANGE UPPER RANGE VALUE
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 21 Unit message appears.
  5. Press the Zero button until the 22 U-RNG message appears.
  6. Press the Span button until the Zero Adjustment message appears.
- CHANGE LOWER RANGE VALUE
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the next menu by pressing the Zero button until the 1 TRIM message appears.
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 21 Unit message appears.
  5. Press the Zero button until the 22 U-RNG message appears.
  6. Press the Zero button until the 23 L-RNG message appears.
  7. Press the Span button until the Change Lower Range Value message appears.
- CHANGE LCD MODE (Cyclic or Fixed Display)
  1. Enter programming menu by pushing both (ZERO+SPAN) button together for 5 seconds. Release buttons when LCD displays Menu and display will automatically change to “1 TRIM” confirming access into programming menu.
  2. Push (ZERO) button when “1 TRIM” message appears on LCD. Release button when display changes to “2 SETUP”.
  3. Push (ZERO) button and release when display changes to “3 LCD”.
  4. To move into sub directory push (Span) button after “3 LCD)” message appears on display. Release button when 31 LCD-MD message is displayed.
  5. To enter this sub-menu, push (Span) button and release when display changes to 311. Bottom line of display will show current Mode setting e.g. NOR-RO, NOR-PV etc.
  6. Push (Zero) button to cycle through available mode options and select desired LCD rotation mode. Options are: NOR-RO (rotate all PV, %, mA), NOR-PV (fixed PV), NOR-% (fixed %), NOR-mA fixed, ENG-RO, ENG-PV, ENG-% or ENG-mA.
  7. Push (Span) to save changes and EXIT programming mode.

- Decimal Place
  1. Access the menu by pressing the Zero+Span buttons.
  2. Move to the next menu by pressing the Zero button until the 1 TRIM message appears
  3. Press the Span button until the 2 SETUP message appears.
  4. Press the Span button until the 3 LCD message appears.
  5. Press the Span button until the 31 DEC-PL message appears.
  6. Press the Span button until the Decimal Place message appears, the decimal place will appear on the second line of the LCD as follows.

Display	Explanation	Max. Value
AUTO	Target value will be displayed automatically	99999
5-0	No decimal place	99999
4-1	Display one decimal place	9999.9
3-2	Display two decimal places	999.99
2-3	Display three decimal places	99.999
1-4	Display four decimal places	9.9999

7. The first line on the LCD will display 0.0.
8. The Decimal Place can be changed by pressing the Zero button. Save the setting by pressing the Span button after the decimal place has been selected.
9. The set value will display the PV value and Engineering value.
10. The LCD will display LCD_OV and the saved Unit when the pressure is over or under a set value.

Figure 3-4 Transmitter Zero/Span Configuration Butons

3.10 Shop Commissioning using HHT

The 3200 Pressure Transmitter can be commissioned using an HHT before or after installation.

▲ Connect an HHT (HART® HANDHELD Communicator) across the “COMM” pins for HART® communication. The TEST pin connections can be used for connecting a multimeter to measure the output current directly from the transmitter. Since the 3200 is a two wire loop powered transmitter, it requires an external loop power supply (11.9V to 45VDC) to enable HART® communication. Any HART® communication via HHT (or PC based configurator) requires a minimum 250 ~ 550 (max) ohm loop resistance.

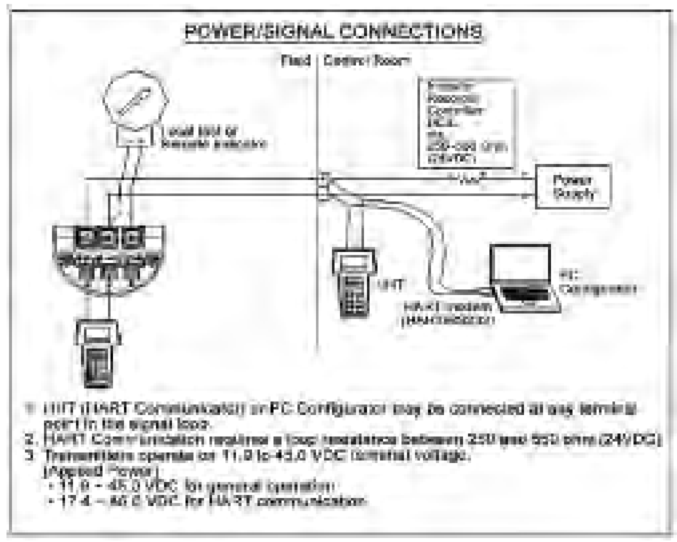


Figure 3-5 Connecting the Transmitter to HHT

Chapter 4 Installation

4.1 Overview

The information in Chapter 4 explains installation.

4.2 Safety Message

Procedures and instructions in this chapter may require special safety measures to ensure the safety of the personnel performing the operation. Potential installation safety issues are indicated by a warning symbol (▲). Refer to the following safety messages before installing the 3200 pressure transmitter.

4.3 Warning

⚠ WARNING Explosion can result in death or serious injury:

- Do not remove the transmitter covers in an explosion-proof environment when the circuit is powered.
- Both transmitter covers must be fully engaged to meet the explosion-proof requirements.

⚠ WARNING Electrical shock can result in serious injury:

- Only qualified personnel can wire the pressure transmitter.

⚠ WARNING Process leaks can cause death or serious injury:

- Install and tighten before applying pressure. If you don't, it can cause process leaks.

⚠ WARNING Electrical shock can result in death or serious injury:

- Avoid contact with the leads and terminals.

4.4 Commissioning on the Bench with Hand-Held Terminal

The 3200 Pressure Transmitter can be commissioned before and after installation. Commissioning is easier if the transmitter is configured on a bench with an HHT before installation.

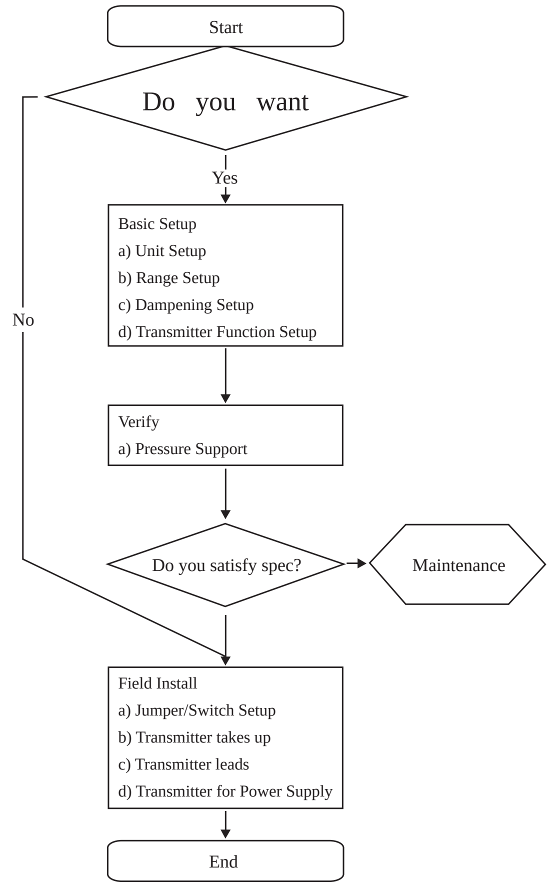


Figure 4-1 Installation Flow Chart

4.5 General Considerations

The transmitter can be mounted near the process to minimize piping. Keep in mind that easy access is required for personnel, field calibration, and installation. Install the transmitter in an area with minimal vibration, shock, and temperature fluctuations.

4.6 Electrical Considerations (Power Supply)

The transmitter housing is composed of two parts. One side is electronics, and the other side is terminal block. The terminal block side is the transmitter's front side and is labeled "Field Terminal" on the housing. The terminal block can be accessed by removing the front cover. When wiring the power supply to the transmitter make sure the positive and negative wires are connected correctly.

A HHT configurator can be connected directly across the (COMM) pin terminal located just below the power supply (PWR) terminal block connections.

4.6.1 Power Supply

The 3200 Pressure Transmitter requires an 11.9 - 45 VDC power supply. A 250 ~ 550Ω (24 VDC) loop resistance is recommended for HART® communication.

Loop resistance is the sum of the resistance in the loop.

Max. Loop Resistance [Ω] = (E-11.9) [vdc] / 0.022 [mA]

4.7 Wiring

4.7.1 Wiring Caution

1. Install the signal cables away from potential sources of electrical noise such as transformers, electrical motors, etc.
2. Before wiring, remove electrical conduit cap.
3. All screwed connections on the housing must be sealed with waterproof sealant. We recommend use of silicone based sealants to minimize post- hardening.
4. Avoid running DC signal and AC power cables in the same ducts/cable conduits to avoid signal noise issues.
5. All explosion proof transmitters must meet the wiring & installation requirements specified within the applicable electrical codes.

4.7.2 Selecting the Wiring Materials

1. Use 600V shielded PVC wire or standard wire of the same class. (To ensure proper communication use 24 AWG or larger wire, and do not exceed 5000 feet.)
2. Use shielded wire in areas with electrical noise.
3. In areas with high or low ambient temperatures, use wire or cable that is rated for the extreme temperatures.
4. If the wire or cable is going to be used in oil, solvent, toxic gas or liquid, make sure it is rated accordingly.
5. Process wire or cable must not be soldered to the terminal lug. Spade connectors are recommended to connect the process wires to the transmitter.

4.7.3 Connecting External Wires to Transmitter Terminal Box

1. Open the cover indicated "FIELD TERMINAL". Do not open the cover if the transmitter is located in an explosion-proof area and powered. Connect the power supply to the terminal indicated "+PWR" (left terminal) and "-" in the central terminal. Do not connect "+" power supply to "+" terminal "TEST". It will damage the test diode.
2. Seal and close the conduit connection to prevent humidity and explosion-proof atmosphere from entering the housing.
3. Transmitter power is supplied by signal wire. Do not install near high voltage wires or high voltage equipment.
4. Close the transmitter cover. To meet the explosion-proof ratings make sure the covers are fully engaged.
   NOTE: Do not power the transmitter with high voltage (AC). It can damage the transmitter.
5. You must connect a 250~550 Ohm Resistor in Current Loop (between Power Supply and Transmitter) for HART® Communication. See Figure 4-2.

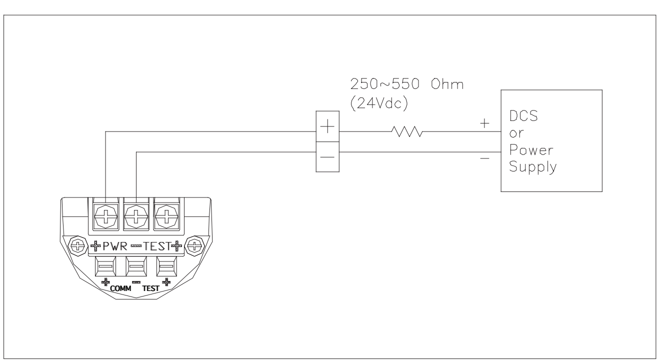


Figure 4-2 Wiring the 3200 Pressure Transmitter

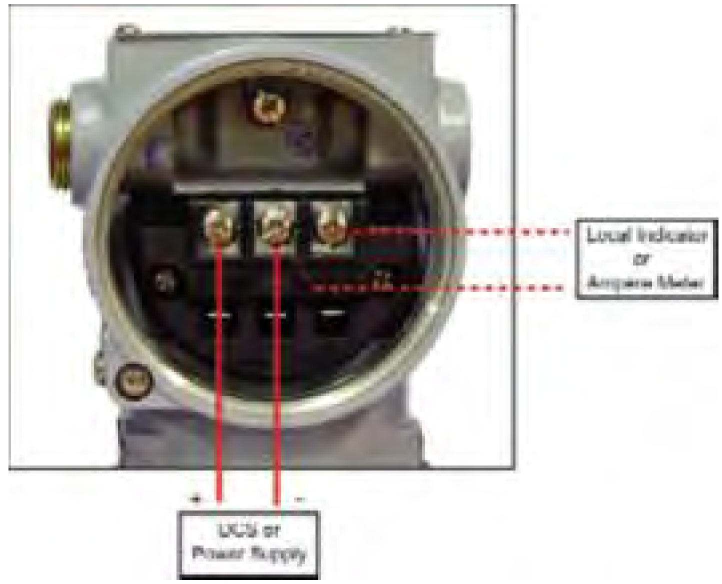


Figure 4-3 Picture of Transmitter Wiring Terminal

4.7.4 Wiring

WARNING Explosion can result in death or serious injury:

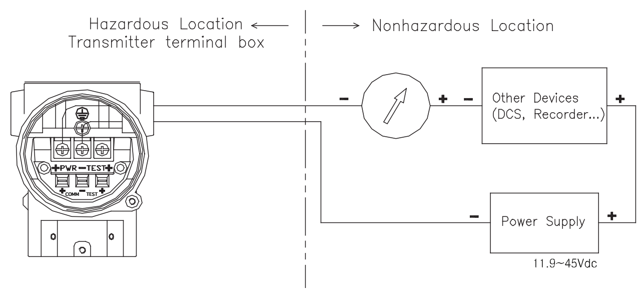
- Do not remove the transmitter covers in an explosion-proof environment when the circuit is powered.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements

A. Loop Configuration

Mercoid® 3200 Series Transmitters use a two-wire system for power, 4~20mA analog signal transmission and HART® digital transmission.

A DC Power Supply is required for the transmitter loop. The transmitter and power supply should be connected as shown below.

1. Explosion-proof



B.Wiring Installation

General-use (Figure 4-4a)

1. Use metallic conduit or waterproof cable glands for wiring.
   a. Apply non-hardening sealant to the terminal box and the threads on the flexible metal conduit for waterproofing.

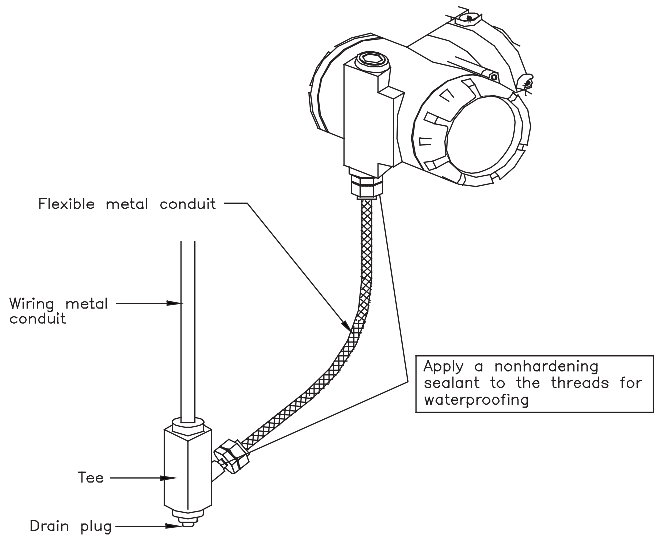


Figure 4-4a Typical Mounting using Flexible Metal Conduit

Explosion-proof

1. Explosion-proof metal conduit wiring (Figure 4-4b)
   a. A seal fitting must be installed near the terminal box port.
   b. Apply a non-hardening sealant to the threads of the terminal connection box.

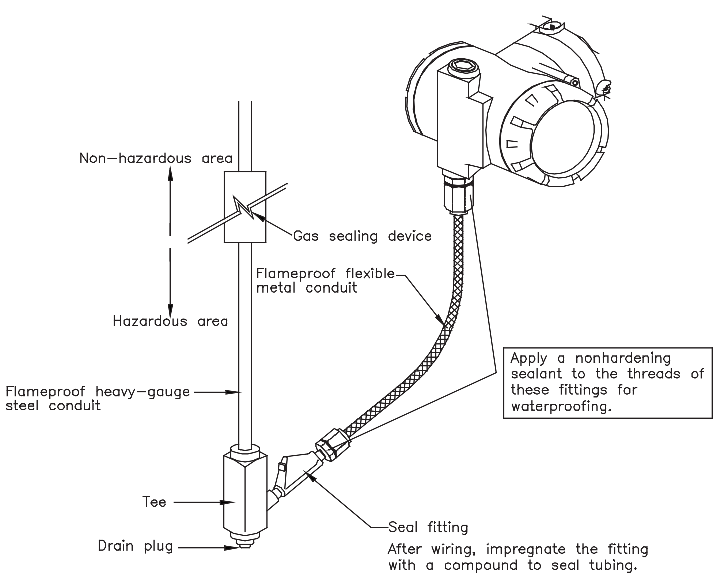


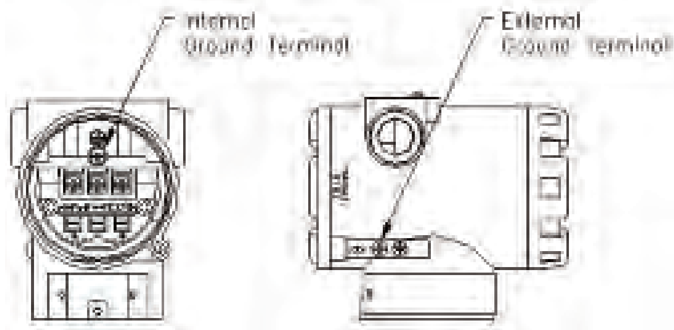
Figure 4-4b Typical Wiring using Explosion-Proof Conduit

4.7.5 Grounding

a. Grounding should satisfy KS requirements (grounding resistance should be 10 ohm or less). Grounding is required for explosion-proof applications and the ground resistance must be below 10 ohms.

b. There are ground terminals on the inside and outside of the transmitter. Either of these terminals may be used

c. Use 600V insulated PVC wire for grounding.



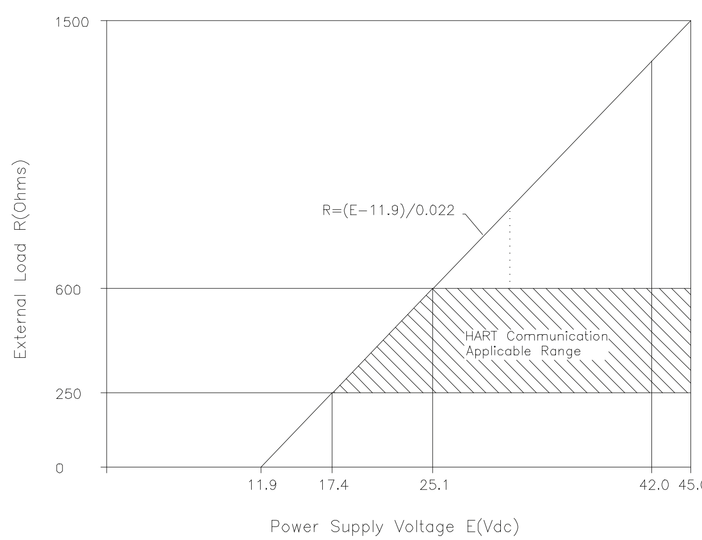
3200 Smart Pressure Transmitter
Internal and External Ground Terminal

4.7.6 Power Supply Voltage and Load Resistance

When configuring the loop, make sure that the external load resistance is within the range (see figure below). The transmitter supply voltage should be:

- Standard: 11.9 to 45 Vdc
- HART Communication: 17.4 to 45 Vdc

And maximum loop current is 24mA, Load resistance R:
R = (E-11.9) / 0.022 (E = Power Supply Voltage)



4.8 Mechanical Considerations

Figure 4-6 is a dimensional drawing for the 3200. Figure 4-7 shows how the A-630 angle bracket is mounted to a pipe.

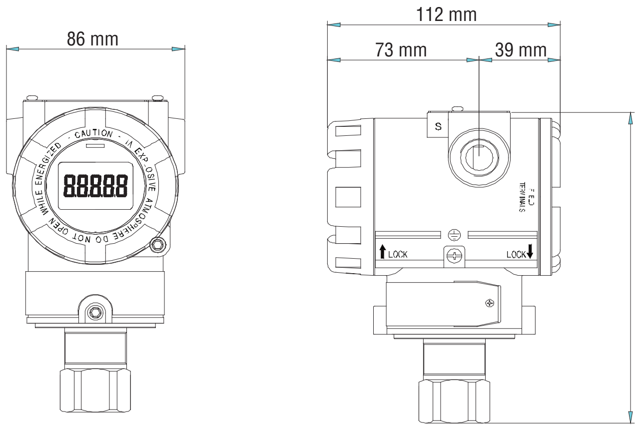


Figure 4-6. Model 3200 Dimensional Drawing

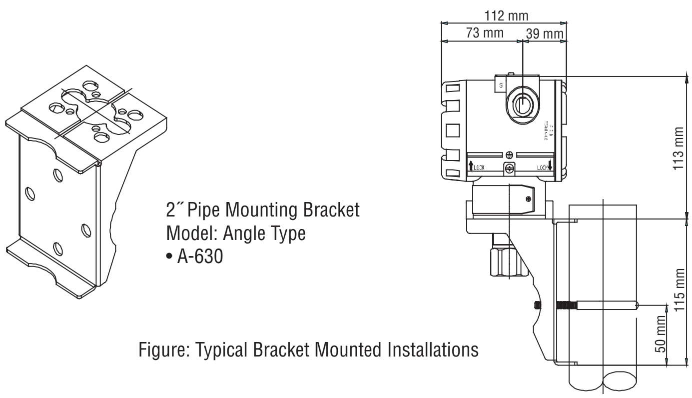


Figure 4-7. A-630 Mounting Bracket

4.8.1 Mounting

Avoid installing transmitters in environments with excessive vibration. If it cannot be avoided, it is highly recommended to provide adequate support when mounting.

4.8.2 Consideration of Transmitter Access

When selecting the installation location, accessibility must be taken into consideration.

- Housing rotation: The housing can be rotated 90°.
- Wiring terminals: The cover and wiring terminals are easily accessible.
- LCD/Circuits: Install the transmitter in a location where it can be seen. For transmitters without an LCD, the cover and jumpers are easily accessible.

4.9 Environmental Considerations

4.9.1 Ambient Temperature

The transmitter ambient temperature range is 4 to 180°F (-20 to 60°C). If the ambient temperature is going to exceed the temperature range, precautions must be taken to keep the temperature within the temperature limits.

4.9.2 Toxic and Moist Environments

The 3200 housing will protected the transmitter against moisture or toxic material. The electronic circuit is separated from the terminals. The housing covers have o-rings that seal the housing, but moisture can penetrate the housing thru the conduit. The transmitter should be mounted in a position to prevent moisture from entering the housing thru the conduit.

4.9.3 Installation in Hazardous Location

The transmitter is designed with an explosion-proof housing. Installation environment must not exceed the explosion-proof rating.

Chapter 5 On-line Operation

5.1 Overview

This chapter describes how to configure the 3200 Smart Pressure Transmitter. The transmitter can be configured in On-Line or Off-Line mode. In On-Line Mode a compatible HHT or PC configuration device must be used.

5.2 Safety Message

For added operator safety please pay specific attention to procedures outlined in this manual listed under the warning symbol (▲)

5.2.1 Warning

▲ WARNING Explosion can result in death or serious injury:

- Do not remove the transmitter covers in explosion-proof environments when the circuit is powered.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

▲ WARNING Electrical shock can result in serious injury:

- When installing transmitters in close proximity of high voltage sources (near power lines) the transmitter leads can be subject to high voltages.
- Avoid contact with the leads and terminals.

5.2.2 Current to Passive Mode Configuration

For multi-drop mode the current output must be configured as passive mode. Please disregard any other messages shown on an HHT.

5.3 Configuration Data Review

Before operating the transmitter make sure the configuration data on the nameplate matches the application.

5.4 Configuration Verification

Before the transmitter is ready for service, the configuration must be checked to confirm the settings are configured for the application.

5.4.1 Process Variable

There are two process variables in the 3200 Smart Pressure Transmitter. The primary variable and temperature compensated SV (Second Variable), the PV value outputs the 4~20mA analog value.

5.5 Basic Setup

The correlation variable must be configured before operating the transmitter.

5.5.1 Select Sensor Range

The pressure range must be selected when ordering the pressure transmitter.

5.5.2 Set Output Units

Select from the following engineering units:

Unit: KPa, kg/cm², bar, psi, mmH_2O etc.

5.5.3 4-20mA Configuration

Set the Zero and Span for the 4~20mA analog output.

5.6 Detailed Setup

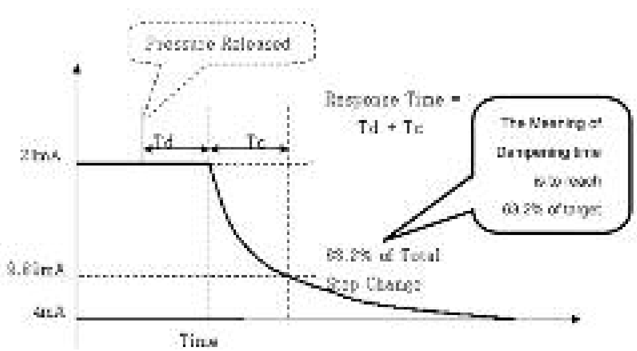
5.6.1 Set Fail Mode

When the sensor or microprocessor is not operating properly, the transmitter will output 3.75mA or 21.75mA based on the Fail Mode setting.

5.6.2 Set Dampening Time

The Dampening Seconds value changes the response time of the transmitter to smooth out variations caused by rapid process changes. Determine the appropriate dampening setting based on the required response time, signal stability, and other requirements of your system.

The Dampening Seconds can be set from 0-60 seconds; the default dampening value is 1.0 second.



5.7 Configuration of Information Variable

5.7.1 Set Tag

Tags are an easy way to classify transmitters in multi transmitter application. Tags can use 8 words/numbers.

5.7.2 Set Messages

When using several transmitters, the user can define each transmitter by using 32 words/numbers. This message is saved in EEPROM.

5.8 Configuration of Breakdown Diagnostic Function

5.8.1 Loop Test

The Loop Test verifies the output of the transmitter, the integrity of the loop, and the operation of any recorders or similar devices installed in the loop. The following procedures are required for a loop test.

- Connect a reference meter to the transmitter.
- Select the Loop Test on the HHT and operate the Loop Test.
- Select curent output (4mA/20mA/etc)
- If the readings match, then the transmitter and the loop are configured and functioning properly. If the readings do not match, then you may have the current meter attached to the wrong loop, there may be a fault in the wiring, the transmitter may require an output trim, or the current meter may be malfunctioning.

5.9 Calibration

The scale is implemented by calibrating the transmitter. Trim function has several calibration functions. Smart transmitters operate differently than analog transmitter. A smart transmitter uses a microprocessor that contains information about the sensor's specific characteristics in response to pressure and temperature for calculating the process variable. 4-20mA configuration sets the transmitter's analog output to a selected upper and lower range and can be done with or without an applied pressure. 4-20mA configuration does not change the factory characterization curve stored in the microprocessor. Sensor trimming requires an accurate pressure input and adds additional compensation to the factory characterization curve to optimize transmitter performance over a specific pressure range. 4-20mA configuration provides the ability to readjust the 4~20mA sensor inputs.

5.9.1 Sensor Trim

The Sensor trim function adjusts the A/D signal conversion within the transmitter sensor electronics and determines how it digitally interprets any pressure changes applied to the sensor inputs. It is highly recommended to perform a sensor trim when first commissioning the transmitter on site. There are three ways to trim the sensor: Sensor zero trim, full trim and zero adjustment. Sensor zero trim is a one-point adjustment typically used to compensate for the mounting position. Two point trim is a full sensor trim, in which two accurate pressures are applied (equal to or greater than the range values), and the output is linear. You should always adjust the low trim value first to establish the correct offset.

5.9.2 D/A (Digital to Analog) Trim

The D/A trim function makes minor adjustments to the analog (4-20mA) output scaling from the transmitter. It is recommended to do a D/A trim on both hi (20mA) & low (4mA) values for best results. This function corrects any minuscule offsets within the the D/A conversion of the transmitter

Chapter 6 Maintenance

6.1 Overview

This chapter describes diagnostic and maintenance.

6.2 Safety Message

When the transmitter is in operation, operators should follow all safety messages. Potential safety issues are indicated by a warning symbol (▲). Refer to the following safety messages before performing any operation proceeded by a (▲) symbol.

6.2.1 Warning

⚠ WARNING Explosion can result in death or serious injury:

• Do not remove the transmitter covers in explosion-proof environments when the circuit is powered.

• Both transmitter covers must be fully engaged to meet explosion-proof requirements.

⚠ WARNING Electrical shock can result in serious injury:

• When installing transmitters in close proximity of high voltage sources (near power lines) the transmitter leads can be subject to high voltages.

• Avoid contact with the leads and terminals.

⚠ WARNING Electrical shock can result in death or serious injury:

• Only qualified personnel can configure and wire the 3200 Smart Pressure Transmitter.

6.3 Hardware Diagnostics

If there is a failure dispite a diagnostic message on the HHT, Table 6.1 can help troubleshoot the problem.

Symptom	Potential Source	Corrective Action
Transmitter does not Communicate with HART® Communicator	Loop Wiring	• Check for a 250-550 ohms resistance between the power supply and HHT. • Check for adequate voltage to the transmitter (the transmitter requires 11.9 ~ 45 Vdc). • Check for intermittent shorts, open circuits, and multiple grounds.
High Output	Sensor Input Failure	• Connect HHT and enter the transmitter test mode to isolate a sensor failure.
	Loop Wiring	• Check for dirty or defective terminals, interconnecting pins, or receptacles.
	Power Supply	• Check the output voltage of the power supply at the transmitter terminals. It should be 11.9 to 45 Vdc.
	Electronics Module	• Connect HHT and enter the transmitter test mode to isolate module failure. Check the sensor limits to ensure the calibration adjustments are within the sensor range.
Erratic Output	Loop Wiring	• Check the output voltage of the power supply at the transmitter terminals. It should be 11.9 to 45 Vdc. • Check for intermittent shorts, open circuits, and multiple grounds. • Check for proper polarity at the signal terminals.
	Electronics Module	• Connect HHT and enter the transmitter test mode to isolate an electronics mode failure.
Low Output or No Output	Sensor Element	• Connect HHT and enter the transmitter test mode to isolate a sensor failure. • Is the PV out of range.
	Loop Wiring	• Check for adequate voltage to the transmitter (the transmitter requires 11.9 ~ 45 Vdc). • Check for intermittent shorts, open circuits, and multiple grounds. • Check polarity of signal terminal • Check the loop impedance.
	Electronics Module	• Connect HHT and check the sensor limits to ensure calibration adjustments are within the sensor range.

Table 6.1 Troubleshooting

6.4 Hardware Maintenance

The Mercoid® 3200 Smart Transmitter has no moving parts and requires little maintenance. If a transmitter fails, it must be retuned to Dwyer Instruments, Inc. for inspection, repair, or replacement.

6.4.1 Test Terminals

The test terminals are marked TEST on the terminal block. The test and negative terminals are connected to the power terminals; so long as the voltage across the receptacles are below the diode threshold voltage, no current will pass through the diode. To ensure that current isn't leaking through the diode, test the reading with an indicating meter. The test connection should not exceed 10 ohms. A resistance value of 30 ohms will cause an approximate 10 percent of reading error.

Figure 6-1 Test Terminals

6.4.2 Disassembling the Electronics Housing

The transmitter is designed with dual-compartment housing; one contains the electronics module, and the other contains all wiring terminals and the communication terminals.

Figure 6-2 Structure of Housing

6.4.2.2 Fail Mode Jumper Switch and EEPROM-Write

Fail-mode jumper switch and EEPROM-Write is located behind the front cover.

Figure 6-3 Structure of Electronics Module

Appendix I

3200 SMART PRESSURE TRANSMITTER - LCD DISPLAY CODE

Message	Description
ADJ-U	Zero adjustment value – used to configure transmitter when it is out of range (on higher side)
ADJ-L	Zero adjustment value – used to configure transmitter when it is out of range (on low side)
ZERO	Initial message when using Zero button
SPAN	Initial message when using Span button
BT-ERR	Button Sequence error
P-LOCK	Button input error - Protect Locked
ZT-ERR	Zero Trim value is over limit (10%)
-TR-	Zero Trim done
ZR-ERR	Setting Limit error when executing Zero button function
SP-ERR	Setting Limit error when executing Span button function
-ZR-	Zero button function done
-SP-	Span button function done
-ZA-	Zero Adjustment done
-DONE-	Configuration completed using buttons
RNGOVR	Limit error when executing other setting function
LCD_OV	Over Values for LCD
SCD-ER	Sensor Code Error
F-RST	Flash Setting Data Reset
F-LOCK	Flash Setting Data Reset, Protect Locked
F-FAIL	Flash Setting Data Reset Failure
-FR-	Flash Reset done
A-RST	Analog EEPROM Initializing Start
A-STOR	Analog EEPROM Stored
A-FAIL	Failure in writing configuration values on to the EEPROM of transmitter CPU
-AC-	Analog EEPROM Configuration done
S-FL	Sensor Fail
S-OP	Sensor Overpressure
AEP-RF	Check error with EEPROM on CPU board
TS-FL	Temperature Sensor Error
AEP-WF	Analog EEPROM write fail
EOSC	Crystal Element Defect Alarm
FAVE	Flash Access Violation

Diaphragm - Type Diaphragm Seal
Type L990.10 - Standard Welded Diaphragm Seal

WIKA Datasheet L990.10

Applications

Process industry diaphragm seal to combine bourdon tube pressure gauges. Intended for corrosive, contaminated, hot or viscous pressure media.

Features

- Multi-purpose diaphragm seal
- Threaded process connection
- Diaphragm welded to upper housing

Design

The diaphragm is welded to the upper housing which allows the replacement of the lower housing without jeopardizing the integrity of the system fill fluid and installed instrument. The upper and lower housing are bolted together and sealed by use of an O-ring. Process wetted components can be manufactured with solid metallic and nonmetallic materials.

Pressure Rating, Maximum[1]: 3,675 psi

Suitable Pressure Span, Minimum[2]:
Gauge (Range[3]): 2½", ≥ 15 psi
4" or 4½", ≥ 15 psi

Pressure Transmitters (TRONIC)[4]: ≥ 15 psi

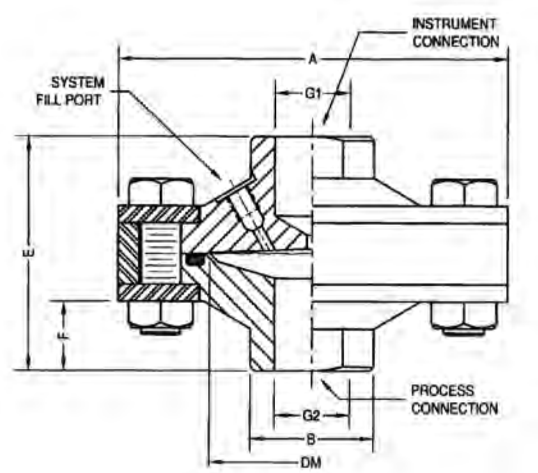
Operating Temperature[5]: -130°F to 752°F (-90°C to 400°C)

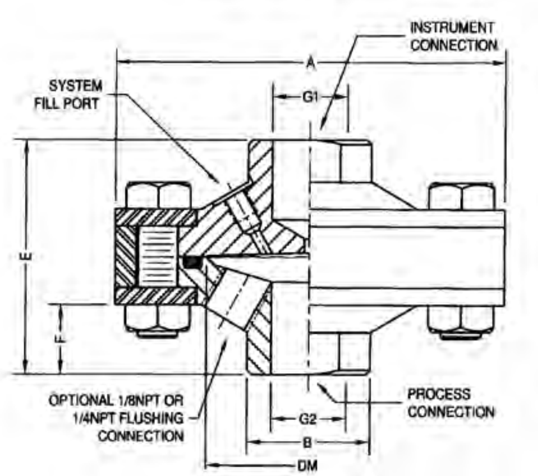
DM: EFFECTIVE DIAPHRAGM DIAMETER
G1: INSTRUMENT CONNECTION
G2: PROCESS CONNECTION
ALL DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED

G1	G2	A	B	DM	E	F	WEIGHT lbs
1/4"NPT OR 1/2"NPT	1/4"NPT OR 1/2"NPT	3.74	1.18	2.1	2.20	0.63	3.0
	3/4"NPT		1.41	2.1	2.36	0.79	3.4
	1"NPT		1.77	2.1	3.46	1.89	3.6

DWG.#2211769-5

Standard Welded Diaphragm Seal Model L990.10





L990.10 Smart Codes for Custom Order Configurations

Field No.	Code	Feature
		Process Connection
	GN2	1/4 NPT Female
	GN4	1/2 NPT Female
	GN5	3/4 NPT Female
	GN6	1 NPT Female
	GNB	1/4 NPT Male
	GND	1/2 NPT Male
	GNE	3/4 NPT Male
	GNF	1.0 NPT Male
1	???	Other - Please Specify
		Nominal Pressure Rating
	XA	200 psi MWP (Maximum 300 °F)
	XB	1500 psi MWP (Standard 4 bolts)
	XT	3675 psi
2	??	Other - Please Specify
		Upper Housing Material
	AP	Carbon Steel 1018 Nickel Plated
	A2	Stainless Steel 316L (1.4435)
	A1	Stainless Steel 316TI (1.4571)
	AE	Titanium Grade 2 (3.7035)
3	??	Other - Please Specify
		Diaphragm Material
	A2	Stainless Steel 316L (1.4435)
	A5	Hastelloy B2 (2.4617)
	A7	Hastelloy C276 (2.4819)
	A8	Monel 400 (2.4360)
	A9	Inconel 600 (2.4816)
	AA	Incoloy 825 (2.4858)
	AB	Tantalum
	AC	Nickel 200 (2.4066)
	AE	Titanium Grade 2 (3.7035) Upper Titanium required
	C2	Carpenter 20
	AG	Stainless Steel 316TI (1.4571) with PTFE-foil
	BB	Stainless Steel 316L with PFA-coating
	BD	Stainless Steel 316TI (1.4571) with Gold Lining 25 µm
4	??	Other - Please Specify
		Lower Housing Material
	AP	Carbon Steel 1018 Nickel Plating
	A1	Stainless Steel 316TI (1.4571)
	A2	Stainless Steel 316L (1.4435)
	A5	Hastelloy B2 (2.4617)
	A7	Hastelloy C276 (2.4819)
	A8	Monel 400 (2.4360)
	A9	Inconel 600 (2.4816)
	AA	Incoloy 825 (2.4858)
5	AE	Titanium Grade 2 (3.7035)

L990.10 Smart Codes for Custom Order Configurations cont'd

Field No.	Code	Feature
		Lower Housing Material (continued)
	AN	Solid Teflon (PTFE) [1] MWP 200 psi
	C2	Carpenter 20
5	??	Other - Please Specify
		Fastening Parts
	A	Retainer Flange and Bolts in Galvanized Steel
	B	Retainer Flange and Bolts in Stainless Steel
6	C	Retainer Flange Stainless Steel and High Tensile Bolts
		Gasket (Process Seal)
	Z	Without
	G	BUNA-N (NBR) Max. 212°F
	J	Viton (FPM) Max. 400°F
	E	Teflon (PTFE) Max. 500°F
	C	Metal Seal Form C, Stainless Steel / Silver
	D	Metal Seal Form C, Inconel / Silver
7	?	Other - Please Specify
		Connection to the Pressure Instrument
	3	1/2 NPT Female
	4	1/4 NPT Female
	5	Axial Weld-in Connection
8	?	Other - Please Specify
		Flushing Connection
	1	Without
	2	1 x 1/8 NPT
	3	1 x 1/4 NPT
	4	2 x 1/8 NPT
	5	2 x 1/4 NPT
9	?	Other - Please Specify
		System Fillport
	A	Without
	C	Filler Hole M6 Set Screw
10	?	Other - Please Specify
		Quality Certificates
	Z	Without
11	1	Quality Certificates
		Additional Order Details
	Z	Without
12	T	Additional Order Details

Note: [1] NO Flushing ports available.
[2] Lot charges for annealing apply

Order Code:

	1	2	3	4	5	6	7	8	9	10		11	12*
L990.10 -											**-**		

*Additional order details ______________________

Description Ordering Code - L990.10

L990.10,1/4X1/4F,CS,CS-0,CS,SS,VI

Gasket Material (See note 10)
VI = Viton®
BN = Buna "N"
TF = Teflon®, virgin
AS = Stainless steel, silver-plated
NA = None (See note 9)

Diaphragm Material
SS = 316L stainless steel
MO = Monel® 400
HB = Hastelloy® B-2
HC = Hastelloy® C-276
PF = 316 stainless steel, Teflon® coated
TF = 316 stainless steel, virgin Teflon® lined
TA = Tantalum
TI = Titanium, grade 2 (See note 8)
NI = Nickel 200
IN = Inconel® 600
IC = Incoloy® 825
CA = Carpenter® 20
SA = 316 stainless steel, gold-plated
VI = Viton® (See note 7)

Clamp & Support Material (Including nuts and bolts)
CS = Carbon Steel, zinc-plated
SS = Stainless steel
HS = High temperature stainless steel (See note 6)
NA = None (See note 5)

Flushing Connection (See note 4)
0 = None
1 = 1/8" NPT female
2 = 1/4" NPT female

Lower Housing Material
CS = Carbon steel, nickel-plated
SS = 316 stainless steel
MO = Monel® 400
HB = Hastelloy® B-2
HC = Hastelloy® C-276
TF = Teflon®, virgin (See note 3)
TI = Titanium, grade 2
NI = Nickel 200
IC = Inconel® 800
IC = Incoloy® 825
CA = Carpenter® 20

Upper Housing Material
CS = Carbon steel, nickel-plated
SS = 316 stainless steel
TI = Titanium, grade 2

Process Connection
1/4F = 1/4" NPT female
1/2F = 1/2" NPT female
3/4F = 3/4" NPT female
1.0F = 1" NPT female
1/4M = 1/4" NPT male
1/2M = 1/2" NPT male
3/4M = 3/4" NPT male

Instrument Connection
1/4 = 1/4" NPT female
1/2 = 1/2" NPT female
CPL = Capillary connection (To weld capillary directly to seal, see note 2)

Diaphragm Seal Design
L990.10 = Welded Diaphragm (Pressure rating up to 3675PSI, see note 1)

Notes

1. Includes previous type 990.10.502.

2. Capillary connection requires a stainless steel upper housing.

3. Teflon® lower housing available in welded diaphragm (type 990.10.501) design only. (MWP 200 psi@ 200°F) Available with 1/4" or 1/2" NPT female process connections only.

4. Customer to supply flushing plug.

5. For all welded design (990.10.520) only.

6. Nuts and bolts only. Clamp rings, support ring and washers are 316 stainless steel. Requires silver-plated stainless steel gasket.

7. Viton® diaphragm is available for clamped design only.

8. For titanium diaphragm welded to upper housing, a titanium upper housing is required.

9. For Teflon® lower housing and all welded design (990.10.520) only. All other lower housings require gaskets.

10. Standard material for stainless steel and carbon steel wetted parts is Viton® (400°F max.). Teflon® is standard for all other wetted parts (500°F max.). Silver-plated stainless steel gasket is used for high temperature applications (752°F max.).

Ordering information
Pressure gauge model / Nominal size / Scale range / Size of connection / Optional extras required
Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing.
Modifications may take place and materials specified may be replaced by others without prior notice.

WIKA Instrument Corporation
1000 Wiegand Boulevard
Lawrenceville, GA 30043
Tel (770) 513-8200 Toll-free 1-888-WIKA-USA
Fax (770) 338-5118
E-Mail info@wika.com
www.wika.com

SECTION 14g: TEMPERATURE TRANSMITTER

P&ID: Item #: TE-0723

Unit Details: **Dwyer Series TTW Temperature Transmitter**
Model TTW 106
Thermal Well TE-TNS-N064N-14

Manufacturer: **Dwyer Instruments, Inc.**
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com

Local Distributor/Contact:

Dwyer Instruments, Inc.
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com

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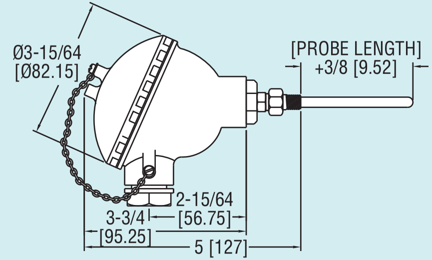
Series TTW

Weatherproof Immersion Temperature Transmitter

Pt100 RTD, PC Programmable Transmitter



The Series TTW Immersion Temperature Transmitter combines three popular products into a single package. Our TBU series head mounted temperature transmitter is factory mounted into our A-709 enclosure. A Pt100 RTD version of our TE series is wired to the transmitter, giving insertion lengths up to 18″. Each transmitter is factory programmed and calibrated to output a 4 to 20 mA signal proportional to the 32 to 212°F (0 to 100°C) temperature range.

Model	Probe Length	Price
TTW-104	4″	$200.00
TTW-106	6″	200.00
TTW-108	8″	200.00
TTW-112	12″	200.00
TTW-118	18″	203.00

Thermowells

Model	Length	Connection (Internal/ External) (NPT)	Price
TE-TNS-N044N-14	4″	1/4″ / 1/2″	$13.25
TE-TNS-N064N-14	6″	1/4″ / 1/2″	15.75
TE-TNS-N094N-14	9″	1/4″ / 1/2″	27.00
TE-TNS-N124N-14	12″	1/4″ / 1/2″	39.25

SPECIFICATIONS

Temperature Sensor

Accuracy: DIN Class B: ±0.3°C @ 0°C (±0.54°F @ 32°F).

Temperature Limits: Operating: -40 to 302°F (-40 to 150°C).

Sensor Curves: Pt100 RTD (TE Series Curve D).

Temperature Transmitter

Input Range: -328 to 986°F (-200 to 530°C).

Output: Two-wire 4 to 20 mA.

Output Impedance: 600 Ω @ 24 VDC.

Power Requirements: 12 to 35 VDC.

Accuracy: ±0.2% FS.

Temperature Limits: -40 to 185°F (-40 to 85°C).

Response Time: <100 msec.

Enclosure

Temperature Limits: -40 to 212°F (-40 to 100°C).

Rating: NEMA 4X (IP65).

Material: Painted aluminum housing.

ACCESSORY

TBU-90, Programming Cable and Software **$80.50**

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SECTION 14h: TURBIDITY METER

P&ID: Item #: **TM-0824**

Unit Details: **H.F. Scientific Model 20053 MicroTol Online Turbidimeter**

Manufacturer: **H.F. Scientific**
3170 Metro Parkway
Fort Myers, FL 33916
Phone: (888) 203-7248
Fax: (239) 332-7643
www.hfscientific.com

Local Distributor/Contact:

Associate Measurement Company
P.O. Box 775
Bellingham, MA 02019
Phone: (508) 966-3060
Fax: (508) 966-3311
www.amcoig.com

Solenoid Valve Information see section 13d

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Water Quality Measurement Solutions

A Watts Water Technologies Company

MicroTOL
Online Turbidimeter Specifications

Instrument Overview

The MicroTOL OnLine Turbidimeter is specifically designed for measuring turbidity continuously in filtered water, raw water, waste water final effluent and industrial applications.

The optional HF Online software allows graphical trending, alarms and filter analysis for multiple networked turbidimeters.

The optional Auto Clean Ultrasonic cleaning system automatically cleans the optical chamber for Finished or Raw water applications.

Standard Features

- **Meets USEPA method 180.1 and ISO 7027 design and performance criteria**
- **Range of 0 - 1000 NTU**
- **One-piece design eliminates the need to mount more than one module per turbidimeter**
- **Fast response time and inexpensive calibration due to low (30 ml) sample volume**
- **Modular design reduces overall costs**
- **Removeable sample cuvettes allow for easy cleaning and calibrating**
- **Optics are not in contact with the sample which reduces the chance of false low readings**
- **Convenient reusable primary calibration standards**

Simple calibration

Optical Design
New optical design allows consistant readings with laboratory and portable turbidimeters.

Bubble Rejection System
The optical chamber of the MicroTOL has been designed to eliminate air in the sample while simultaneously creating a vortex cleaning action throughout the optical chamber.

Calibration
Calibration with primary standards is completed using sealed cuvettes, similar to laboratory procedures. This dry method of calibration is fast, clean and reusable. On-screen menu items guide you through the calibration procedure quickly and easily.

New Design
One-piece mounted design allows for simple mounting and minimal use of space. Increased range of 0-1000 NTU allows for use of low NTU filtered water or raw water. New optical design increases accuracy and provides more consistent readings with online, laboratory and portable turbidimeters.

Light Source
White light is recommended for use in turbidimeters reporting results under US EPA (US standard) jurisdiction. HF scientific has developed NEW krypton filled white light technology with lamp life expectancy up to 7 years. Infrared light is recommended for use in turbidimeters reporting results under ISO 7027 (European standard) jurisdiction. Infrared light is also recommended for waste water final effluent and industrial applications where color is present in the sample stream.

Regulatory
USEPA method 180.1, ISO 7027

Optional Data Network Interface Acquisition System
The data acquisition system is designed to sequentially collect data from a series of interfaced HF scientific, inc. turbidimeters. The software system stores data, prints reports, graphs and alarms on each individual turbidimeter. In addition it can compare filters and monitor individual or multiple filter efficiency.

Certification
Listed or Certified to CE, UL, CSA (ETL,ETLc)

3170 Metro Parkway, Ft. Myers FL 33916 USA • Phone (239) 337-2116 • Fax: (239) 332-7643 • Toll free: 888-203-7248 • www.hfscientific.com

Sample Specifications

The continuous monitoring system shall include a single modular unit with power supply, display and sensor as one single unit. The turbidimeter shall meet all requirements specified by the USEPA Method 180.1 (White Light Model), ISO 7027 (Infrared Model) and Standard Methods 2130B. The turbidimeter shall have a similar optical design to a laboratory turbidimeter, for accuracy. The turbidimeter shall have consistent readings with laboratory and portable turbidimeters. The turbidimeter shall be Modbus compatible. The turbidimeter shall have the option of using an automatic ultrasonic cleaning system in finished or raw water applications. Accuracy shall be 2% of reading or plus or minus .02, whichever is greater, from 0-40 NTU, and 5% of reading or plus or minus .02, whichever is greater, from 40-1000 NTU. Resolution will be 0.0001 NTU (selectable).

The sensor shall consist of a rotational flow through assembly with a 30ml cuvette. The specially designed flow head bubble rejection system eliminates the need for a bubble trap and ensures an immediate response time. The sensor shall be able to accommodate grab samples. Calibration and standardization will be accomplished using small volumes (30ml) of reusable primary standards in a cuvette. The Primary Standards shall be reusable for multiple online turbidimeters and be interchangeable with laboratory turbidimeters. Calibration procedures can be completed without disrupting the sample flow. The lamp source and detector shall not come in contact with the sample, eliminating false low readings. The turbidimeter shall use menu driven software for user ease. The turbidimeter enclosure shall be designed to meet NEMA 4X (IP66) and suitable for outdoor installation. The Online Turbidimeter shall be HF scientific MicroTOL Online Turbidimeter.

Range	0 - 1000 NTU
Measurement Principle	Nephelometry (90 degrees)
Accuracy	2% of reading or ± 0.02 below 40 NTU (whichever is greater), 5% of reading above 40 NTU
Resolution	0.0001 (below 10NTU) Selectable
Response Time	Adjustable (5 to 500 seconds) (0 - 1000 NTU)
Input Pressure	1 - 200psi (built in regulator set at 15psi)
Standard Outputs	4-20 ma Galvanic Isolated or RS-485 (selectable)
RS-485 Protocols	Modbus, HF Simplebus, HF Online Interface
Light Source	White Light - 5 year life, Infrared Light (850nm LED) - 7 year life
User Alarms	2 High / Low Alarms
Alarm Contacts	FORM C 250 VAC 2A
Display	Multiline Custom Backlight LCD
Security Code	Prevents unauthorized access
Built in Diagnostics	Yes
Storage Temperature	-4°F to 140°F (-20°C to 60°C)
Operating Temperature	34°F to 122°F (1°C to 50°C)
Wetted Surfaces	Nylon, Borosilicate Glass, Silicon, Polypropylene, Stainless Steel
Enclosure	Designed to meet NEMA 4X, IP66
Outdoor Installation	34°F to 122°F (1°C to 50°C))
Certifications	USEPA, ISO 7027, CE Approved, ETL Listed to UL 3111-1 and ETL Certified to CSA 22.2 No. 1010-1-92
Dimensions	14 " x 12" x 12" (35 cm x 30 cm x 30 cm)
Shipping Weight	2.5 kg (5.5 lbs.)

Specifications subject to change without notice.

Ordering Information*

Catalog No.	Model	Range in NTU	Ultrasonic Autoclean	USEPA Method 180.1	ISO 7027
20053	#2 White Light	0 - 1000		X	
20054	#2 Infrared	0 - 1000			X
20055	#3 White Light	0 - 100	X	X	
20056	#3 Infrared	0 - 100	X		X
20063	#4 White Light	0 - 1000	X	X	
20064	#4 Infrared	0 - 1000	X		X

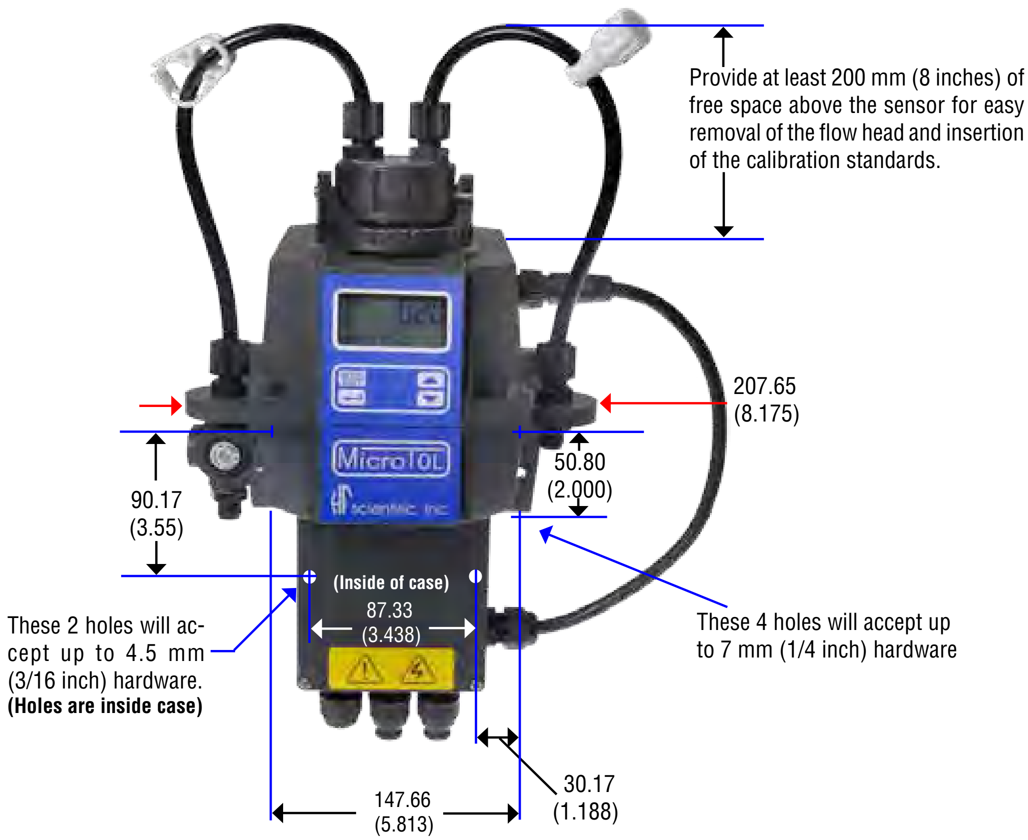
*All models are delivered fully calibrated and include 4-20ma, backlight display, RS-485/ Modbus, inline pressure regulator, desiccant, universal power supply (100-240 VAC) & operator's manual. Model 2 also includes spare measuring cuvette w/light shield.

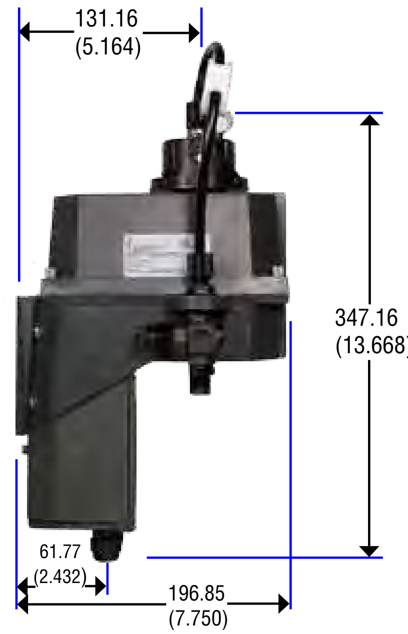
Accessories

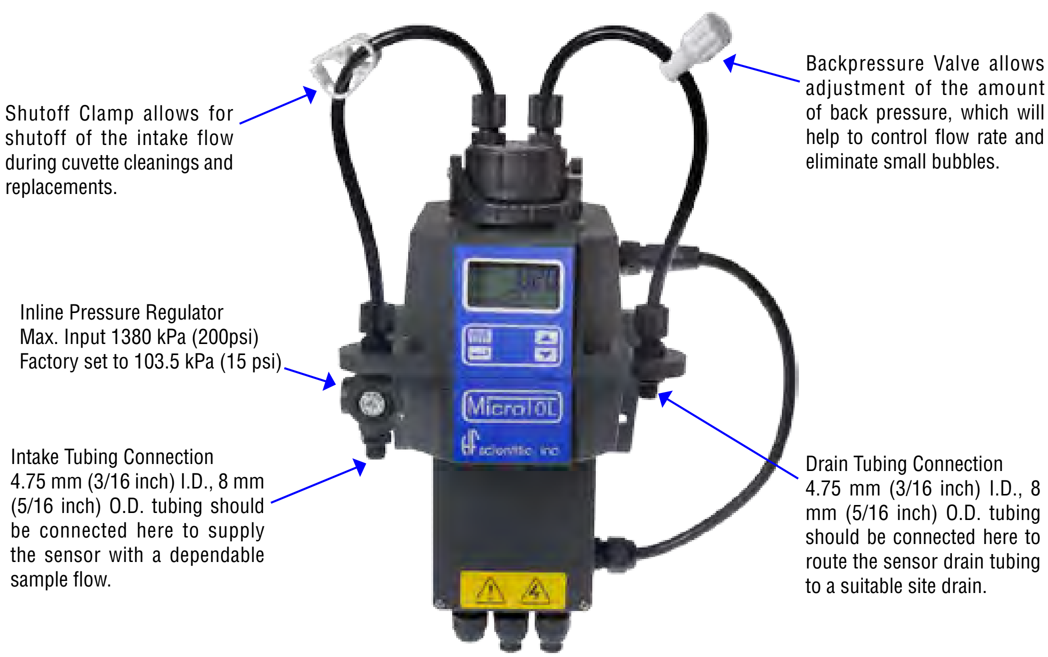
19783	HF OnLine Windows Software for data collection and reporting
19609	Remote Display for an additional digital readout
29953	ProCal Primary Calibration Kit, .02 & 10 & 100 NTU
29957	ProCal Primary Calibration Kit, Full Range, .02, 10 & 1000 NTU
21555R	Desiccant Refill
20779S	Power Cord - 120VAC / 240 VAC

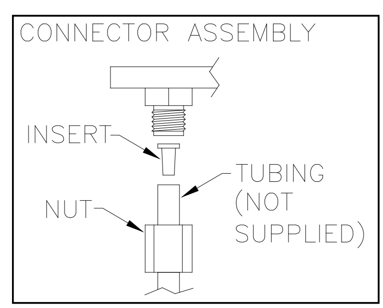
Dimensions

All Dimensions are in millimeters (inches).









OWNER'S MANUAL

MicroTOL Series Turbidimeter

HF scientific
3170 Metro Parkway
Ft. Myers, FL 33916
Phone: 239-337-2116
Fax: 239-332-7643
Toll free: 888-203-7248
E-Mail: HFinfo@Watts.com
Website: www.hfscientific.com

Catalog No. 24034   (5/10)
Rev. 4.8

DECLARATION OF CONFORMITY

Application of Council Directive
Standards to Which Conformity is Declared:

Product Safety - Tested and passed ETL (tested to UL 61010B-1), 1st Edition, Dated January 24, 2003
- Tested and passed ETLc (tested to CSA C22.2#1010.1-92)
- Tested and passed CE to IEC 61010-1: 2001 Edition 2.0

Emissions & Immunity – Tested and passed EN61326-1:2006

Manufacturer's Name:	HF scientific, inc.
Manufacturer's Address:	3170 Metro Parkway, Fort Myers, Florida 33916-7597
Importer's Name:	
Importer's Address:	
Type of Equipment:	Process Turbidimeter
Model No:	Micro TOL

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive and Standard

Place: Fort Myers, Florida USA

(Signature)

Rowan T. Connelly, General Manager

Table of Contents

Table of Contents (continued)

Specifications

Measurement Range	0 – 1000.0 NTU 0 – 100 NTU (Model 20055 & 20056)
Accuracy	±2% of reading or ±0.02 NTU below 40 NTU whichever is greater ±5% of reading above 40 NTU
Resolution	0.0001 NTU (below 10 NTU)
Response Time	Adjustable
Display	Multi-Line Liquid Crystal Backlit Display
Alarms	Two Programmable, 120-240VAC 2A Form C Relay
Analog Output	Powered 4-20 mA, 600 Ω drive
Communications Port	Bi-directional RS-485, Modbus
Maximum Water Pressure	Integral pressure regulator rated 1380kPa (200 PSI.) Also refer to **Flow Rate**
Flow Rate	100 ml/min. – 1 liter/min. (.026-.26 Gal/min)
Operating Temperature	1°C – 50°C (34°F – 122°F)
Wetted Materials	Nylon, Borosilicate Glass, Silicon, Polypropylene, Stainless Steel
Sample Temperature Range	1°C – 50°C (34°F – 122°F)
Power Supply	100 – 240 VAC, 47 – 63 Hz, 80VA
Insulation Rating	Double Insulated, Pollution Degree 2, Overvoltage Category II
Environmental Conditions	Not recommended for outdoor use. Altitude up to 2000 meters Up to 95 % RH (non-condensing)
Enclosure Rating	Designed to meet IP 66 /NEMA 4X
Regulatory Compliance And Certifications	White Light Version compliant to U.S. EPA 180.1 Infrared Version compliant to ISO 7027 CE Approved, ETL listed to UL 61010B-1 & ETL Certified to CSA 22.2 No. 1010-1-92
Shipping Weight	2.5 kg (5.5 lbs.)
Warranty	1 Year from date of shipment

1.0 Overview

The MICRO TOL process turbidimeter allows for the measurement of the turbidity of process water on-line. The White Light MICRO TOL has been designed to meet the design criteria specified by the US EPA 180.1 on turbidity measurement. The infrared MICRO TOL was designed to meet the design criteria specified in ISO 7027 and DIN 27027 for the measurement of the turbidity of a sample. Both models have long life lamps.

Some models have ultrasonic cleaning. Refer to section 8.2 for more information.

A pressure regulator on the incoming line is a standard on all Micro TOL instruments and will reduce pressures up to 1380kPa (200 PSI) down to (104kPa) 15 PSI.

1.1 The Micro TOL Series

The Micro TOL series instruments have a wide variety of options available. Refer to the table below to determine which factory installed options are available.

Catalog No.	Description	RS-485	Modbus	Backlight	Ultrasonic Cleaning	Range NTU	Flow Alarm
20053	Micro TOL2 WL	Standard	Standard	Standard	N/A	0-1000	Option
20054	Micro TOL2 IR	Standard	Standard	Standard	N/A	0-1000	Option
20055	Micro TOL3 WL	Standard	Standard	Standard	Standard	0-100	Option
20056	Micro TOL3 IR	Standard	Standard	Standard	Standard	0-100	Option
20063	Micro TOL4 WL	Standard	Standard	Standard	Standard	0-1000	Option
20064	Micro TOL4 IR	Standard	Standard	Standard	Standard	0-1000	Option

1.2 Unpacking and Inspection of the Instrument and Accessories

The table below indicates the items in the turbidimeter shipment.

Item	Quantity
MICRO TOL Turbidimeter c/w Field Terminal Box & Flow Through Assembly	1
Instruction Manual	1
Desiccant Pack	1
Cuvette (Single Pack)	1
Tubing Kit: 1-shutoff clamp 1-backpressure valve 2-connecting tubing with fittings for flow through assembly 1-drain vent screw (used in pressurized systems)	1

Remove the instrument from the packing carton. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items received do not match the order, please immediately contact the local distributor or the HF scientific Customer Service department.

Note: The spare cuvette part# 50033 is not included for models 20055, 20056 20063 & 20064.

1.3 The Display

Figure 1 illustrates all the items that can appear on the display. The upper row of the display (1) is used for reporting the turbidity levels and to provide user guidance in the customer setting routine. The lower row of the display (2) is used to communicate error messages and provide user guidance. The display has two icons (3) that are used to indicate the use of access code and offset mode. In addition, mode arrows (4) are used to indicate the current instrument operating mode; AUTO (normal operation), CAL (calibration) and CONFIG (configuration).

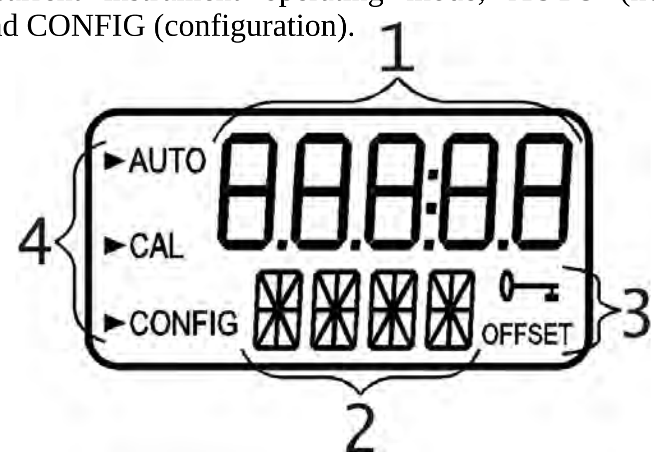


Figure 1 – Display used in the instrument.
All items used on the display are shown in this figure

1.4 The Touch Pad

Figure 2 illustrates the touch pad. The touch pad has four buttons: **MODE/EXIT, ↵, ▲**, and ▼. The **MODE/EXIT** button is used to cycle between the three operational modes of the instrument: **CAL, CONFIG,** and **AUTO** (Measurement) mode. The ↵ button enters the option (or mode that is highlighted or chosen. The ▲ and ▼ buttons are used to change settings.

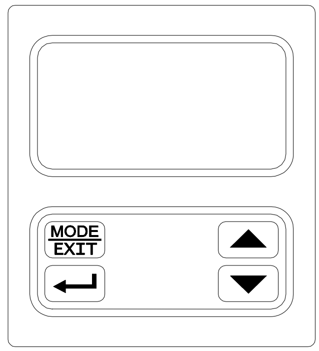


Figure 2: Touch Pad

1.5 Vapor Purge

The Micro TOL is equipped with a continuous vapor purge system. A replaceable desiccant pouch in the lower portion of the instrument dries the air. System heat is used to warm the air. A fan inside the instrument continuously circulates heated dry air around the optical well and the flow through cuvette. This feature eliminates the need for a dry purge line.

The Micro TOL monitors the replaceable desiccant pouch condition continuously. The LCD display will show **DESC** on the lower line in the event that the desiccant pouch needs replacement. Replacement desiccant pouches are available from HF scientific or the local representative (Part # 21555R). Refer to section 10.2 *Replacing or installing the Desiccant Pouch*.

The desiccant can activate an alarm to notify the operator of a saturated desiccant. See section 7.15 *Desiccant Alarm*.

Note: Prior to installing the desiccant pouch for the first time the shipping support must be removed. This tube can be discarded after installation.

2.0 Safety

This manual contains basic instructions that must be followed during the commissioning, operation, care and maintenance of the instrument. The safety protection provided by this equipment may be impaired if it is commissioned and/or used in a manner not described in this manual. Consequently, all responsible personnel must read this manual prior to working with this instrument.

In certain instances **Notes**, or helpful hints, have been highlighted to give further clarification to the instructions. Refer to the *Table of Contents* to easily find specific topics and to learn about unfamiliar terms.

3.0 Installation and Commissioning

Prior to use for the first time, the supplied desiccant pouch will need to be installed. Refer to section 10.2 *Replacing or Installing the Desiccant Pouch*.

3.1 Mounting & Site Selection

The instrument is designed for wall mounting. If wall mounting is not practical, the instrument can be mounted on any suitable level surface. For ease of service there should be about 20 cm (8") free area above the instrument; this will ensure enough room for calibration and cuvette maintenance. Choose a location that is easily accessible for operation and service and ensure that the front display rests at eye level. The overall mounting dimensions of the instrument are shown in Figure 3. The recommended mounting screws are M6 (¼") for the instrument enclosure and M4 (#8) for the field terminal box. The Micro TOL is designed to have the field terminal box cradled under the sensor portion of the instrument. It is recommended that the field terminal box be mounted first, and then the rest of the instrument be mounted on top. The template on the last page of this manual may be used to establish mounting hole locations.

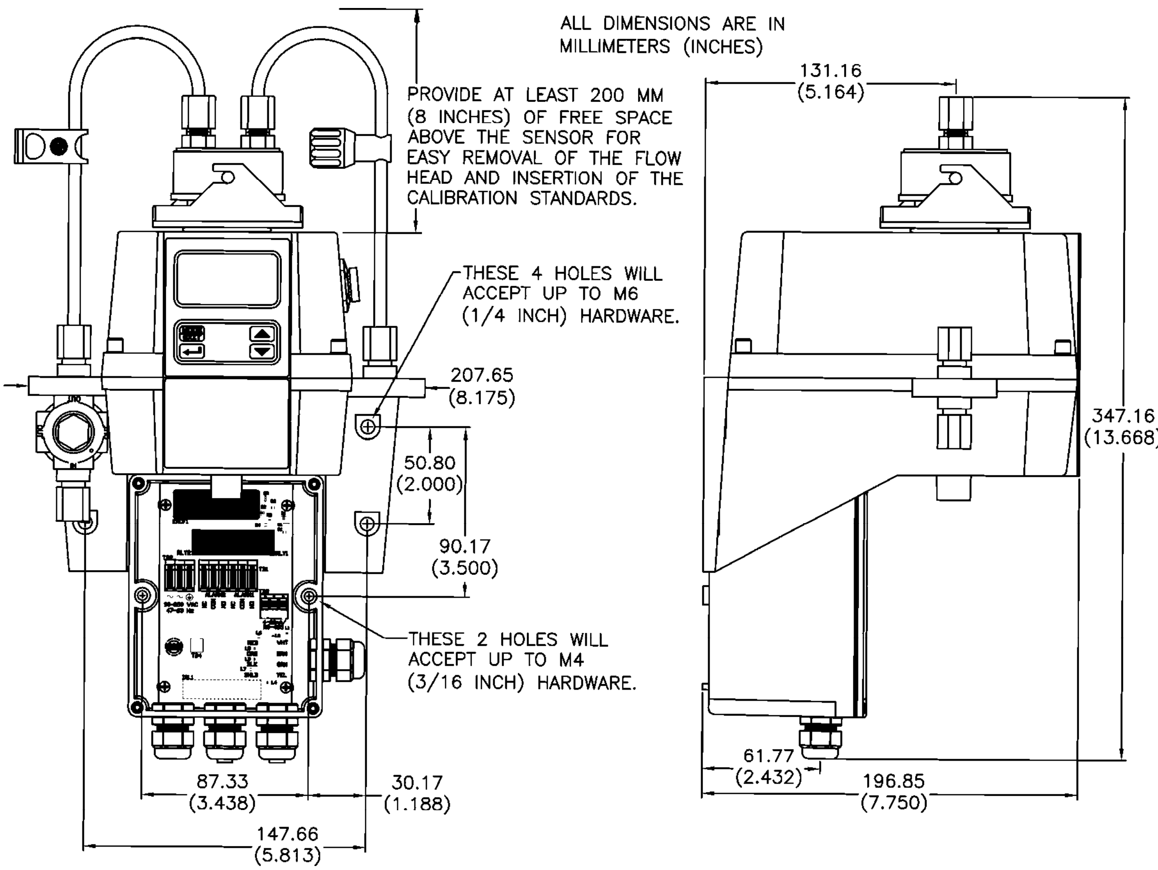


Figure 3: Overall Mounting Dimensions of the Instrument

It is critical that the instrument be mounted as close as possible to the sampling point to ensure a quick response time (within 2-3 meters (6-10 ft) of the sampling point).

3.2 Plumbing

The recommended plumbing for the instrument is shown in Figure 4. The instrument is designed to require very little head pressure to operate; around 6.9kPa (1 PSI). The flow through cuvette is rated for a flow of 100ml/min. – 1 liter/min. (0.026-0.26Gal/min). The integral pressure regulator is rated for a maximum pressure of 1380 kPa (200 PSI.). The maximum allowable fluid temperature is 50°C (122°F).

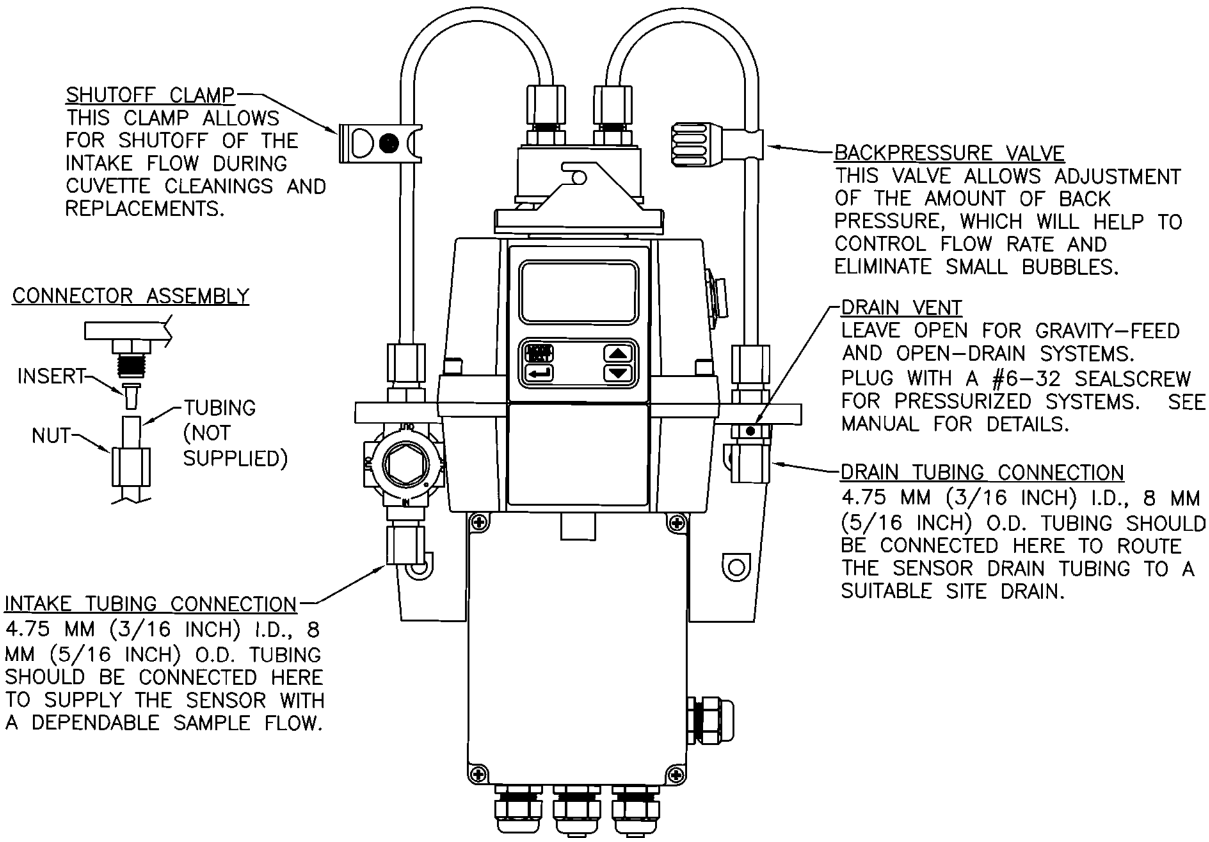


Figure 4: Recommended Plumbing for the Instrument

The instrument is equipped to be plumbed using 4.75 mm (3/16") ID, 8 mm (5/16") OD flexible tubing. Opaque tubing should be used if the tubing will be exposed to sunlight, to prevent algae growth.

In figure 4, there are two flow devices shown. The one on the input side is a shutoff clamp used during cuvette maintenance. The other device is a backpressure valve. Backpressure may be required to prevent air from coming out of solution, which may be observed as tiny air bubbles.

3.2.1 Drain Vent: The Micro TOL has been fitted with a drain vent in the "OUT" bulkhead fitting. This fitting allows for atmospheric equalization, thus helping to alleviate bubble formation in the cuvette. Refer to Figure 4.

Upon initial flow minor leakage may occur through the drain vent. This will subside once normal flow is established.

For some high pressure systems, where the vent hole continuously leaks, a 6:32 seal screw is provided which should be inserted into the vent hole and tightened.

The sensor drain tubing MUST be routed to a suitable drain. DO NOT reintroduce the drain sample to the process stream. This is due to the fact that the wetted materials are not FDA approved. See below for more information.

3.2.2 Wetted Materials: HF scientific accepts no responsibility for damage caused by the introduction of vapors, fluids or other materials into the instrument process stream which is not compatible with the instrument's wetted materials. A list of the wetted materials can be found in the specifications on page 1 of this manual.

3.3 Electrical Connections

All of the electrical connections to the instrument are made through the field terminal box, which should be located directly under the sensor portion of the instrument. The connections are labeled within the terminal box and are self-descriptive (see Figure 5). Please follow all local and government recommendations and methods for installation of electrical connections to and between the instrument and other peripheral devices.

Plugs are inserted into the alarm and 4-20mA/RS-485 cable bulkheads when shipped, to ensure a watertight seal. These plugs should be removed and discarded when cabling to either of these connections.

The power cable bulkhead will accept cable diameters from 5.8mm (.230 in.) up to 10 mm (.395 in.). All terminals are designed to accept wires in the range of 14-28 AWG. All wires should be stripped to a length of 6 mm (¼"). A strain relief strap is provided to reduce tension on the power terminals.

It is the user's responsibility to assure that the watertight seal is maintained after the terminal box has been wired for operation. If any of the bulkheads are not tightened properly around a cable or plug, the ratings of the instrument will be jeopardized and there is a possibility of creating a shock hazard.

Note: Only qualified electricians should be allowed to perform the installation of the instrument as it involves a line voltage that could endanger life.

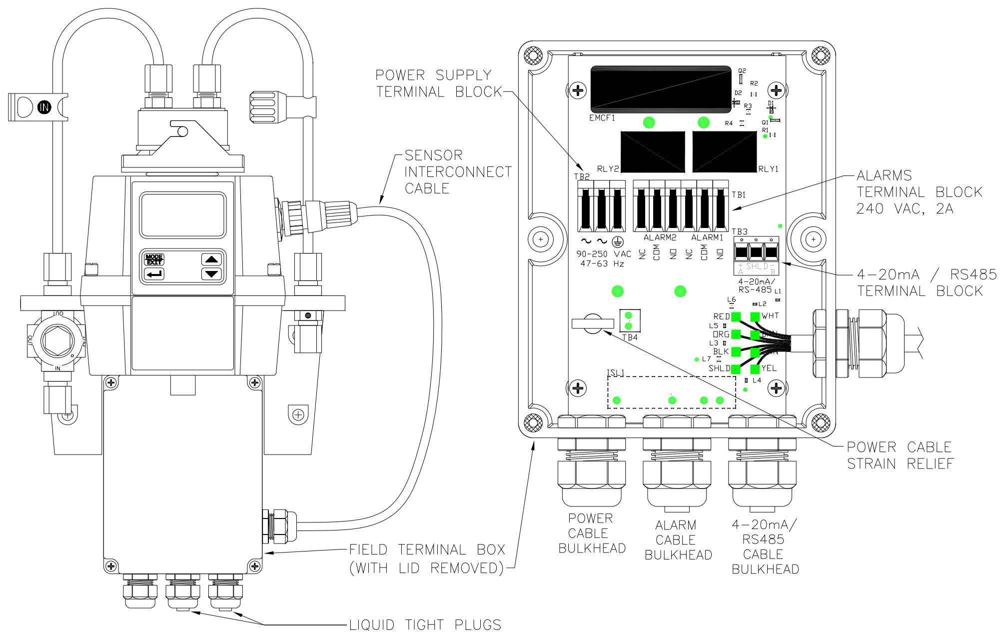


Figure 5: Electrical Connections for the Instrument

3.3.1 Power: The instrument is equipped with a 100-240 VAC, 47-63 Hz switching power supply; please verify that the line voltage falls within these specifications. It is recommended that a circuit breaker be placed prior to the power connection to allow for service. While making connections, refer to Figure 5. **The Micro TOL is not supplied with a power cord**.

3.3.2 RS-485: The RS-485 half-duplex (2-wire) digital interface operates with differential levels that are not susceptible to electrical interferences. This is why cable lengths up to 3000 ft can be implemented. The last device on each bus may require terminating with a 120-ohm resistor to eliminate signal reflection on the line. Do not run RS-485 cables in the same conduit as power.

To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Connections are labeled beneath this termination.

3.3.3 Relays: The Alarm 1 and Alarm 2 relays are mechanical relays rated at 240 VAC 2A. Please note that the relays are labeled NO (Normally Open), NC (Normally Closed) and C (Common). As these alarms are configured fail-safe, the normal condition is with power applied to the Micro TOL and in a non-alarm condition. Operation of these alarms is covered in section *7.5 Configuring the Alarms*.

3.3.4 4-20 mA: The 4-20 mA output is driven by a 15 VDC power source and can drive recorder loads up to 600 ohms. This 4-20 mA output is isolated from line power and earth ground. Do not run 4-20 mA cables in the same conduit as power. Operation of this output is covered in section *7.2 Setting the 4-20 mA*. Optional transformer isolated outputs are available as a factory installed option (Catalog No. 21045A).

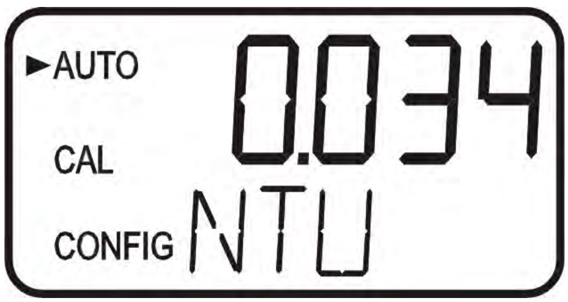
Note: The installation of the 4-20 mA isolator will render the RS-485 non-operational.

Ensure each instrument is not powered when connecting the 4-20 mA. To prevent damage to the instrument, ensure that power is disconnected prior to making connections. For ease of connecting, remove the plug in terminal block. Polarities of the connections are labeled beneath this termination.

4.0 Operation

This process turbidimeter allows for the measurement of the turbidity of process water on-line. The turbidity of the process water is usually reported in **N**ephelometric **T**urbidity **U**nits (NTU), but may be reported in **F**ormazin **N**ephelometric **U**nits (FNU). Readings above 1000 NTU (100 for models 20055 & 20056) are outside the range of this instrument. Readings above 1100 NTU (110 for models 20055 & 20056) will cause the display to flash indicating an over range condition.

During normal operation, the instrument will have the arrow beside **AUTO** highlighted with the current scale displayed on the lower row of the display and the measured reading on the upper row of the display (see illustration below).



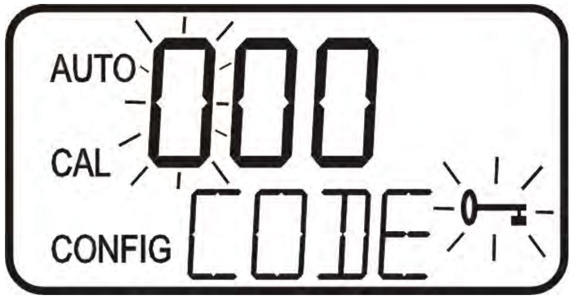
4.1 Routine Measurement

The following steps describe how to measure the turbidity of a sample using this instrument:

1. Apply power to the instrument and allow the unit to warm up (typically 45 minutes – 1 hour on initial commissioning).
2. When a continuous process stream is flowing through the instrument, the instrument will display the measured turbidity level of the sample by displaying it on the LCD screen. In addition, the equivalent signal is provided on the analog (4-20 mA) output, or the digital output, depending on the options selected.

4.2 Security Access Feature

The instrument is equipped with a security access code feature that can be activated in the configuration mode. If the security feature is enabled, the screen shown in the illustration below will appear when the **MODE/EXIT** button is pressed.



The security code (333) must be entered to gain access to **CAL** or **CONFIG** menus. Notice that the first number in the code is flashing; the flashing indicates that this is the number to be changed. Use the ▲ or ▼ arrows to select the first of the three numbers in the code and then press the ↵ button to accept the first number of the code. Now enter the second number in the code. Proceed as with the first number followed by ↵. Then repeat the process for the third number in the access code, and finish with the ↵ button.

If the valid access code has been selected, the instrument will be directed to the calibration mode. If the wrong access code is selected, the instrument will return to the **AUTO** mode. Refer to section 7.7 *Enabling the Security Access* for more information.

5.0 Instrument Calibration

The instrument was calibrated and tested prior to leaving the factory. Therefore, it is possible to use the instrument directly out of the box. Under normal conditions, re-calibration is recommended at least once every three months[1].

Relay contacts will change to the alarm state while the instrument is in the calibration and/or in the configuration mode. While in the calibration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a fifteen (15) minute period of inactivity.

5.1 Calibration Standards

If the Micro TOL will be used over the entire range of .02 to 1000 NTU a complete calibration as described below will be required. If instrument accuracy is only required below 10 NTU, such as potable water, a calibration may be performed using only a 10 NTU and a 0.02 NTU standard. To calibrate starting at the 10 NTU, press the ▼ button to bypass the 1000 NTU and proceed to Section 5.2 *Calibration Procedures*, step 5.

We recommend that the following materials be used during calibration to achieve the full-scale accuracy stated in this manual:

1. 0.02 NTU *ProCal* Calibration Standard available from HF scientific
2. 10.0 NTU *ProCal* Calibration Standard available from HF scientific
3. 1000 NTU *ProCal* Calibration Standard available from HF scientific

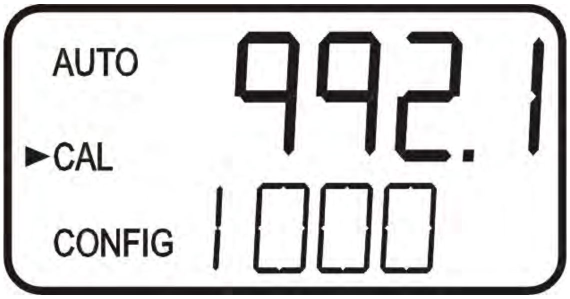
It is well known that diluted Formazin is unstable. If Formazin is used to calibrate the instrument, ensure that a fresh stock suspension of Formazin is used to achieve the accuracy quoted for the instrument. A Formazin Stock Solution Kit is available from HF scientific (Catalog No. 50040). The HF scientific *ProCal*, primary calibration standards (refer to section 11.0 *Accessories and Replacement Parts List*) are more stable than Formazin and have a minimum shelf life of 12 months. Prior to recalibration, review the expiration dates, to ensure that the standards have not expired.

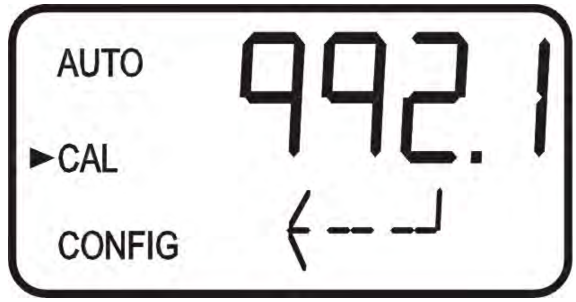
Note: The range of Models 20055 & 20056 is .02 to 100 NTU. For calibrating these models replace the 1000 NTU standard with a 100 NTU standard.

[1] The EPA recommends that on-line turbidimeters be calibrated with a primary standard at least once every three months if they are to be used for EPA reporting.

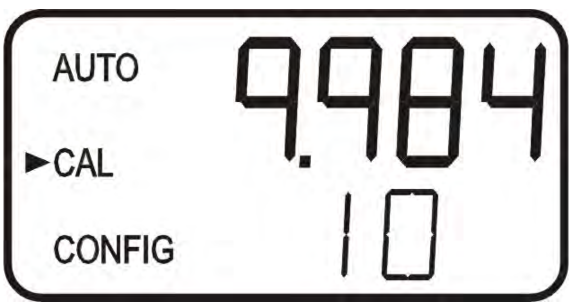
5.2 Calibration Procedures

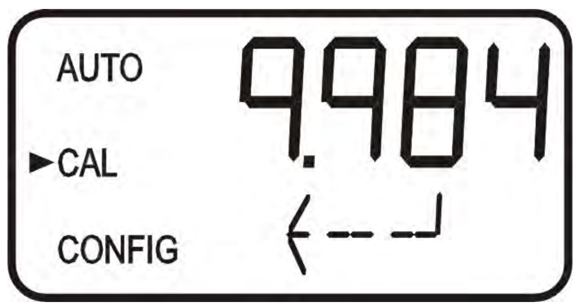
1. Select the calibration function of the instrument by pressing the **MODE/EXIT** button once. The arrow beside **CAL** will be illuminated on the display. The lower display shows alternating **1000 (**the value of the standard that is requested) and ↵. The upper display shows the real-time reading to allow the standard to be indexed. Refer to section 6.1 for information on indexing cuvettes.



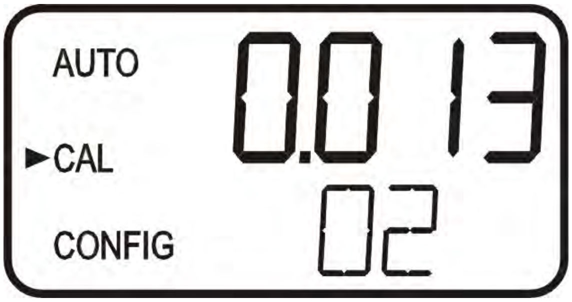


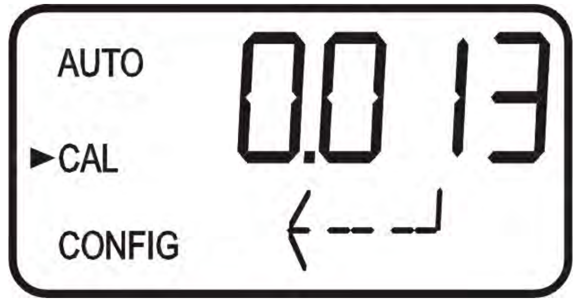
2. Remove the flow through unit.
3. Insert the requested 1000 NTU standard. Index the standard to the lowest value on the upper display.
4. Press the ↵ button to accept the calibration.
5. The lower display will count down the progress of the calibration step.
6. The lower display will now change to show alternating **10** and ↵, requesting the 10.0 NTU standard.





7. If the alternating **10** and ↵ is not displayed, push the ▲ or ▼ until this display is shown.
8. Insert the requested 10.0 NTU standard. Index the standard to the lowest value on the upper display.
9. Press the ↵ button to accept the calibration.
10. The lower display will count down the progress of the calibration step.
11. The lower display will now change to show **02** and ↵, requesting the 0.02 NTU standard.



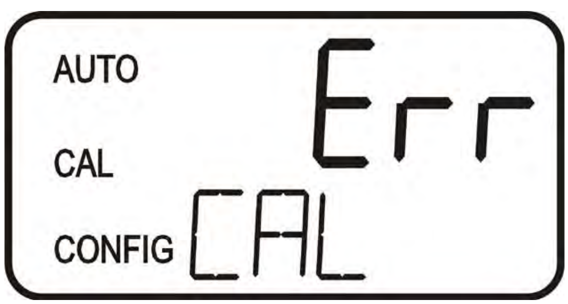


12. Insert the requested 0.02 NTU standard. Index the standard to the lowest value on the upper display.
13. Press the ↵ button to accept the calibration.
14. The lower display will count down the progress of the calibration step.
15. The instrument will return to **AUTO** mode at the end the calibration**.**

Note: During calibration, the fan inside the instrument is turned off to extend the life of the desiccant. The fan will be turned on during calibration countdowns and after returning to the AUTO mode or after five minutes, which ever comes first. It is recommended that the measurement chamber be kept covered during the calibration period and that the flow through cuvette be replaced immediately after the calibration to prevent premature saturation of the desiccant.

5.3 Calibration Error

If the screen shown below, is displayed after calibration, the internal diagnostics have determined that the calibration standards were either bad or that they were inserted in the wrong order. Either check the standards and recalibrate or restore the factory calibration see 6.2 *Restoring Factory Settings*. The instrument cannot be used without performing one of these operations.



To recalibrate press the MODE key and start the calibration sequence again. To restore the factory calibration, push and hold the ⏶ button. Now push and release the ↵ then release the ⏶ button**.**

6.0 Instrument Offset

In certain instances, it may be desirable to use an offset factor to calibrate the instrument rather than performing a physical calibration of the instrument (as described in section 5.2). This procedure is not recommended in lieu of regular instrument calibration but it can be used in situations where the number of instruments used makes regular calibration prohibitive. This calibration technique will make the instrument accurate ***only*** at turbidity levels in the immediate vicinity of the grab sample and ***not*** in the full range of the instrument. Note that the **OFFSET** icon will be illuminated whenever an offset used. The maximum offset is ± 1.00 NTU. If instrument variation is greater than 1 NTU a full calibration is recommended.

The procedures are as follows:

1. Collect a grab sample of the process water that is being monitored by the instrument and record the turbidity reported by the instrument.
2. Take the grab sample and measure its turbidity using a laboratory turbidimeter (contact the HF scientific customer services department for examples of laboratory turbidimeters).
3. Compare the turbidity reported by the instrument to that obtained in the laboratory. If the readings are very close, then no offset adjustment or calibration is required and the procedure may be stopped at this step. However, if the readings are substantially different (but less that 1 NTU), continue on in this procedure to utilize the offset option to improve the turbidity reading of the instrument so that it will agree with the laboratory reading between calibrations.
4. Select the offset function of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated on the display. Refer to the following screen.
5. Push the ↵ button until **OFST** is displayed on the lower row.
6. At this point, the lower row of the display will indicate the operational status of the offset function (**On** or **OFF**). Change this status by using the ▲ and ▼ buttons. Once the desired operational status of the offset function has been set, press the ↵ button to accept it. If the option was turned off, return to **AUTO** mode by pressing **MODE/EXIT.**

7. If the option was turned **On**, the upper row will display the offset required. This will add or subtract the value of the offset to the measured NTU value. As an example if the Micro TOL measures the process at 0.16 NTU but the laboratory instrument read the sample at 0.12 NTU, adding an offset of –0.04 would result in the Micro TOL displaying 0.12 NTU.

   Select the desired offset level using the ▲ and ▼ buttons. Once the desired level has been set, press the ↵ button to accept it.
8. This completes the offset configuration.
9. At this point, the instrument will continue through the configuration (**CONFIG**) mode of the instrument or press **MODE/EXIT** to return to the **AUTO** mode.

6.1 Indexing Calibration Cuvettes

To achieve the greatest accuracy, and account for normal scratches and aberrations in cuvette glass when calibrating, HF scientific recommends indexing the cuvettes.

Standards and standard kits purchased from HF scientific are supplied with indexing rings.

The following steps allow repeatable indexing of calibration standards:

1. With the instrument in AUTO mode insert the standard.
2. Slowly rotate the standard, inside the optical well, one complete revolution (360º). While rotating the standard slowly, observe the measured turbidity and locate the position of the cuvette having the lowest reading.
3. With the calibration standard positioned at the location having the lowest turbidity reading, install the Indexing Ring over the cap on the standard so that the pointer of the Indexing Ring faces directly forward.

When using the standards in future, always insert the standard so that the pointer of the indexing ring faces forward. Slowly rotate the standard back and forth about 5° to find the lowest point. The standard is now indexed and ready for use.

6.2 Restoring Factory Settings

If the instrument is unable to perform a calibration due to a low lamp output or a calibration using the wrong standards, the instrument will display **CAL** on the lower row of the display and **Err** on the upper row. The operator has two choices to correct this problem. If the operator can determine whether a poor calibration or a low lamp caused the problem, he/she can remedy the problem and recalibrate. If all else fails, the operator may restore the factory calibration and configuration settings by performing the following operation. Push and hold the ▲ button. Now push and release the ↵ then release the ▲ button**.** Factory calibration and factory configuration have now been restored.

Note: Restoring the factory settings allows the use of the Micro TOL with reduced accuracy. The original problem still exists and must be determined and corrected before accurate operation of the Micro TOL will be resumed.

7.0 Instrument Configuration (CONFIG mode)

The instrument has been designed to provide the ability to customize the instrument according to needs at any time during normal operation. This mode has been split into sub-menus to facilitate instrument configuration. This section describes how to use each of the sub-menus to configure the instrument. While in the configuration mode, the instrument has a time-out feature that automatically returns the system operation to the **AUTO** mode after a fifteen (15) minute period.

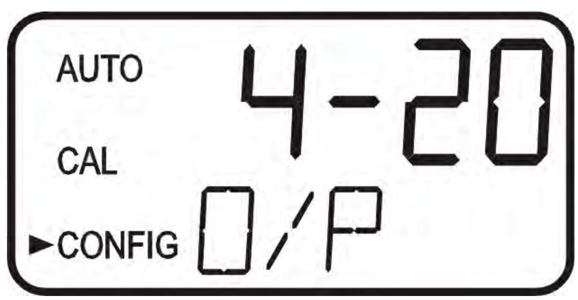
Enter the **CONFIG** mode of the instrument by pressing the **MODE/EXIT** button until the arrow beside **CONFIG** is illuminated, then press the ↵ button.

Note: To exit the CONFIG mode, press the MODE/EXIT button.

7.1 Selecting the Output (O/P)

The first configuration selection is the **O/P**. The selections are **4-20** for the 4-20 mA output, **485** for the RS-485 and **OFF** if no outputs are required. Select the desired output by using the ▲ and ▼ buttons. Once the desired output has been set, press the ↵ button to accept it. The next prompts will depend on the output selected.

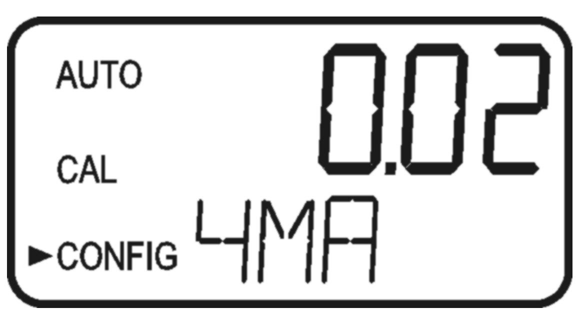
7.2 Setting the 4-20 mA



If the 4-20 mA output was turned on, prompts to set the 4mA **(4MA)** and 20mA **(20MA)** turbidity limits levels will be displayed. There is also a menu to adjust the error level **(ERLV**). The first prompt will be the turbidity limit assigned to the 4 mA output level:

Select the turbidity level to assign to the **4MA** using the ▲ and ▼ buttons.

The factory setting is 0.02 NTU.

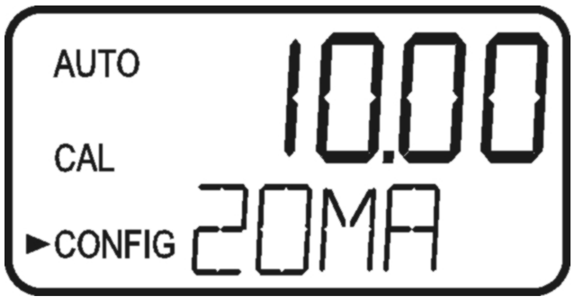


Once the desired level has been set, press the ↵ button to accept it.

Note: The 4MA can be set higher than the 20 MA level to invert the output current if required. This may be required to control a dosing pump

The next, prompt will be the turbidity level assigned to the 20 mA output level (**20MA)** on the lower row of the LCD display). Select the turbidity level to assign to the **20MA** using the ▲ and ▼ buttons. Once the desired level has been set, press the ↵ button to accept it.

The factory setting is 10.00 NTU.



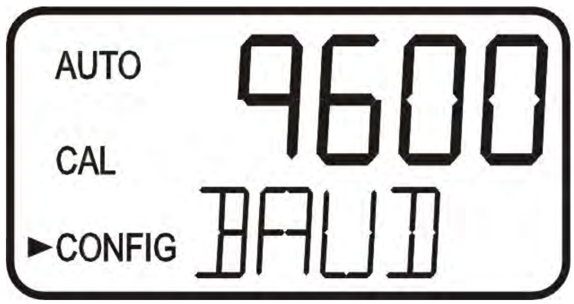
7.3 Configuring the Error Level

In case of an error in the Micro TOL, the 4-20 mA reading can be used to indicate a problem by sending the current to either 4.00 mA, 2.00 mA or 0 mA or OFF. In the case of OFF, the 4-20mA is unaffected by any error condition. The factory default setting is OFF. Select the desired ERLV by using the ▲ and ▼ buttons then press the ↵button to accept the desired error response.

7.4 Configuring the RS–485 Port

If the instrument is equipped with this option, and the I/O selection is changed to **485**, prompts will appear for setting the baud rate and the address.

Select the correct baud rate (1200, 2400, 4800, 9600, or 19200) for operation of the I/O port by pressing the ▲ or ▼ buttons to change the displayed baud rate.



Press the ↵ button to continue on and select the desired instrument address using the ▲ or ▼ buttons. Once the selection is satisfactory, press the ↵ button.

Select the address using ▲ or ▼ buttons. Press the ↵ button to save.

To enable the Modbus mode, select **ASCII** or **RTU**. For more information refer to the Modbus Manual (Catalog #19777). This manual can also be downloaded for no charge at www.hfscientific.com.

7.5 Configuring the Alarms

Two relays are provided that are designed to operate as two independent programmable alarms. Three types of information must be input to fully program each alarm:

1. The alarm function (HI, LO, OFF or Error)
2. The alarm set point (level at which the alarm activates)
3. The delay time for the alarm: the time that the set point must be exceeded prior to alarm activation and the time before resetting the alarm (prevents chatter in the relay)

These three items are described below:

Alarm Function: The alarms can either be turned OFF or programmed to operate in one of three different manners:

1. HI alarm: the relay changes state when the measured turbidity level is higher than the programmed alarm level for a prescribed amount of time.
2. LO alarm: the relay changes state when the measured turbidity level is lower than the programmed alarm level for a prescribed amount of time.
3. Error: the relay changes state when a system error occurs. If a system error occurs a message will appear on the lower row of the screen describing the problem.

Alarm Set Point: The level at which an alarm activates is called the alarm set point. On the instrument, the alarm set point is designated as “S/P”. The set point is adjustable to any valid turbidity level over the range of the instrument in steps of 0.01 NTU.

Alarm Delay Time: The alarm delay times are used to prevent ringing of the alarm when the measured turbidity level is close to the set point. The function of the delay times is as follows:

Delay On: The turbidity level must exceed the alarm set point continuously for at least this number of seconds before the alarm activates.

If the delay on time is set at 5 seconds and the process turbidity exceeds the set point continuously for only 4 seconds, the alarm will not be activated. However, process turbidity exceeds the set point continuously for 5 seconds or more, the instrument will activate the alarm.

Delay Off: The turbidity level must not exceed the alarm set point continuously for at least this number of seconds prior to deactivation of the alarm.

If the delay off time is set to 5 seconds and the process has exited out of the alarm condition, the alarm will be reset only if the process is out of the alarm condition for a continuous 5 seconds. Otherwise, the instrument will still signal an alarm condition.

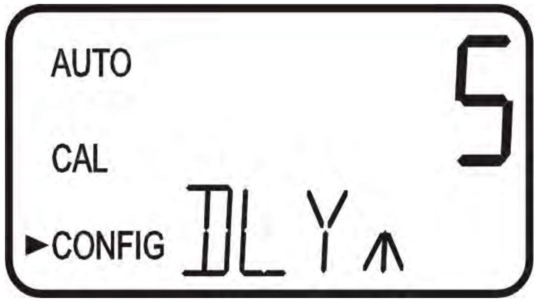
7.5.1 Alarm 1

Alarm 1 Function: The **ALM1** is displayed and the display indicates the current function of alarm 1 (**HI**, **LO**, **OFF** or **Error**). Use the ▲ or ▼ buttons to cycle through and select the desired function. Press the ↵ button to accept the selection.

If the alarm was turned **OFF** a prompt will appear to set up alarm 2 (go to section 7.5.2). If, on the other hand, one of the other functionalities was selected a prompt will appear to set the delay times.

Alarm 1 Set Point: This prompt is used to select the set point for this alarm; this is indicated by “S/P” shown on the lower row of the display. Select the desired alarm level by using the ▲ and ▼ buttons. Once the desired set point has been set, press the ↵ button to accept it.

Alarm 1 Delay Times: *Delay On*: The following display will appear to allow to select the number of seconds currently set for the "delay on" time.



The current selected number of seconds will be shown. Select the desired number of seconds for the "delay on" time for this alarm using the ▲ and ▼ buttons. Once the desired delay time has been set, press the ↵ button to accept it.

Delay Off: Next, the following display will appear to select the number of seconds currently set for the "delay off" time.

The current selected number of seconds will be shown. Select the desired delay off time for this alarm using the ▲ and ▼ buttons. Once the desired delay time has been set, press the ↵ button to accept it. After the settings for alarm 1 have been completed, prompts will allow for the set up of the information on alarm #2.

7.5.2 Alarm 2

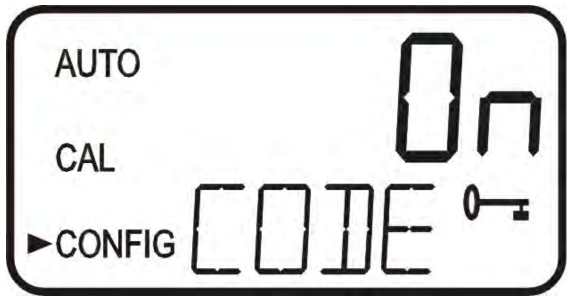
Repeat the procedure listed in section 7.5.1 to set up the parameters for alarm 2. If one of the other functionalities is selected, a prompt to set the delay times and the set point, as with Alarm #1, will be displayed.

7.6 Offset Calibration

Refer to section 6.0 for more information on this selection.

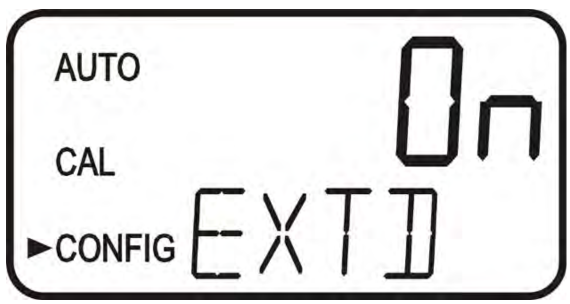
7.7 Enabling the Security Access

The instrument is equipped with a security access. If this option is turned on, the user is required to input the access code into the instrument to get to any mode other than **AUTO**. The only code is **333**. This code may not be changed. See section 4.2 for more information on this security feature. The security key icon will be visible and flashing on the display whenever the access option is selected using the ▲ or ▼ buttons. (**On** or **OFF**).



7.8 Extended Settings

The last few settings are grouped together to prevent them from being adjusted by accident. To gain access to the extended settings, select **On** using the ▲ or ▼ buttons and press the ↵ button.



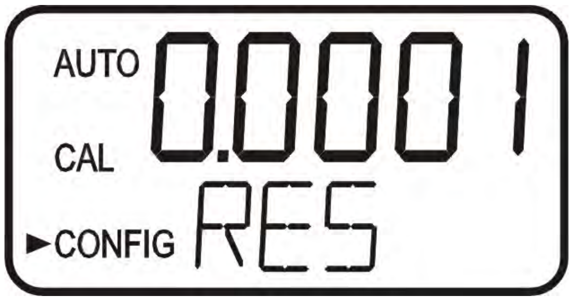
7.9 Speed of Response

The speed of response for both displayed and output values of NTU can be adjusted in this menu. The default setting is 10, however 100 response speeds are available. Although the displayed number is a relative speed, the approximate response time, in seconds, is the displayed number multiplied by 5. Select the desired speed of response using the ▲ and ▼ buttons. Press the ↵ button to accept it.

To avoid reading air and other anomalies, select the slowest speed (highest number). Select the fastest response where monitoring of rapid changes is needed.

7.10 Displayed Resolution

The instrument is equipped with the ability to display several levels of resolution. The instrument can display up to four digits to the right of the decimal place for turbidity readings below 10 NTU. The default setting is 0.01 NTU. If the last digit or two is not stable, adjust the resolution to hide these digits.



Change the resolution by pressing the ▲ or ▼ button. When the desired digit resolution has been selected, press the ↵ button.

7.11 LCD Backlight Brightness

The LCD backlight brightness may need to be adjusted. This is of particular interest if multiple instruments are located in the same area and it is desired for the entire group to have the same appearance. Ten levels are available. The default brightness is 8.

Change the brightness by pressing the ▲ or ▼ button. When the desired brightness has been selected, press the ↵ button.

7.12 Setting the Units

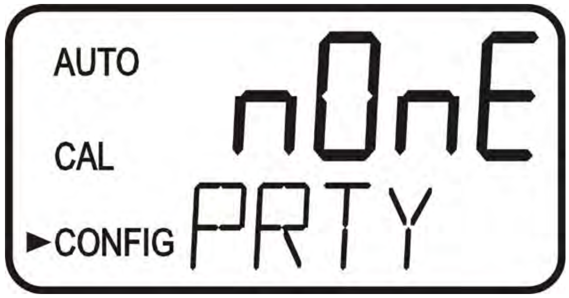
The most common unit is **NTU** (Nephelometric Turbidity Units) however the instrument can display in **FNU** (Formazin Nephelometric Units). All instruments are shipped from the factory set in NTU mode. Make a selection using the ▲ and ▼ buttons then press the ↵ button.

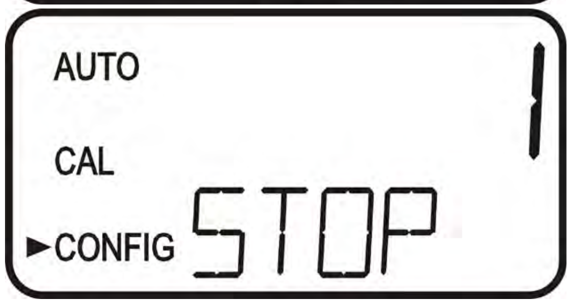
7.13 Ultrasonic Cleaning (Model 20055, 20056, 20063 & 20064)

This allows for a selection menu to turn off the ultrasonic cleaning function if desired. The default mode is On. Make a selection using the ▲ and ▼ buttons then press the ↵ button.

7.14 RS-485 Parameters

For instruments manufactured on or after June 2003, the following menus can be used to modify the RS-485 parameters. These menus will only appear if the RS-485 is enabled (see 7.1). The default is 8 Bit, no (nOnE) Parity, 1 Stop Bit. Make selections using the ▲ and ▼ buttons then press the ↵ button to move to the next menu.





7.15 Desiccant Alarm

When the humidity detector in the Micro TOL indicates that the internal environment is close to the point where humidity could cause condensation, the instrument will display **DESC** as a screen warning.

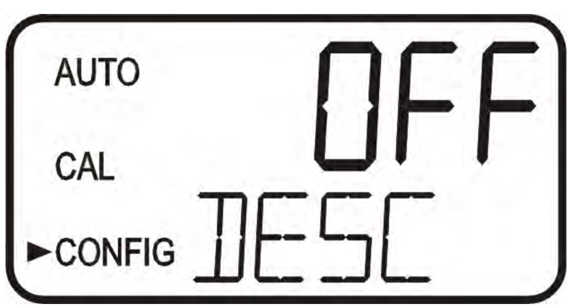
If desired, a desiccant warning can:

- Activate the alarms relays.
- Can activate an alarm condition on the 4-20mA.

To activate the alarm relays when the desiccant fails, select set one or both alarms to Error (see section 7.5 *Configuring the Alarms*).

To activate an alarm condition on the 4-20 mA set the ERLV to one of the three alarm states (see section 7.3 *Configuring the Error Level*)

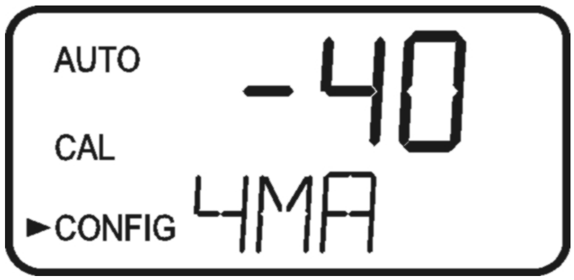
For either alarm modes to activate **On** must be selected in the **DESC** menu. The default for this menu is **OFF**. Make selections using the ▲ and ▼ buttons then press the ↵ button to move to 4-20 mA calibration.



7.16 4mA Adjustment

If the 4-20 mA setting is turned ON (*7.2 Setting the 4-20 mA Output*), the following two menus will appear. The first menu outputs a constant 4 mA while allowing for a small amount of adjustment. The adjustment can be made using the ▲ and ▼ buttons. This adjustment will allow the operator to make the Micro TOL agree with a PLC or SCADA system. The adjustment limits are ± 200 counts or about ± 0.2 mA.

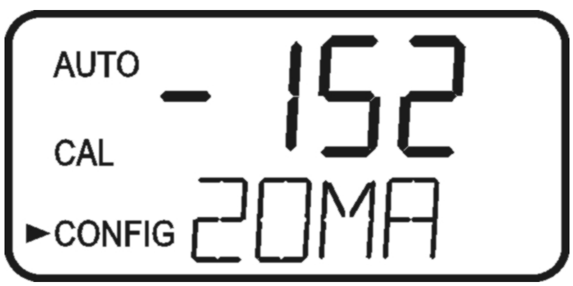
This setting will be slightly different on each instrument as each Micro TOL will be factory set to 4.00mA. Press the ↵ button when adjustments are complete to save this setting and move on to the 20mA adjustment.



7.17 20mA Adjustment

This menu operates similar to the previous menu. This menu outputs a constant 20 mA while allowing for a small amount of adjustment. The adjustment can be made using the ▲ and ▼ buttons. The adjustment limits are ± 1000 counts or about ± 1 mA.

This setting will be slightly different on each instrument as each Micro TOL will be factory set to 20.00mA.



7.18 Saving Configuration Settings

If extended settings are set to **OFF**, pressing the ↵ button will save all settings and the Micro TOL will automatically return to the normal **AUTO** mode of the instrument.

If extended settings are set to **On**, after the last menu of the extended settings, pressing the ↵ button will save all settings and the Micro TOL will automatically return to the normal **AUTO** mode of the instrument.

The **CONFIG** menu may be used at any time to reset or change any of the parameters. The **CONFIG** menu may be exited at any point in the menu by using the **MODE/EXIT** key. Any features that have been modified will be saved.

8.0 Additional Features and Options

8.1 Backlit LCD
The backlit LCD allows for easier readability of the LCD display in low light or no light conditions. The backlight is intended for continuous operation. The brightness is adjustable from a menu in the **CONFIG** mode.

8.2 Ultrasonic Cleaning (Models 20055, 20056, 20063 & 20064)
This factory installed option is used to continuously clean the flow through cuvette. It is not intended to clean cuvettes that are already dirty, or replace manual cleaning entirely. The system will increase the time between cleanings dramatically. Please note that the system requires the use of a special cuvette. This cuvette must be used for the system to operate correctly.

The system works by sending an ultrasonic frequency through spring connections into a piezo transducer bonded to the bottom of a flow through cuvette (refer to figure 6).

The system can detect that an incorrect cuvette is installed, an error has occurred in the transducer or the transducer is not making contact with the spring connections. This error is indicated by **CLN** being posted to the lower screen. Since this is an error condition, this may affect the 4-20 mA and alarms depending in the setting of the ERLV (4-20 mA) and if an alarm is set up to Error.

If the correct cuvette is installed, and the error is still posted, try rotating the flow through unit slightly to improve the connection. If this fails to work, the cuvette may have to be replaced (Catalog #24166S). The detection for this cuvette only operates in **AUTO** mode. If the system is operating correctly **AUTO** will flash on the display.

***Hint:** The connection can be improved with use of a small film of an anti-oxidant compound such as OX-GARD ™ made by GB Electrical Inc. This product is available in the electrical section at most hardware stores.*

Note: The cuvette must be completely dry before it is inserted into the sensor. If there is any visible moisture present on the cuvette or transducer, there is a great risk of damaging the sensor electronics and the transducer. Be sure to clean and dry the cuvette completely just before inserting it into the sensor.

The Vapor Purge system can <u>NOT</u> remove large droplets of water, only residual moisture.

Note: For the Vapor Purge system to function properly, all instrument seals must be maintained and the desiccant pack must be in good condition (no DESC display).

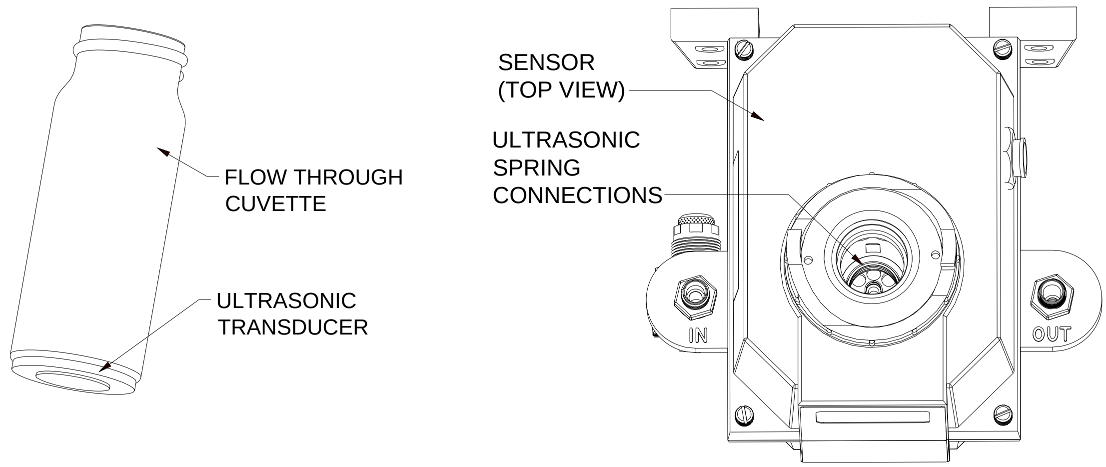


Figure 6: Operational parts of the Ultrasonic Cleaning System

8.3 RS-485 Outputs

The Micro TOL has the capability to operate in three different RS-485 modes for all models. Included is a mode for interfacing into the HF Online software package (section 8.3.1 below), and a simple communication mode. A third operating mode is the Modbus communications. All modes will automatically configure and do not require any changes or selections.

8.3.1 HF Online (HF catalog # 19783)

The Micro TOL can operate as a small SCADA system with an optional PC software package, called HF ONLINE. This system allows for an interface with up to 255 Micro TOL's for the purpose of data logging. This system will interface directly with common database and spreadsheet software.

8.3.2 Simple Communication

The Micro TOL can provide basic communications over simple programs such as the Hilgraeve HyperTerminal that is included with most Microsoft Windows packages. The user could also use Visual Basic or other programs. The default communication parameters are 8 bits, no parity and 1 stop bit. These can be changed in the Extended **CONFIG** menus 7.14 *RS-485 Parameters*.

The master computer will send out:

- Byte #1 the attention character "**:**" in ASCII or **3A** Hex
- Byte #2 the address of the Micro TOL being queried
- Byte #3 & 4 CR LF or 0D 0A in hex

The Micro TOL will respond with:

- The same attention character “**:**” in ASCII or **3A** Hex
- The address of the Micro TOL
- The Reading
- The Unit (NTU)

A sample communication would look like this:

(Master computer requesting a report from address #1) **: 1 CRLF**

(Micro TOL set to address #1 Response) **:001 0.0249 NTU**

8.3.3 Modbus Communication

Modbus protocol communication is operational on all models. The Modbus information is covered in a separate manual (Catalog # 19777). This manual is also available as a free download from our website at www.hfscientific.com.

8.4 Flow Alarm (Catalog # 19945A)

The flow switch for the Micro TOL is a factory-installed option. This option indicates a “Low Flow” condition by switching both relays to the fail state and setting the 4-20 mA signal to 2 mA. There is also a screen indication of the low flow condition and a modbus register is set.

8.5 Flow Controller (Catalog # 19778)

The flow controller limits the flow, in high-pressure systems, to safe flow limits of less than 1 liter/minute.

8.6 Remote Panel Meter (Catalog # 19609)

The remote panel meter allows for remote indication of the NTU reading using the 4-20 mA loop. No external power is required as the meter is run off of the 4-20 mA source.

9.0 Troubleshooting & Maintenance

9.1 Micro TOL Fault Detection

The Micro TOL performs continuous diagnostic monitoring. In the Micro TOL there are three levels of fault detection; warnings, errors and failures. Any faults are displayed in a queue form in the bottom row of the LCD. How these faults are indicated depends on the settings made in sections 7.3 ***Configuring the Error Level*** and 7.5 *Configuring the Alarms*. If ERLV is set to OFF and Alarms are not set to Error, there will be no remote, indication of a problem.

If the desiccant alarm is turned off and the desiccant becomes saturated only a screen **warning** of **DESC** will appear and no alarms are activated. Another **warning** of **ALM1** or **ALM2** is displayed if an alarm is set and the threshold is exceeded.

An **error** indicates a failure or a problem that usually can be corrected by the operator. These errors consist of:

- Lamp out **LAMP**.
- 4-20 mA loop open **MA**.
- Bad calibration **CAL**.
- If desiccant alarm activated and replacement required **DESC**.
- If enabled and no flow **FLOW** (if equipped with the flow switch).
- If the Micro TOL is equipped with ultrasonic cleaning, an additional message will indicate that the ultrasonic transducer is not making contact or the flow through has been removed **CLN**.

If any of these errors occur the instrument will still display readings, however the accuracy is not known and the instruments readings may not be reliable.

A **failure** is a system fault. This is NOT a problem that the operator can correct, and the unit must be returned to the factory for service. These failures consist of failures in the CPU, A/D, EEPROM or other devices internal to the instrument (**FAIL**). If a failure occurs, the instrument will not function properly and will display the word FAIL on the lower row.

If any fault conditions occur, the message indicating the fault will be shown on the lower row of the display.

9.2 System FAIL Message

Normally, this condition indicates that the instrument will require servicing. Contact either the HF scientific Technical Service Department or the HF scientific Customer Service Department.

HF scientific
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116
Fax: (239) 332-7643
Toll free: 888-203-7248
Email:HFinfo@Watts.com
www.hfscientific.com

9.3 Diagnostic Chart

Symptom	Cause	Cure
Lower display shows **MA**	4-20 mA loop open	Check wiring. See sections 3.3.4 and 7.2
Lower display shows **DESC**	Desiccant pouch bad	Change desiccant pouch. See section 10.2
Lower display shows **LAMP**	Lamp failed	Replace lamp. Refer to section 10.3
Lower display shows **FLOW**	Sample flow has stopped	Restore flow. Contact HF about factory installed option
Lower display shows **FAIL**	Major system fault	Refer to section 9.1 & 9.2
Readings are higher than expected	**(1)** Bubbles in solution	**(1)**Ensure that the drain vent is open and is not obstructed. See section 3.2.2. **(2)**Apply backpressure. See section 3.2 and figure 4 **(3)** For sever cases of bubbles a stilling chamber is available. Call HF scientific. Part# 20106
	(2) Condensate or leaky cuvette	Check flow through cuvette for condensate or leaks.
	(3) Flow through cuvette dirty	Clean cuvette. See section 10.1
	Instrument out of calibration	Recalibrate. Refer to section 5
Readings are erratic	**(1)** Bubbles in solution **(2)** Debris in flow through	**(1)** See above **(2)** Clean debris from cuvette
Readings are lower than expected	Instrument out of calibration	Recalibrate. Refer to section 5
Upper display flashes	Sample Over-Range	Check sample. Sample may be too high to read.

9.4 Technical and Customer Assistance

If for any reason assistance is needed regarding this instrument please do not hesitate to contact either the HF scientific Technical Service Department or the HF scientific Customer Service Department:

HF scientific
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116 Fax: (239) 332-7643
Toll free: 888-203-7248
Email: HFinfo@Watts.com
www.hfscientific.com

10.0 Routine Maintenance

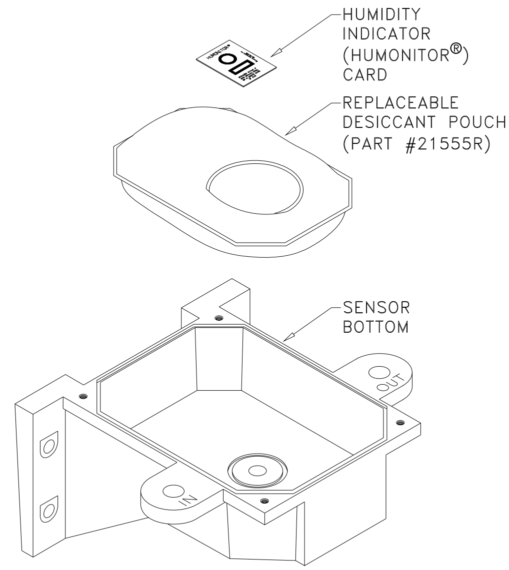
10.1 Cleaning the Flow Through Cuvette

Measurement cuvettes used for both grab sample and the flow through should be clean and free of marks or scratches. Cleaning is accomplished by cleaning the interior and exterior with a detergent solution and then rinsing several times with distilled or de-ionized water. The cuvette can be replaced by first shutting off the flow using the provided shutoff clamp; unscrewing the old cuvette and replacing with a fresh clean one.

10.2 Replacing or Installing the Desiccant Pouch

The Micro TOL continuously checks the condition of the desiccant. When the desiccant gets in such a condition that it may cause problems, the instrument will display **DESC** on the lower portion of the display to indicate the presence of humidity. See 7.15 *Desiccant Alarm*.

Proper use of the supplied desiccant is essential in maintaining the performance of the instrument. The desiccant has been designed to have a long life; however, replacement of the desiccant pouch will be required from time to time.



It is essential that the enclosure seal on the instrument base be maintained to ensure adequate desiccant life. Inspect the seal each time the desiccant pouch is replaced. Replace or reseat the seal if it is found to be defective.

The desiccant should be replaced when the instrument displays **DESC**. A new sealed desiccant pouch and indicator card are available from HF scientific part #21555R.To initially install or remove the old desiccant, simply unscrew the four corner thumbscrews and remove the electronics half of the instrument. Open the bag protecting the new desiccant pouch and replace (or install for a new instrument) in the instrument base assembly. To speed up the recognition, by the instrument, of the new desiccant it will be necessary to reset the instrument by disconnecting the sensor interconnect cable for 2 seconds and then reconnecting it.

Note: Once the bag is opened, install the desiccant pouch immediately to prevent premature degradation of the desiccant.

10.3 Replacing the Source Lamp

The source lamps in the Micro TOL's are designed for long life. The IR lamp is rated for 10 years and the white light version is rated for 7 years. If the lamp should need replacement, we recommend calling HF Service Department for assistance.

11.0 Accessories and Replacement Parts List

The items shown below are recommended accessories and replacement parts.

Accessory	Catalog Number	
	White Light	Infrared
Electronic Service Module For Micro TOL 2	02053	02054
Electronic Service Module For Micro TOL 3	02055	02056
Electronic Service Module For Micro TOL 4	02063	02064
Operating Manual, Micro TOL	24034	
ProCal Calibration Kit, .02, 10 & 100 NTU	39953	
ProCal Calibration Kit, Full Range, .02, 10 & 1000 NTU	39957	
Formazin Stock Kit	50040	
Formazin Stock Solution, 4000 NTU, 500 ml	70914	
Replacement Desiccant Pouch	21555R	
Software for data collection and reporting	19783	
Flow Regulator, Micro TOL	19778	
Pressure Regulator	24306S	
Replacement Cuvette – MicroTOL 2 (3 pack)	50036	
Replacement Cuvette with Ultrasonic Transducer	24166S	
Tubing Kit Containing: 1-shutoff clamp, 1-backpressure valve, 2-connecting tubing with fittings for flow through assembly, drain vent.	21062	

To order any accessory or replacement part, please contact the HF scientific Customer Service Department. If for any reason technical assistance is needed regarding this instrument please do not hesitate to contact the HF Technical Services Department.

HF scientific
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Fax: (239) 332-7643
Toll free: 888-203-7248
Email: HFinfo@Watts.com
www.hfscientific.com

12.0 Warranty

HF scientific inc., as vendor, warrants to the original purchaser of this instrument that it will be free of defects in material and workmanship, in normal use and service, for a period of one year from date of delivery to the original purchaser. HF scientific inc.'s obligation under this warranty is limited to replacing, at its factory, the instrument or any part thereof. Parts, which by their nature are normally required to be replaced periodically, consistent with normal maintenance, specifically reagent, desiccant, sensors, electrodes and fuses are excluded. Also excluded are accessories and supply type items.

Original purchaser is responsible for return of the instruments, or parts thereof, to HF scientific' inc.'s factory. This includes all freight charges incurred in shipping to and from HF scientific inc.'s factory.

HF scientific inc .is not responsible for damage to the instrument, or parts thereof, resulting from misuse, environmental corrosion, negligence or accident, or defects resulting from repairs, alterations or installation made by any person or company not authorized by HF scientific inc.

HF scientific inc. assumes no liability for consequential damage of any kind, and the original purchaser, by placement of any order for the instrument, or parts thereof, shall be deemed liable for any and all damages incurred by the use or misuse of the instruments, or parts thereof, by the purchaser, its employees, or others, following receipt thereof.

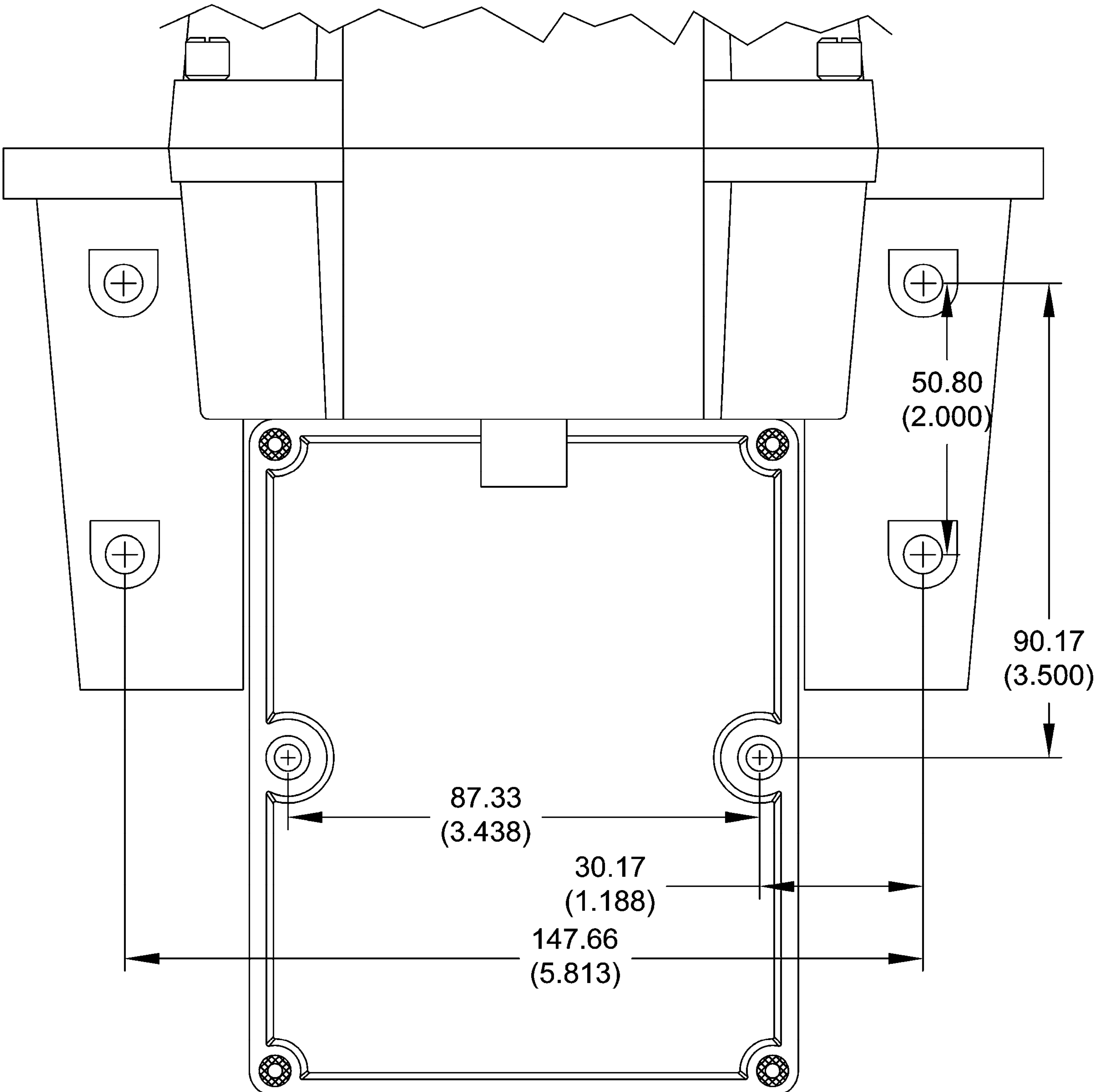
Carefully inspect this product for shipping damage, if damaged, immediately notify the shipping company and arrange an on-site inspection. HF scientific inc cannot be responsible for damage in shipment and cannot assist with claims without an on-site inspection of the damage.

This warranty is given expressly and in lieu of all other warranties, expressed or implied. Purchaser agrees that there is no warranty on merchantability and that there are no other warranties, expressed or implied. No agent is authorized to assume for HF scientific inc., any liability except as set forth above.

HF scientific, inc.
3170 Metro Parkway
Fort Myers, Florida 33916-7597
Phone: (239) 337-2116
Fax: (239) 332-7643
Toll free: 888-203-7248
Email: HFinfo@Watts.com
Website:www.hfscientific.com

MOUNTING TEMPLATE

ALL DIMENSIONS ARE IN MILLIMETERS (INCHES)



NOTE:

1) SEE THE MOUNTING INSTRUCTIONS IN THE MANUAL FOR MOUNTING HARDWARE SIZES.

2) PROVIDE AT LEAST 200 MM (8 INCHES) OF FREE SPACE ABOVE THE SENSOR FOR EASY REMOVAL OF THE FLOW HEAD AND INSERTION OF THE CALIBRATION STANDARDS.

SECTION 14i: LEVEL TRANSMITTERS

P&ID: Item #: LS-0221

Unit Details: **Equalization Tank Level Transmitter**
Dwyer Mercoid Series PBLT2 Submersible Level Transducer
Model PBLT2-10-70

P&ID: Item #: LS-0621

Unit Details: **Post Anoxic Tank Level Transmitter**
Dwyer Mercoid Series PBLT2 Submersible Level Transducer
Model PBLT2-10-40

P&ID: Item #: LS-1121

Unit Details: **Dosing Tank Level Transmitter**
Dwyer Mercoid Series PBLT2 Submersible Level Transducer
Model PBLT2-10-60

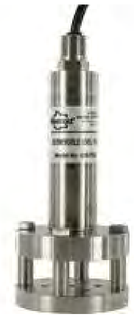
P&ID: Item #: LS-0825

Unit Details: **Permeate / Backwash Tank Level Transmitter**
Dwyer Series 626 Industrial Pressure Transmitter
Model 626-07-CH-P1-E5-S1

Manufacturer: **Dwyer Instruments, Inc.**
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com

Local Distributor/Contact:

Dwyer Instruments, Inc.
102 Indiana Hwy 212
Michigan City, IN 46360
Phone: (219) 879-8000
Fax: (219) 872-9057
www.dwyer-inst.com



Series PBLT2 & PBLTX
Submersible Level Transmitter

Perfect for Sludge and Slurries, Lightning Protected, Intrinsically Safe

Product Specifications

Service: Compatible liquids.

Wetted Materials: 316 SS, 316L SS, Buna-N, cable: ETFE or polyurethane.

Accuracy: ±0.25% full scale (includes linearity, hysteresis, and repeatability).

Temperature Limit: PBLT2: 0 to 200°F (-18 to 93°C), PBLTX: 0 to 176°F (-18 to 80°C).

Compensated Temperature Range: PBLT2: 0 to 180°F (-18 to 82°C), PBLTX: 0 to 176°F (-18 to 80°C).

Thermal Effect: ±0.02% FS/°F.

Pressure Limit: 2X full scale.

Power Requirement: PBLT2: 13 to 30 VDC, PBLTX: 10 to 28 VDC.

Output Signal: 4 to 20 mA DC, two wire.

Response Time: 50 msec.

Loop Resistance: 900 Ω.

Electrical Connection: Wire pigtail.

Mounting Orientation: Suspended in tank below level being measured.

Weight: 4.3 lb (2.0 kg).

Electrical Protection: PBLT2: Lightning and surge protection, PBLTX: none.

Agency Approvals: PBLT2: None, PBLTX: CE, cUL, UL intrinsically safe for Class I, Div. 1, Groups A, B, C, D; Class II, Div. 1, Groups E, F, G; Class III, Div. 1. (According to control drawing 01-700797-00).

Product Details
Pricing / Ordering
Introduction
Specifications
Options/Accessories
Features
Applications
Approvals
Model Chart
Instruction Manuals
Dimensional Drawings
Catalog Pages
Related Products
Product Images
Product Downloads

Add to My Favorite Pages

Product Videos
Informational Video

Informational Video

Series PBLT2 & PBLTX
Submersible Level Transmitter
Perfect for Sludge and Slurries, Lightning Protected, Intrinsically Safe

Product Model Chart

EXAMPLE	**PBLT2**	**60**	**500**	**LSP**	**Series PBLT2-60-500-LSP Lightning and Surge Protected Submersible Level Transmitter, 60 psi sensor, 500' cable length, with 2 year lightning surge protection guarantee.**
SERIES	PBLT2 PBLTX				Lightning & Surge Protected Submersible Level Transmitter Intrinsically Safe Submersible Level Transmitter
SENSOR		5 7.796 10 12.992 15 20 25 30 60 100 3.5M 5M 10M 100M			5 psi Sensor 7.796 psi Sensor (18' w.c.) (available on PBLT2 only) 10 psi Sensor 12.992 psi Sensor (30' w.c.) 15 psi Sensor 20 psi Sensor 25 psi Sensor 30 psi Sensor 60 psi Sensor (available on PBLT2 only) 100 psi Sensor (available on PBLT2 only) 3.5 meters (available on PBLT2 only) 5 meters(available on PBLT2 only) 10 meters(available on PBLT2 only) 100 meters(available on PBLT2 only)
CABLE LENGTH			X XM		Cable Length in Feet (minimum: 10'; maximum: 2000') Cable Length in Meters (minimum 1m; maximum 600m)
OPTIONS				PU 2YR LSP	Polyurethane Cables (ETFE is standard) 2 Year Warranty 2 Year Lightning Surge Protection Guarantee (available on PBLT2 only)

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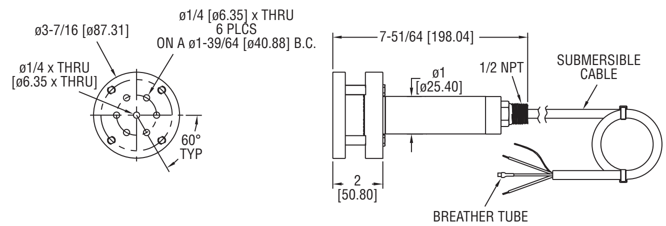
CABLE LENGTH:

EQ Tank - *70 feet*
Post Anoxic Tank - *40 feet*
Dosing Tank - *60 feet*

Series PBLT2 Submersible Level Transducer

Specifications - Installation and Operating Instructions



The PBLT2 Submersible Level Transducer is manufactured for years of trouble free service in the harshest applications. The PBLT2 measures the height of liquid above its position in the tank referenced to atmospheric pressure. The transducer consists of a piezoresistive sensing element, encased in a 316 SS housing. Perfect for wastewater and slurry applications with features to protect the unit from these demanding applications. Superior lightning and surge protection utilizing dual arrestor technology, grounded to case, eliminating both power supply surges and lightning ground strike transients (surge protection is not guaranteed and is not covered by warranty). Large diameter 316 SS diaphragm seal is non-clogging and damage resistant to floating solids.

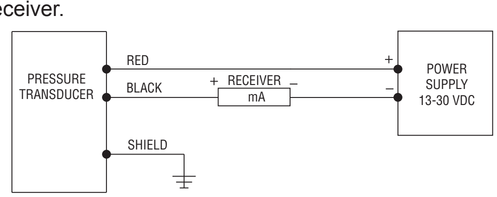
Comes equipped with a 270-pound tensile strength, shielded, vented cable. Ventilation tube in the cable automatically compensates for changes in atmospheric pressure above the tank. The vent tube has a filter attached to the end that will block particles, such as dust, dirt, and water droplets, from entering the tube.

APPLICATIONS

• Wastewater: sludge pits, clarifiers, digesters; Alum tanks; Chemical storage tanks; Oil tanks; Lime slurry; Sumps; Reservoirs.

ELECTRICAL INSTALLATION

An external power supply delivering 13-30 VDC with minimum current capability of 40 mA DC (per transmitter) is required to power the control loop. See figure below for connection of the power supply, transmitter and receiver.



The maximum receiver load resistance (RLmax) for the DC power supply voltage (Vsup) is expressed by the formula:

$$RLmax = \frac{Vsup - 13V}{0.02A}$$

Shielded cable is recommended for control loop wiring.

SPECIFICATIONS

Service: Compatible liquids.
Wetted Materials: 316 SS, 316L SS, epoxy adhesive; Cable: Polyether polyurethane or ETFE.
Accuracy: ±.25% full scale.
Temperature Limits: 0 to 200ºF (-18 to 93°C).
Compensated Temperature Range: 0 to 180ºF (-18 to 82°C).
Thermal Effect: Less than ±.02%/°F.
Pressure Limit: 2X full scale.
Power Requirement: 13 to 30 VDC.
Output Signal: 4 to 20 mA DC, two wire.
Response Time: 50 msec.
Loop Resistance: 850 ohms at 30 VDC.
Electrical Connection: Wire pigtail.
Mounting Orientation: Suspended in tank below level being measured. Can be placed on the bottom of the tank on its side.
Weight: 4.3 lb (2.0 kg).
Electrical Protection: Lightning and surge protection.

Model Number Guide

Example	**PBLT2**	**20**	**40**		**PBLT2-20-40**
Construction	**PBLT2**				Cage style submersible level transmitter, ETFE cable
Range		**XXX**			In psi (5000 psi maximum)
Cable Length			**XXX**		In feet (1500 feet maximum)
Options				**PU**	Polyurethane cable

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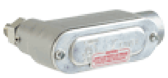
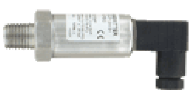

Conduit

General Purpose


Series 626 & 628
Industrial Pressure Transmitter

Complete Offering of Ranges, Connections and Outputs

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Product Specifications

Service: Compatible gases and liquids.

Wetted Materials: Type 316L SS.

Accuracy:
626: 0.25% FS; 0.20% RSS;
628: 1.0% FS; 0.5% RSS;
626 Absolute Ranges: 0.5% FS; 0.35% RSS.
(Includes linearity, hysteresis, and repeatability).

Temperature Limit: 0 to 200°F (-18 to 93°C).

Compensated Temperature Range: 0 to 175°F (-18 to 79°C).

Thermal Effect: ±0.02% FS/°F. (includes zero and span).

Pressure Limits: See Catalog page.

Power Requirements: 10-30 VDC (for 4-20 mA, 0-5, 1-5, 1-6 VDC outputs); 13-30 VDC (for 0-10, 2-10 VDC outputs); 5 VDC ±0.5 VDC (for 0.5-4.5 VDC ratio-metric output).

Output Signal: 4-20 mA, 0-5 VDC,1-5 VDC, 0-10 VDC, or 0.5-4.5 VDC.

Response Time: 50 msec.

Loop Resistance: 0-1000 Ohms max. R max = 50 (Vps-10) Ohms (4-20 mA output), 5K Ohms (0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output).

Stability: 1.0% FS/year (Typ.).

Current Consumption: 38 mA maximum (for 4-20 mA output); 10 mA maximum (for 0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output); 140 mA maximum (for all 626/628/629-CH with optional LED).

Electrical Connections: Conduit Housing (-CH): terminal block; 1/2" female NPT conduit. General Purpose Housing (-GH): cable or DIN EN175801-803-C.

Process Connection: 1/4" male or female NPT and BSPT.

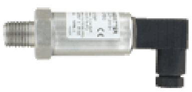
Enclosure Rating: NEMA 4X (IP66).

Mounting Orientation: Mount in any position.

Weight: 10 oz (283 g).

Agency Approvals: CE.


Conduit



General Purpose

Series 626 & 628
Industrial Pressure Transmitter

Complete Offering of Ranges, Connections and Outputs

CE

Product Model Chart

EXAMPLE	**626**	**30**	**CH**	**P1**	**E1**	**S1**	**AT**	**Series 626-30-CH-P1-E1-S1-AT Industrial Pressure Transmitter, 0.25% full scale accuracy, range 15-0 psia, conduit housing, 1/4" male NPT, cable gland with 3' of prewired cable, 4-20 mA output, with aluminum tag.**
SERIES	626							0.25% Full Scale Accuracy
	628							1.0% Full Scale Accuracy
RANGE		30						15-0 psia
		23						0-7.5 psia
		00						0-15 psia
		01						0-30 psia
		02						0-50 psia
		03						0-100 psia
		04						0-200 psia
		05						0-300 psia
		31						0-500 psia
		32						3-15 psig
		06						0-5 psig
		28						0-10 psig
		07						0-15 psig
		27						0-25 psig
		08						0-30 psig
		09						0-50 psig
		10						0-100 psig
		11						0-150 psig
		12						0-200 psig
		24						0-250 psig
		13						0-300 psig
		25						0-400 psig
		14						0-500 psig
		22						0-600 psig
		29						0-750 psig
		15						0-1000 psig
		16						0-1500 psig
		17						0-2000 psig
		18						0-3000 psig
		19						0-5000 psig
		26						0-8000 psig
		61						1-0 bar absolute
		62						0-2.5 bar absolute
		63						0-4 bar absolute
		64						0-6 bar absolute
		65						0-8 bar absolute
		66						0-10 bar absolute
		89						0-16 bar absolute
		67						0-0.5 bar
		68						0-1 bar
		69						0-1.5 bar
		70						0-2 bar
		71						0-2.5 bar
		72						0-3 bar
		92						0-4 bar
		73						0-5 bar
		91						0-6 bar
		74						0-7 bar
		75						0-10 bar
		76						0-15 bar
		90						0-16 bar
		77						0-17 bar

?

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		78 93 79 80 81 82 83 84 85 86 87 88						0-20 bar 0-25 bar 0-30 bar 0-35 bar 0-40 bar 0-70 bar 0-100 bar 0-150 bar 0-200 bar 0-350 bar 0-500 bar 0-550 bar
HOUSING			CH GH					Conduit Housing, NEMA 4X, IP66 General Purpose Housing, NEMA 4X, IP66
PROCESS CONNECTION				P1 P2 P3 P5 P8 P9				1/4" Male NPT 1/4" Female NPT 1/4" Male BSPT 1/4" Female SAE with Refrigerant Valve Depressor (1) 1/8" Male NPT (1) 1/2" Male NPT (1)
ELECTRICAL CONNECTION					E1 E2 E3 E4 E5 E6 E7 E8			3' Cable 6' Cable 9' Cable Heirschmann DIN Plug (1) 1/2" Female NPT Conduit Connection(2) M-12 4-Pin Connector Heirshmann DIN Plug with 6' Cable (1) Packard Connector (1)
SIGNAL OUTPUT						S1 S2 S3 S4 S5 S6 S7		4-20 mA 2 Wire 1-5 Volts 2-10 Volts 0-5 Volts 0-10 Volts 1-6 Volts 0.5-4.5 Volts Ratiometric
OPTIONS							AT NIST LED SPCL	Aluminum Tag NIST Traceable Certificate Bright Red LED Display (2,3) Special Cleaning for Oxygen Use

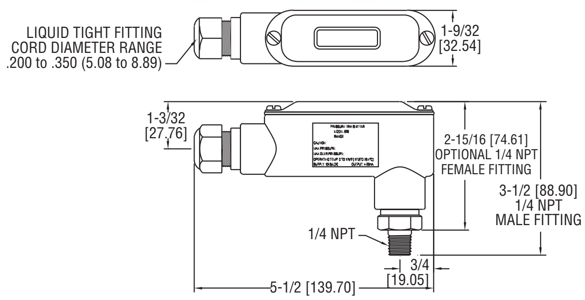
(1) Available with -GH Housing only
(2) Available with -CH Housing only
(3) LED option is not NEMA 4X.

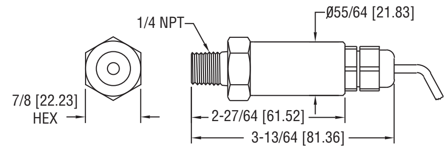
Series 626 & 628 Pressure Transmitters

Specifications - Installation and Operating Instructions

-CH Conduit Housing

-GH General Purpose Housing





The Series 626 and 628 Pressure Transmitters converts a single positive pressure into a standard 4-20 mA output signal. The Series 626 and 628 can be used to accurately measure compatible gases and liquids; Series 626 full scale accuracy is 0.25%; Series 628 full scale accuracy is 1.0% (see specifications). Designed for industrial environments with a NEMA 4X (IP66) housing, this transmitter resists most effects of shock and vibration.

CAUTION: Do not exceed specified supply voltage ratings. Permanent damage not covered by warranty will result. This device is not designed for 120 or 240 volt AC operation. Use only on 13 to 30 VDC.

Pressure Ranges		
Pressure Range	**Maximum Pressure**	**Over Pressure**
0-15 psia	30 psia	45 psia
15-0 psia	30 psia	45 psia
0-30 psia	60 psia	90 psia
0-50 psia	100 psia	150 psia
0-100 psia	200 psia	300 psia
0-200 psia	400 psia	600 psia
0-300 psia	600 psia	900 psia
0-5 psig	10 psig	50 psig
0-15 psig	30 psig	150 psig
0-30 psig	60 psig	300 psig
0-50 psig	100 psig	300 psig
0-100 psig	200 psig	500 psig
0-150 psig	300 psig	750 psig
0-200 psig	400 psig	1000 psig
0-300 psig	600 psig	1500 psig
0-500 psig	1000 psig	2500 psig
0-1000 psig	2000 psig	5000 psig
0-1500 psig	3000 psig	5000 psig
0-2000 psig	4000 psig	5000 psig
0-3000 psig	6000 psig	7500 psig
0-5000 psig	7500 psig	10000 psig
0-8000 psig	10000 psig	12000 psig

SPECIFICATIONS
Service: Compatible gases and liquids.
Wetted Materials: Type 316 SS.
Accuracy:
626: 0.25% FS;
: 0.20% RSS;
628: 1.0% FS;
: 0.5% RSS;
626 absolute ranges: 0.5% FS;
: 0.35% RSS.
(Includes linearity, hysteresis, and repeatability).
Temperature Limit: 0 to 200°F (-18 to 93°C).
Compensation Temperature Range: 0 to 175° (-18 to 79°C).
Thermal Effect: 626: ±0.02% FS/°F. 628: ±0.04% FS/°F (includes zero and span).
Pressure Limits: See table.
Power Requirements: 10-30 VDC (for 4-20 mA, 0-5, 1-5, 1-6 VDC outpus); 13-30 VDC (for 0-10, 2-10 VDC outputs); 5 VDC ±0.5 VDC (for 0.5-4.5 VDC ratio-metric output).
Output Signal: 4-20 mA, 0-5 VDC,1-5 VDC, 0-10 VDC, or 0.5-4.5 VDC.
Response Time: 50 msec.
Loop Resistance: 0-1000 Ohms max. R max = 50 (Vps-10) Ohms (4-20 mA output), 5K Ohms (0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output).
Current Consumption: 38 mA maximum (for 4-20 mA output); 10 mA maximum (for 0-5, 1-5, 1-6, 0-10, 2-10, 0.5-4.5 VDC output); 140 mA maxumum (for all 626/628/629-CH with optional LED).
Electrical Connections: Conduit Housing (-CH): terminal block, 1/2˝ female NPT conduit; General Purpose Housing (-GH): cable DIN EN 175801-803-C.
Process Connection: 1/4˝ male or female NPT and BSPT.
Enclosure Rating: NEMA 4X (IP66).
Mounting Orientation: Mount in any position.
Weight: 10 oz (283 g).
Agency Approvals: CE.

INSTALLATION

1. Location: Select a location where the temperature of the transmitter will be between 0 and 175°F (-18 to 79°C). Distance from the receiver is limited only by total loop resistance. The tubing or piping supplying pressure to the unit can be practically any length required but long lengths will increase response time slightly.

2. Position: The transmitter is not position sensitive. However all standard models are originally calibrated with the unit in a position with the pressure connection downward. Although they can be used at other angles, for best accuracy it is recommended that units be installed in the position calibrated at the factory.

3. Pressure Connection: Use a small amount of plumber's tape or other suitable sealants to prevent leaks. Be sure the pressure passage inside the port is not blocked.

4. Electrical Connections
Wire Length -The maximum length of wire connecting the transmitter and receiver is a function of wire size and receiver resistance. Wiring should not contribute more than 10% of the receiver resistance to total loop resistance. For extremely long runs (over 1000 feet), choose receivers with higher resistance to minimize the size and cost of connecting leads. Where wiring length is under 100 feet, wire as small as 22 AWG can be used.

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CURRENT (4-20 mA) OUTPUT OPERATION

An external power supply delivering 10-30 VDC with minimum current capability of 40 mA DC (per transmitter) is required to power the control loop. See Fig. A for connection of the power supply, transmitter and receiver. The range of appropriate receiver load resistance (R_L) for the DC power supply voltage available is expressed by the formula:

$$R_L \text{ Max} = \frac{\text{Vps} - 10}{20 \text{ mA DC}}$$

Shielded cable is recommended for control loop wiring.

Current Output

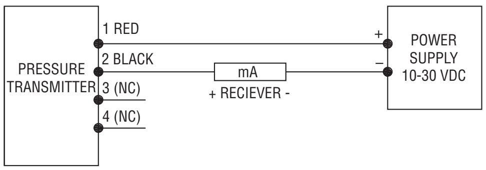

Fig. A: Current output connection

Conduit Housing with 4-20 mA Output (-CH) Electrical connections to the pressure transmitters are made to the terminal block located inside the housing. Remove the screws and lift off the cover. Wire as shown in Fig. A, B or C. Use Fig. A for current output connection. Use Fig. B for current output with optional LED display. Use Fig. C for current output with optional LED display using two power supplies.

If ordering optional pre-wired cable, black wire is negative (-) and red wire is positive (+).

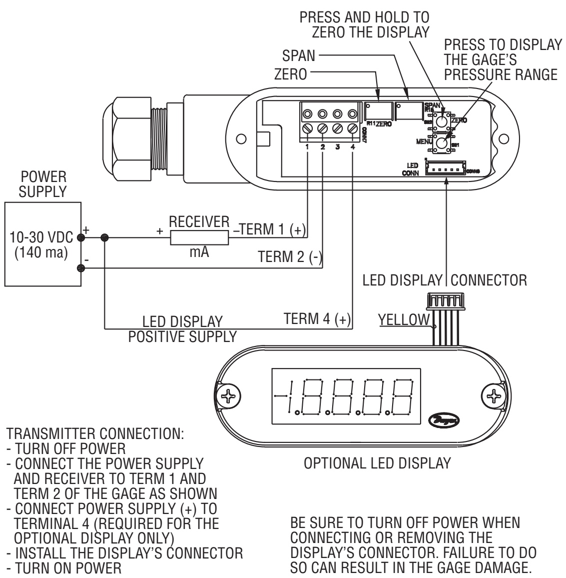

Fig. B: Current output with optional LED display connection

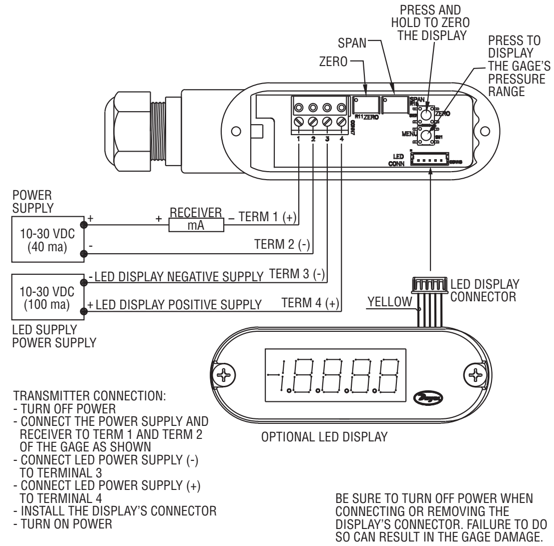

Fig. C: Current output with optional LED display using two power supplies

Heirschman DIN Connector with 4-20 mA When using cable version of -GH General Purpose Housing, black wire is negative (-) and red wire is positive (+). When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. D. For optional 4-pin M-12 connector, wire to pins as shown in Fig. E.

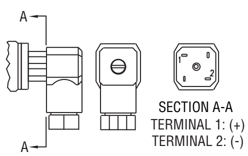

Fig. D

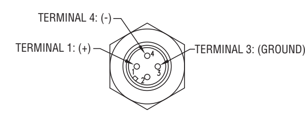

Fig. E

VOLTAGE (0-5, 1-5, 0-10, 1-6 or 2-10 VDC) OUTPUT OPERATION
(Other outputs contact the factory) See Fig. F for connection of the power supply, transmitter and receiver.

Voltage Output

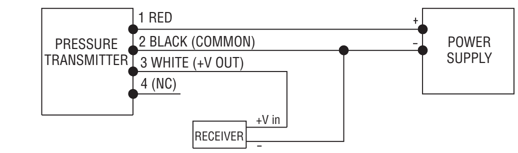

Fig. F: Voltage output connection

Conduit Housing (-CH) Electrical connections to the pressure transmitters are made to the terminal block located inside the housing. Remove the screws and lift off the cover. Wire as shown in Fig. F or Fig. G. Use Fig. F for voltage output connection. Use Fig. G for voltage output with optional LED display connection. If ordering optional pre-wired cable, black wire is negative (-), red wire is positive (+) and white wire is +Vout.

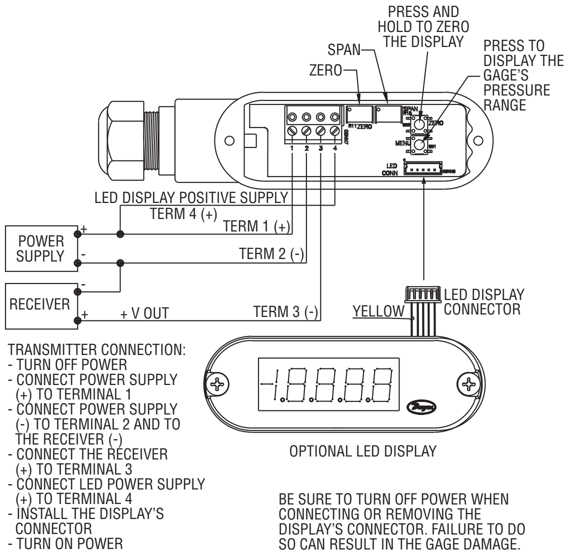

Fig. G: Voltage output with optional LED display connection

Heirschman DIN Connector with Voltage Output When using cable version of -GH General Purpose Housing, black wire is negative (-), red wire is positive (+) and white wire is output. When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. H. For optional 4-pin M-12 connector, wire to pins as shown in Fig. I. If utilizing optional A-164 cable for M-12 connection, brown wire corresponds to pin #1, white #2, blue #3, and black #4.

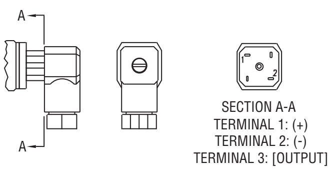

Fig. H

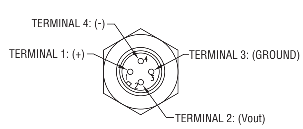

Fig. I

RATIOMETRIC (0.5-4.5 VDC) OUTPUT OPERATION
(Other outputs contact the factory) See Fig. J for connection of the power supply, transmitter and receiver.

Voltage Output

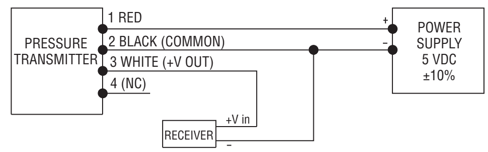

Fig. J: Voltage output connection

General Purpose Housing with Ratiometric Output When using cable version of -GH General Purpose Housing, black wire is negative (-), red wire is positive (+) and white wire is output. When using optional Heirschman DIN Plug, remove top-center screw and lift off the terminal block assembly. Wire to terminals shown below in Fig. K. For optional 4-pin M-12 connector, wire to pins as shown in Fig. L. If utilizing optional A-164 cable for M-12 connection, brown wire corresponds to pin #1, white #2, blue #3, and black #4.

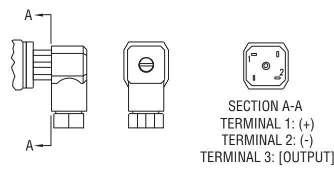

Fig. K

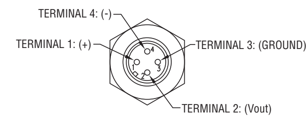

Fig. L

MAINTENANCE
After final installation of the pressure transmitter and its companion receiver, no routine maintenance is required. A periodic check of system calibration is suggested. The Series 626 and 628 transmitters are not field repairable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

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E-mail: info@koboldusa.com

CANADA

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E-mail: kobold@kobold.ca

Visit KOBOLD Online at
www.kobold.com

Model:
KAL-L

The Kobold KAL-L flow switch allows rapid detection of flow rate change of non-hazardous gases. Fast reaction times are guaranteed by the KAL-L's analog electronic design. Through use of two RTDs . . . one to sense flow and the other to detect ambient temperature, the switch can compensate for thermal changes in its surroundings. This "smart" behavior minimizes erroneous switching due to spurious changes caused by things such as the weather.

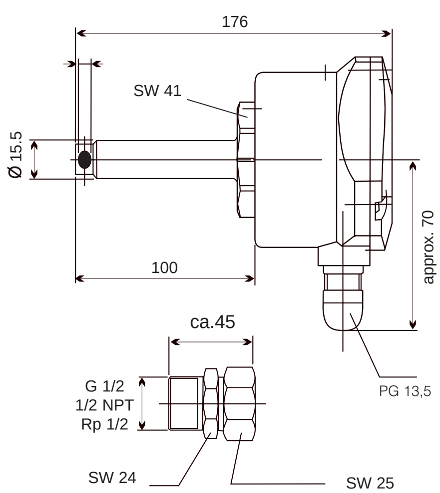
Any conceivable pipe size can be accommodated by the KAL-L's insertion style design. Knowledge of the flow velocity in your system is all that you need to make the KAL-L work.

KOBOLD KAL-L Flow Switch

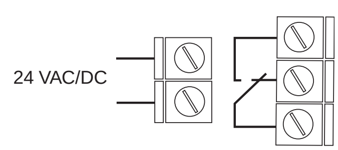
Specifications

Range:	3.3 - 66 ft/sec @20°C, 14.5 PSIA (restricted span for other pressure and temperature conditions)
Switchpoint:	potentiometer adjustable
Accuracy:	±10% of flow rate
Reproducibility:	±1% of flow rate
Display	
Flow Rate:	8-LED flow trend
Switch Status:	two-color LED
Maximum Temperature Gradient	30°K(°C)/min @ 8m/s, 90°C
Response Time:	1 to 60 sec (adjustable)
Warm-up Time:	30 sec
Maximum Pressure:	120 PSIG
Maximum Temperature	
Process:	–10°F to +250°F
Ambient:	+15°F to +140°F
Wetted Parts:	Ni-plated brass
Housing Material:	Nylon
Electrical Data	
Power Supply:	24 VDC/VAC –15%/+10%
Switch:	Qty. 1 - SPDT
Max. Voltage:	250 VAC
Max. Current:	4 A
Max. Power:	1,000 VA
Wiring Connector	
Standard:	PG13.5 cable gland
Optional:	½" NPT conduit
Protection:	NEMA 4

Dimensions (millimeter)



Electrical Connection



KAL-L Ordering Information

Fitting	Order Number
½" NPT	KAL-8115
2-Bolt Flange	KAL-8115FL
Smooth Shank	KAL-8100
Options:	-C: Conduit Hub -M12: Quick disconnect

Subject to change without prior notice.

KOBOLD KAL-L (KAL-8000 Series)

Thermal Air Flow Switch

User Instructions

KOBOLD Instruments Inc. 1801 Parkway View Drive Pittsburgh PA 15205

Phone (412) 788-2830 • Fax (412)-788-4890

Manual-KAL-L_3-99

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List of Diagrams

List of Tables

CAUTION: For safety reasons, please read the cautionary information located at the end of the manual, before attempting installation.

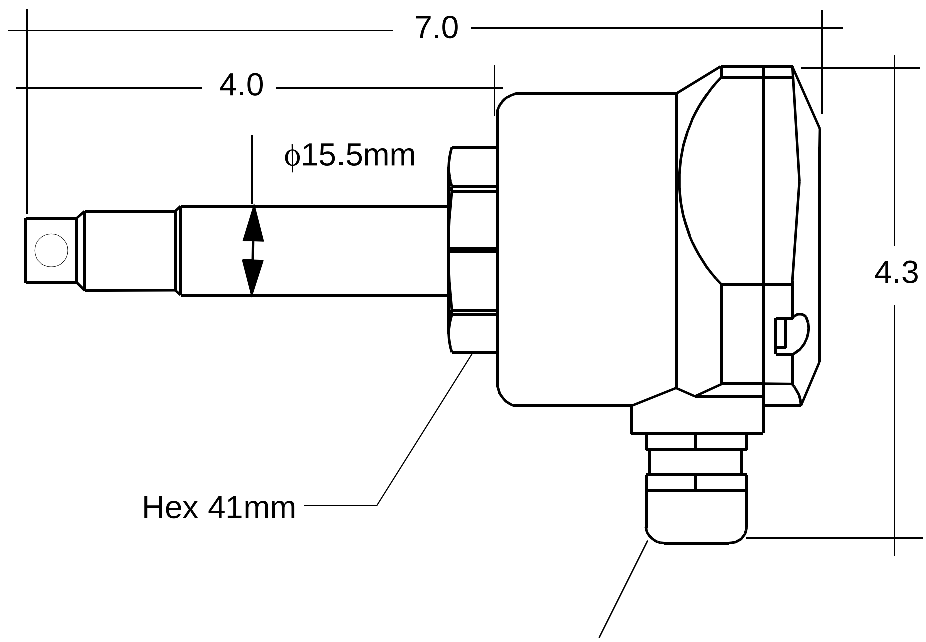
1.0 General

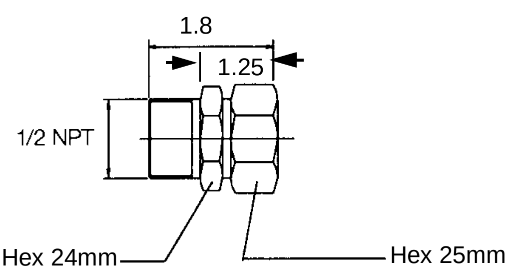
The KAL-L (KAL-8000 Series) Thermal Air Flow Switch uses the proven calorimetric principle to monitor the flow of air or non-hazardous gases. A sensing resistive thermal device (RTD) is heated to a few degrees above the temperature of the flow medium. As the medium flows across the sensing RTD it cools the RTD. The rate of cooling is proportional to flowrate. A second RTD measures medium temperature and the KAL-L electronics uses this measurement to compensate for changes in medium temperatures thus preventing false readings due to medium temperature transients. If the measured flow value drops below the setpoint value, an output relay is activated providing an alarm or control input.

2.0 Specifications

Switching Range:	3.3 to 66. feet/second @68°F/14.5 PSIA Restricted span for other pressure and temperature conditions
Accuracy:	±10% of flow rate
Repeatability:	±1% of flow rate
Display	
Flowrate:	8 LED trend indicator
Switchpoint:	Flashing LED in trend indicator
Switch Status:	Dual colored LED RED = Flow below switchpoint GREEN = Flow above switchpoint
Max. Temperature Gradient:	30°K(°C)/Min. @ 25 feet/sec and 190°F
Response Time:	Adjustable 1 to 60 seconds
Warm-up Time:	30 seconds
Max. Pressure:	120 PSIG
Temperature Range	
Process:	-10 to +250°F
Ambient:	+15 to +140°F
Wetted Parts:	Ni-Plated brass
Housing:	Nylon
Electrical Data	
Power Requirements:	24 VDC/VAC +10%/-15%
Switch Characteristics:	1-SPDT relay Max. 250 VAC/4 A/1000 VA
Electrical Connection	
Standard:	PG 13.5 Cable gland
Optional:	1/2” NPT Conduit or M-12 plug
Protection:	NEMA 4/IP 65

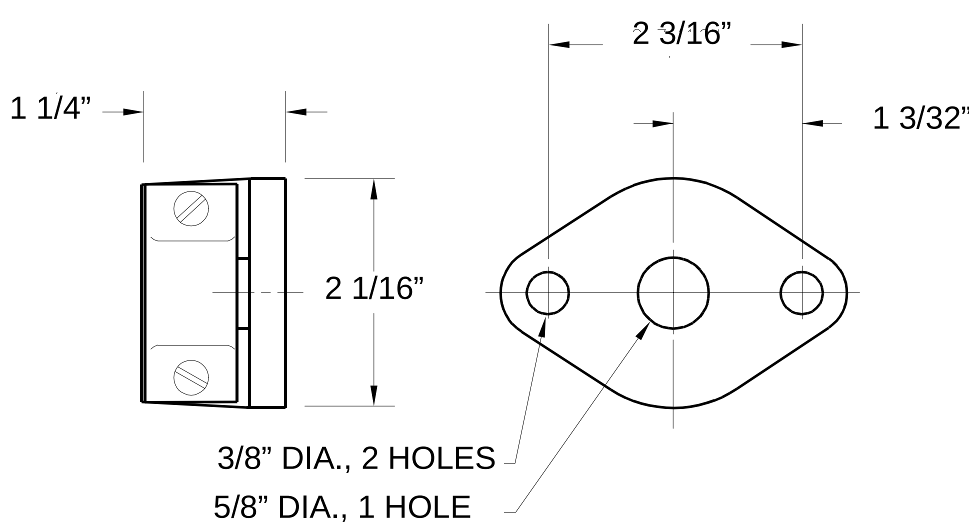
Diagram 2.1 Dimensions





1/2” NPT
Compression Fitting

HVAC Duct Mount
Flange



All dimensions in inches
Unless otherwise noted

Table 2.1 Model Number Codes

Model Code	Description
KAL-8115	15mm smooth bore probe with 1/2” NPT compression fitting
KAL-8115FL	15mm diameter probe with clamping flange per DIN 43 743
Options	
Option Suffix	Description
-M12	NEMA 4 electrical plug connector
-C	1/2” NPT conduit connection

3.0 Mechanical Installation

CAUTION

Prior to mechanical installation, ensure that the process flow velocity to be monitored is within the switching range of the device. Also ensure that system temperature and pressure are within the limit of the device. See Section 2.0 ”Specifications”.

3.1 Installation General

The following general installation instructions and precautions apply to all KAL-8000 series installations:

3.1.1 The probe tip **must be inserted a minimum of 3/8” beyond the inside diameter of the pipe or duct into which it is to be installed.** Best results are obtained if the probe is inserted into the pipe or duct 1/2” or greater.

3.1.2 In order to ensure that the sensing elements are facing directly into the flow stream, a notch has been placed on the probe hex nut to aid in alignment. For optimal results, the probe should be installed so that the notch is aligned directly over the centerline of the pipe or duct.

3.1.3 In order to ensure a uniform flow profile across the probe tip, install the probe to allow for 10 pipe diameters of straight run piping upstream and 5 downstream. This piping should be free of tees, elbows, bends, valves, dampers or any other such appurtenances.

3.1.4 The probe should not be installed in the lower hemisphere of the pipe or duct. Liquid and debris which collect in the lower portion of the pipe will cause the probe to function erratically if they come in contact with the probe.

Diagram 3.1 General Installation

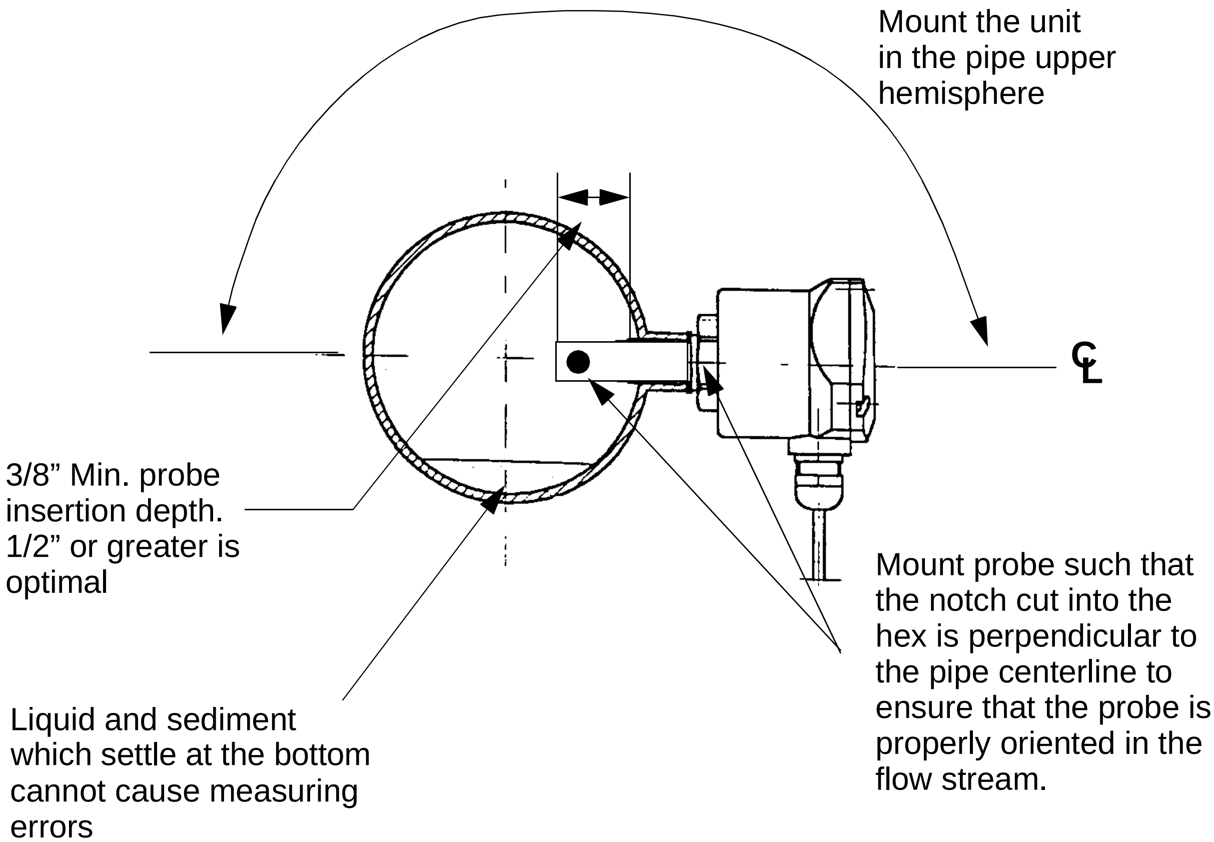
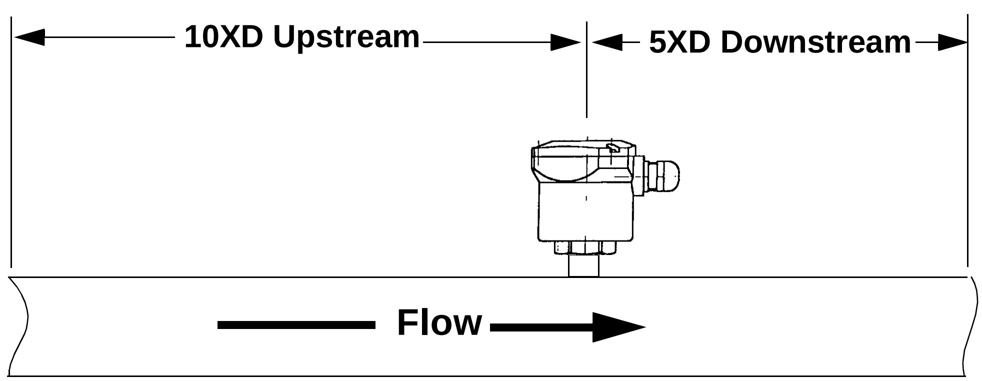


Diagram 3.2 Required Straight Pipe Runs



3.2.1 Units with NPT threaded connections are best suited for round pipes or ducts in which systems are under pressure. The NPT connection makes a leaktight seal to 120 PSIG.

3.2.2 The threaded connection should be installed into a pipe via a 1/2” weld coupling or a pipe tee with 1/2” connection. If a bushing is used to reduce a larger fitting size to 1/2”, ensure that the probe insertion requirements are met. See Section 3.1 ”Installation General”.

3.2.3 Ensure that a thread sealant such as teflon tape is used to seal the threads.

3.3 Installation of Units with HVAC Flange Connection

3.3.1 Units with flanged connections are best suited for square ducts in HVAC applications where adding an NPT connection is impractical.

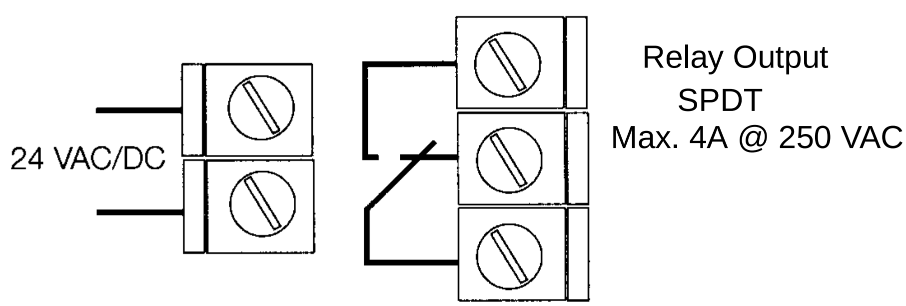
3.3.2 Prior to installing the flange, the flange face which contacts the surface of the HVAC duct should be sealed using a field manufactured gasket or RTV compound. This will minimize leakage at the flange face.

4.0 Electrical Connections

4.0.1 All electrical connections are made at the terminal blocks inside the electronics enclosure of the KAL-L.

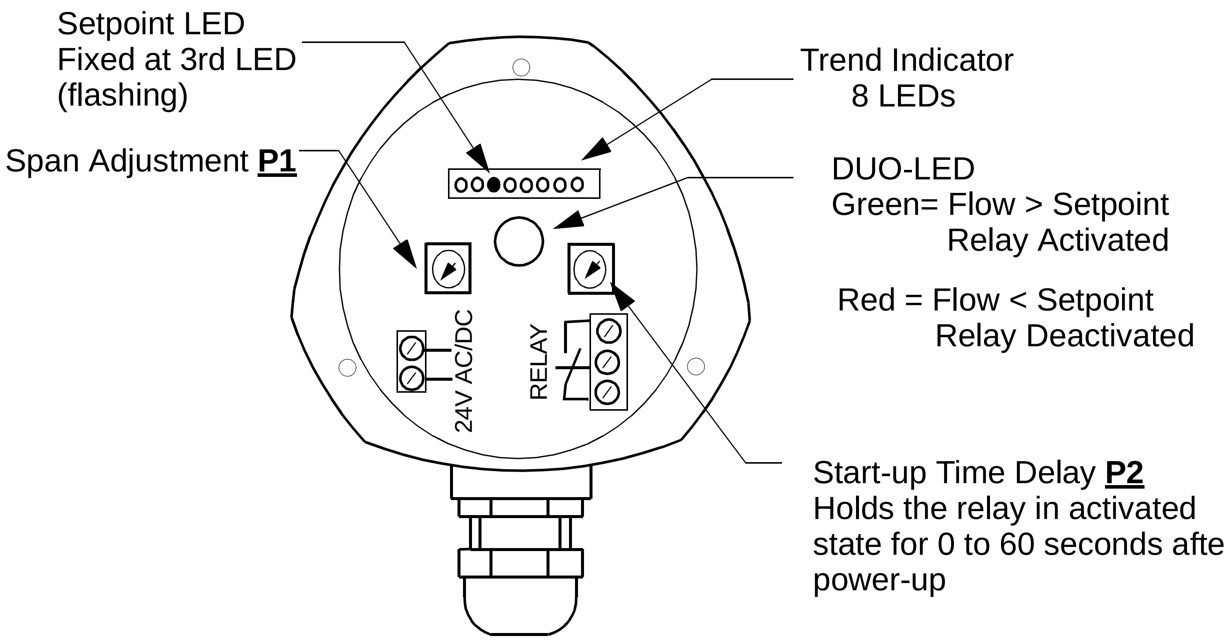
4.0.2 The KAL-L can operate using a power supply of 24 VAC or DC. **When DC voltage is used, the input supply is non-polarized. The polarity of the DC input voltage does not matter and can be wired in either direction without affecting the operation of the unit.**

Diagram 4.1 Electrical Connections



5.0 Operation

Diagram 5.1 Interior Controls Layout for the KAL-L



5.1 Flow Setpoint Adjustment

The section describes the procedures for adjustment of the flow setpoint for three scenarios:

- Adjustment of precise setpoint on falling flow.
- Adjustment of precise setpoint on rising flow.
- Setup for flow/no flow detection.

5.1.1 Flow Setpoint Adjustment - General

The flow switch point on the KAL-L is fixed at 50% of its span. Because of the trend indicator's non-linear response, this corresponds to the third LED on the indicator bar. The third LED is wired to flash permanently to allow users to judge the location of the flow setpoint relative to system flow.

The flow switch point is set by adjusting the span potentiometer P1. Doing this increases or decreases the span of the trend indicator thereby changing the point at which the KAL-L switches. The next three sections describe how to set the KAL-L switchpoint in specific situations

5.1.2 Adjustment of Precise Setpoint on Falling Flow

To adjust the KAL-L for a precise switchpoint on falling flow, refer to Diagram 5.1 on page 6 and proceed as follows:

5.1.2.1 With power connected to the KAL-L, adjust the span potentiometer **P1** clockwise to its right hand stop.Turn time delay potentiometer **P2** counter-clockwise to its far lefthand stop.

5.1.2.2 Initiate system flow and adjust it to the desired switchpoint flow rate. Note that at this time the DUO LED should be green. If it is red your desired flowrate is below the measuring capability of the KAL-L.

5.1.2.3 Slowly turn **P1** counter-clockwise. You will note that the LEDs on the trend indicator will extinguish sequentially as the span is reduced. Continue turning **P1** counter-clockwise until the trend indicator span is reduced to the third LED (which is flashing). At this point, the DUO-LED turns red and the relay switches over. The KAL-L is now adjusted at the desired setpoint.

5.1.2.4 Adjust system flow to normal.

5.1.3 Adjustment of Precise Setpoint on Rising Flow

To adjust the KAL-L for a precise switchpoint on rising flow, refer to Diagram 5.1 on page 6 and proceed as follows:

5.1.3.1 With power connected to the KAL-L, adjust the span potentiometer **P1** counter-clockwise to its left hand stop. Turn time delay potentiometer **P2** counter-clockwise to its far lefthand stop.

5.1.3.2 Initiate system flow and adjust it to the desired switchpoint flow rate.

5.1.3.3 Slowly turn **P1** clockwise. You will note that the LEDs on the trend indicator will light sequentially as the span is increased from zero. Continue turning **P1** clockwise until the trend indicator span is increased to the third LED (which is flashing). At this point, the DUO-LED turns green and the relay switches over. The KAL-L is now adjusted at the desired setpoint.

5.1.3.4 Adjust system flow to its normal value.

5.1.4 Setup of the KAL for Flow/No-flow Detection

Alternatively, the KAL-L can be quickly set-up to switch on a loss of flow. Using this procedure does not yield a precise switchpoint but is generally acceptable for flow/no-flow detection. When set up in this manner, the KAL-L will switch when approximately a 50% reduction from normal flow occurs. To set the KAL-L for flow/no-flow detection, refer to Diagram 5.1 and proceed as follows:

5.1.4.1 With power connected to the KAL-L, adjust the span potentiometer **P1** counter-clockwise to its left hand stop.Turn time delay potentiometer **P2** counter-clockwise to its far lefthand stop.

5.1.4.2 Initiate system flow. Ensure that system flow rate is at normal operating value.

5.1.4.3 Slowly turn **P1** clockwise. You will note that the LEDs on the trend indicator will light sequentially as the span is increased from zero. Continue turning **P1** clockwise just until all 8 trend indicator LEDs are lit. As the trend indicator span is adjusted past the third LED (which is flashing) note that the DUO LED changes from red to green and the relay switches over.

5.1.4.4 The KAL-L is now adjusted for flow/no flow detection. The switch point will occur on a flow rate reduction of approximately 50% from normal operating value.

5.2 Adjustment of the Start-up Time Delay

The KAL-L has a start-up time delay feature which holds the output relay in the activated state and disables flow monitoring for a period of up to 60 seconds after power-up of the KAL-L. This feature is designed to prevent nuisance alarms during system start-up and until steady state flow conditions are achieved.

To adjust the start-up time delay, refer to Diagram 5.1 on page 6 and proceed as follows:

5.2.1 Potentiometer **P2** adjusts the start-up time delay. Turning **P2** counter-clockwise to its far left hand stop adjusts the time delay to zero. Turning **P2** clockwise increases the time delay to a maximum possible of 60 seconds at the far right hand stop. The time delay adjustment is approximately linear between the left and right hand stops.

6.0 Maintenance

The KAL-L is an electronic device which uses no moving parts. This design ensures reliable operation and long service life. Dirt and debris which can build up on the sensing probe over time will result in degraded performance. For this reason we strongly recommend that the proper filtration be installed in the system. It is also recommended that the KAL-L be occasionally removed from the system and its measuring probe inspected for dirt buildup and cleaned as needed. The frequency of this cleaning will vary depending on the cleanliness of the system.

7.0 Need Help with Your KAL-L Flow Switch?

Contact one of our friendly engineers at 412-788-2830.

CAUTION

PLEASE READ THE FOLLOWING WARNINGS BEFORE ATTEMPTING INSTALLATION OF YOUR NEW DEVICE. FAILURE TO HEED THE INFORMATION HEREIN MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE SUBSEQUENT PERSONAL INJURY.

- **User's Responsibility for Safety:** KOBOLD manufactures a wide range of process sensors and technologies. While each of these technologies are designed to operate in a wide variety of applications, it is the user's responsibility to select a technology that is appropriate for the application, to install it per these installation instructions, to perform tests of the installed system, and to maintain all components. The failure to do so could result in property damage or serious injury.
- **Proper Installation and Handling:** Use a proper sealant with all installations. Never overtighten the unit within the fitting. **Never use the housing to thread the unit into its fitting**. Always use only an appropriate sized wrench on the hex portion of the probe. Always check for leaks prior to system start-up.
- **Wiring and Electrical:** A supply voltage of 24 Volts AC or DC +10%/-15% is used to power the KAL-L. The sensor systems should never exceed this rating. Electrical wiring of the sensor should be performed in accordance with all applicable national, state, and local codes.
- **Temperature and Pressure:** The KAL-K is designed for use in application temperatures from -10 to 250°F, and for use at pressures up to 115 PSIG. Operation outside these limitations will cause damage to the unit and possible personal injury.
- **Material Compatibility:** The KAL-K sensor probe is made of nickel plated brass. The housing is polycarbonate. Check your model number with the wetted materials specification in Section 2.0 ,"Specifications", on page 1 of this manual. Make sure that the model which you have selected is chemically compatible with the application environment. While the switch housing is liquid resistant when installed properly, it is not designed to be immersed. It should be mounted in such a way that it does not normally come into contact with liquid.
- **Flammable, Explosive and Hazardous Applications:** The KAL-L is not an explosion-proof or intrinsically safe design. It should not be used in hazardous areas where risk of explosion exists.
- **Make a Fail-safe System:** Design a fail-safe system that accommodates the possibility of switch or power failure as well as operator error. In critical applications, KOBOLD recommends the use of redundant backup systems and alarms in addition to the primary system.

SECTION 16: PROCESS AIR PRESSURE SWITCH

P&ID: Item #: PS-1221

Unit Details: Omega Pressure Switch PSW-108 3-100 psi

Manufacturer/Local Distributor/Contact:

OMEGA Engineering, Inc.
One Omega Drive
P.O. Box 4047
Stamford, CT 06907-0047
Phone: (800)-848-4286
Fax: (203)-359-7700
www.omega.com

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GENERAL PURPOSE PRESSURE SWITCHES
IN NEMA 4X (IP66) ENCLOSURES

PSW-100 Series
Vacuum to 3000 psi

Starts at $140

- Ranges from 0.5 inH_2O to 3000 psi
- SPDT or DPDT Switches
- Adjustment Lock
- Safe, Easy Wiring Access

OMEGA's affordable, general purpose pressure switches offer distinct advantages over most similar-style switches, including DPDT or adjustable deadband switches, as well as a wide selection of adjustable ranges from 0.5 inH_2O to 3000 psi.

SPECIFICATIONS

Approval: UL listed, CSA certified

Storage Temperature: -55 to 70°C (-67 to 158°F)

Process Temperature:
- **Stainless Steel:** -55 to 205°C (-67 to 401°F)
- **Phosphor Bronze:** -40 to 150°C (-40 to 302°F)
- **Buna-N:** -25 to 95°C (-13 to 203°F)

Ambient Temperature: -40 to 70°C (-40 to 158°F), except models PSW-107 to PSW-117 and PSW-134 to PSW-139: -20 to 70°C (-4 to 158°F); setpoint typically shifts less than 1% of range for a 30°C (54°F) ambient temperature change

Shock: Setpoint repeats after 15 g, 10 ms duration

Vibration: Setpoint repeats after 2.5 g, 5 to 500 Hz

Setpoint Repeatability: All models ±1% of adjustable range, except models PSW-118 to PSW-125 and PSW-132 to PSW-133, which are ±1.5%

Switch Output: One SPDT or DPDT switch can be wired "normally open" or "normally closed"

Electrical Rating: Standard 15 A 125/250/480 Vac resistive

External Manual Reset: 15 A 125/250 Vac resistive

Double Pole Double Throw: 10 A 125/250 Vac resistive

Enclosure: Die-cast aluminum (max 0.6% copper); epoxy-coated blue enclosure, gasketed, complies with NEMA 4X (IP66)

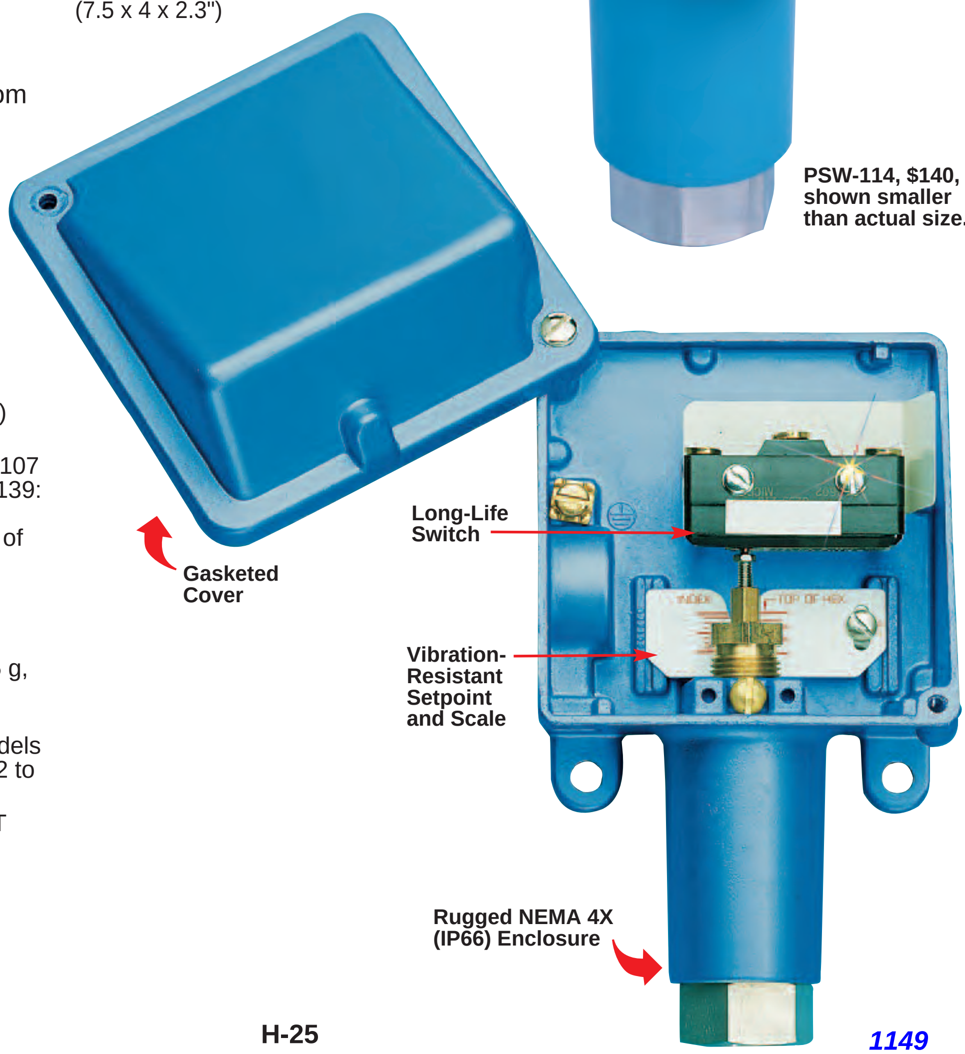
Weight: Approximately 0.9 kg (2 lb)

Electrical Connection: ½ NPT and two ⅞" diameter knockouts

Pressure Connection: See "To Order" on next page

Dimensions: 191 max H x 101 W x 60 mm D (7.5 x 4 x 2.3")

PSW-114, $140, shown smaller than actual size.



Long-Life Switch

Gasketed Cover

Vibration-Resistant Setpoint and Scale

Rugged NEMA 4X (IP66) Enclosure

GENERAL PURPOSE PRESSURE SWITCHES

MOST POPULAR MODELS HIGHLIGHTED!

To Order *(Specify Model Number)*

MODEL NO.	PRICE	ADJUSTABLE RANGE STANDARD	ADJUSTABLE RANGE METRIC	DEADBAND STANDARD UNITS	PROOF PRESSURE	SWITCH	ADDED FEATURE
BUNA-N DIAPHRAGM, O-RING AND ¼ FNPT NICKEL-PLATED BRASS PRESSURE CONNECTION							
PSW-107	**$140**	1.5 to 30 psi	0.1 to 2 bar	1 to 2 psi	600 psi	15 A SPDT	—
PSW-108	**140**	3 to 100 psi	0.2 to 6.9 bar	1 to 4 psi	600 psi	15 A SPDT	—
PSW-109	**175**	3 to 100 psi	0.2 to 6.9 bar	—	600 psi	15 A SPDT	External Manual Reset
PSW-110	**225**	3 to 100 psi	0.2 to 6.9 bar	11.3 Typ.	600 psi	10 A DPDT	DPDT Switch
PSW-111	**170**	3 to 100 psi	0.2 to 6.9 bar	3 to 7 psi	600 psi	15 A SPDT	Adjustable Deadband
PSW-112	**140**	9 to 300 psi	0.7 to 20.7 bar	1 to 5 psi	600 psi	15 A SPDT	—
PSW-113	**170**	9 to 300 psi	0.7 to 20.7 bar	4 to 11 psi	600 psi	15 A SPDT	Adjustable Deadband
PSW-114	**140**	15 to 500 psi	1 to 34.5 bar	2 to 8 psi	2500 psi	15 A SPDT	—
PSW-115	**170**	15 to 500 psi	1 to 34.5 bar	5 to 12 psi	2500 psi	15 A SPDT	Adjustable Deadband
PSW-116	**175**	15 to 500 psi	1 to 34.5 bar	—	2500 psi	15 A SPDT	External Manual Reset
PSW-117	**140**	30 to 1000 psi	2 to 69 bar	3 to 20 psi	2500 psi	15 A SPDT	—
BUNA-N DIAPHRAGM, O-RING AND ½ FNPT ALUMINUM PRESSURE CONNECTION							
PSW-134	**$335**	300 inWC vac to 0 inWC	747.24 to 0 mbar	0.2 to 8 inWC	400 psi	15 A SPDT	—
PSW-135	**335**	10 inWC vac to 10 inWC	-24.91 to 24.91 mbar	0.1 to 0.6 inWC	400 psi	15 A SPDT	—
PSW-136	**335**	50 inWC vac to 50 inWC	-124.54 to 124.54 mbar	0.1 to 3.0 inWC	400 psi	15 A SPDT	—
PSW-137	**335**	0.5 to 5 inWC	1.25 to 12.45 mbar	0.1 to 0.3 inWC	400 psi	15 A SPDT	—
PSW-138	**335**	2.5 to 50 inWC	6.23 to 124.54 mbar	0.1 to 0.8 inWC	400 psi	15 A SPDT	—
PSW-139	**335**	10 to 250 inWC	24.91 to 622.70 mbar	0.1 to 6.0 inWC	400 psi	15 A SPDT	—
316 SS DIAPHRAGM AND ½ FNPT PRESSURE CONNECTION*							
PSW-104	**$300**	1 to 20 psi	70 mbar to 1.4 bar	0.1 to 1 psi	500 psi	15 A SPDT	—
PSW-105	**300**	2 to 50 psi	140 mbar to 3.4 bar	0.1 to 1.5 psi	500 psi	15 A SPDT	—
PSW-118	**170**	5 to 30 psi	0.4 to 2 bar	1 to 3 psi	2500 psi	15 A SPDT	—
PSW-120	**170**	10 to 100 psi	0.7 to 6.9 bar	1 to 8 psi	2500 psi	15 A SPDT	—
PSW-121	**170**	15 to 300 psi	1 to 20.7 bar	3 to 18. psi	2500 psi	15 A SPDT	—
PSW-123	**200**	15 to 300 psi	1 to 20.7 bar	3 to 18 psi	2500 psi	15 A SPDT	Adjustable Deadband
PSW-124	**170**	20 to 500 psi	1.4 to 34.5 bar	4 to 30 psi	2500 psi	15 A SPDT	—
PSW-125	**170**	80 to 1700 psi	5.5 to 117 bar	5 to 120 psi	2500 psi	15 A SPDT	—
PHOSPHOR BRONZE BELLOWS AND ¼ FNPT BRASS PRESSURE CONNECTION							
PSW-127	**$160**	30 inHg vac to 0	-1 to 0 bar	1 to 2 inHg	0 psi	15 A SPDT	—
PSW-128	**245**	30 inHg vac to 0	-1 to 0 bar	3 to 6.5 inHg	0 psi	10 A DPDT	DPDT Switch
PSW-129	**160**	4 to 200 psi	0.3 to 13.7 bar	1 to 4 psi	250 psi	15 A SPDT	—
316 SS BELLOWS AND ¼ FNPT PRESSURE CONNECTION							
PSW-130	**$230**	15 to 200 psi	1 to 13.7 bar	1 to 3 psi	250 psi	15 A SPDT	—
PSW-131	**230**	25 to 500 psi	1.8 to 34.5 bar	1.5 to 5 psi	575 psi	15 A SPDT	—
PSW-132	**290**	100 to 1700 psi	6.9 to 11.7 bar	9 to 40 psi	2500 psi	15 A SPDT	—
303 SS PISTON, BUNA N O-RING AND ¼ FNPT SS PRESSURE CONNECTION							
PSW-133	**$200**	125 to 3000 psi	8.6 to 206 bar	40 to 250 psi	10000 psi	15 A SPDT	—

***Note:** The use of metallic diaphragms where higher pressures, shock or heavy cycling is expected should be avoided. When choosing a pressure range, it is recommended that the switch operate in the middle 80% of its adjustable range. Switching may not be accurate in the lower and upper 10% of the range.*
Switches come complete with operator's manual.
***Oxygen Clean Option:** Available on -SS models only; add suffix **"-X6B"** to model number, and add **$85** to price.*
Ordering Example: PSW-115,** Buna-N diaphragm, ¼ brass FNPT thread, range of 50 to 500 psi and adjustable deadband, **$170.

Recommended Reference Book: Total Quality Management, **GE-0658, $50.** See Section Y For Additional Books.

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User's Guide

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ISO 9001 CERTIFIED CORPORATE QUALITY MANCHESTER, UK

PSW-100 SERIES

Pressure Switches

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e-mail: espanol@omega.com
FAX: (001) 203-359-7807
info@omega.com.mx

Servicing Europe:

Czech Republic:
Frystatska 184, 733 01 Karviná, Czech Republic
TEL: +420 (0)59 6311899
FAX: +420 (0)59 6311114
Toll Free: 0800-1-66342
e-mail: info@omegashop.cz

Germany/Austria:
Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 9398-0
FAX: +49 (0)7056 9398-29
Toll Free in Germany: 0800 639 7678
e-mail: info@omega.de

United Kingdom:
ISO 9001 Certified
One Omega Drive, River Bend Technology Centre
Northbank, Irlam, Manchester
M44 5BD United Kingdom
TEL: +44 (0)161 777 6611
FAX: +44 (0)161 777 6622
Toll Free in United Kingdom: 0800-488-488
e-mail: sales@omega.co.uk

PSW-100 Series
General Purpose Pressure Switches

Part Numbers: PSW-104, 105
PSW-107-117
PSW-118-125
PSW-127-133
PSW-134-139

Please read all instructional literature carefully and thoroughly before starting.

GENERAL

BEFORE INSTALLING, CHECK THE SENSOR MODEL SELECTED FOR COMPATIBILITY TO THE PROCESS MEDIA IN CONTACT WITH THE SENSOR AND WETTED PARTS.

The PSW-100 Series pressure switches are activated when a bellows, diaphragm or piston sensor responds to a pressure change. This response, at a pre-determined set point, actuates a single snap-acting switch, converting the pressure signal into an electrical signal. Control set point may be varied by turning the internal adjustment hex. (See Adjustment -PART II).

PROOF PRESSURE* LIMITS STATED IN THE LITERATURE AND ON NAMEPLATES MUST NEVER BE EXCEEDED, EVEN BY SURGES IN THE SYSTEM. OCCASIONAL OPERATION OF UNIT UP TO PROOF PRESSURE IS ACCEPTABLE (E.G., START-UP, TESTING). CONTINUOUS OPERATION SHOULD NOT EXCEED THE DESIGNATED OVER RANGE PRESSURE**.

*Proof Pressure - the maximum pressure to which a pressure sensor may be occasionally subjected, which causes no permanent damage (e.g., start-up, testing). The unit may require re-gapping.

**Over Range Pressure - the maximum pressure to which a pressure sensor may be continuously subjected without causing damage and maintaining set point repeatability.

THESE PRODUCTS DO NOT HAVE ANY FIELD REPLACEABLE PARTS.

Part I - Installation

Tools Needed
Adjustable Wrench
Screwdriver
Hammer (for alternate wire knockouts)

MOUNTING

INSTALL UNIT WHERE SHOCK, VIBRATION AND TEMPERATURE FLUCTUATIONS ARE MINIMAL. ORIENT UNIT SO THAT MOISTURE IS PREVENTED FROM ENTERING THE ENCLOSURE. IF UNIT IS BEING INSTALLED WHERE HEAVY CONDENSATION IS EXPECTED, VERTICAL MOUNTING (PRESSURE CONNECTION DOWN) IS REQUIRED. DO NOT MOUNT IN AMBIENT TEMPERATURES EXCEEDING PUBLISHED LIMITS.

Controls may be mounted and operated in any position. They may be surface mounted via the two mounting ears on either side of the enclosure, or directly to a rigid pipe by using the pressure connection. Should the control be installed where condensation is expected, vertical mounting is recommended as a means of keeping water away from switch terminals.

Never use the enclosure for leverage to hand tighten the pressure connection. Always use a wrench to tighten the pressure connection to the pipe.To prevent damaging the pressure sensor, use a back-up wrench to hold the hex nut in place when surface mounting.

On models supplied with an external manual reset button, be sure to leave sufficient finger space over the reset button for the operator to reset the control.

WIRING

DISCONNECT ALL SUPPLY CIRCUITS BEFORE WIRING.

ELECTRICAL RATINGS STATED IN LITERATURE AND ON NAMEPLATES SHOULD NEVER BE EXCEEDED. OVERLOAD ON A SWITCH CAN CAUSE FAILURE ON THE FIRST CYCLE.

WIRE UNITS ACCORDING TO NATIONAL AND LOCAL ELECTRICAL CODES. MAXIMUM RECOMMENDED WIRE SIZE IS 14 AWG.

Remove the two screws retaining the cover and cover gasket. A 1/2" NPT conduit connection is provided on the left hand side of the enclosure. Two cast-in 7/8" diameter knockouts for electrical conduit are located on the side and back of the enclosure. These can easily be knocked out by placing the blade of a screwdriver in the groove and tapping sharply with a hammer. The three switch terminals are clearly labeled "common", "normally open" and "normally closed".

For optional switches supplied with leadwires, the following color coding applies:

	Manual Reset	DPDT	
	PSW-109, 116	PSW-110, 128	
	SPDT	**Circuit 1**	**Circuit 2**
Common	Violet	Violet	Yellow
Normally Closed	Black	Black	Red
Normally Open	Blue	Blue	Orange

A grounding screw and clamp (cast in symbol) is provided which meets a 35 lb. pull test. Keep the wire as short as possible to prevent interface with the plunger and, if applicable, the adjustable differential switch wheel.

Part II - Adjustments

Tools Needed
5/8" Open End Wrench
1/4" Wrench
3/16" Wrench

SOME MODELS HAVE A TWO-PIECE, ADJUSTABLE PLUNGER. THIS FEATURE IS CHARACTERIZED BY A 3/16" HEX HEAD SCREW INSTALLED IN THE 1/4" HEX PLUNGER. THE LENGTH OF THIS ASSEMBLY IS ADJUSTED AT OUR FACTORY AND IS CRITICAL TO THE FUNCTION OF THE CONTROL.

PSW-100 Series

Remove pressure switch cover. Loosen Phillips screw adjustment lock. Adjust set point by turning 5/8" hex adjustment screw clockwise (left) to raise set point, or counter clockwise (right) to lower set point. Tension on adjustment screw can be increased by tightening adjustment lock onto it. (See diagram 1). Controls include uncalibrated reference scales for high, low or mid range settings.

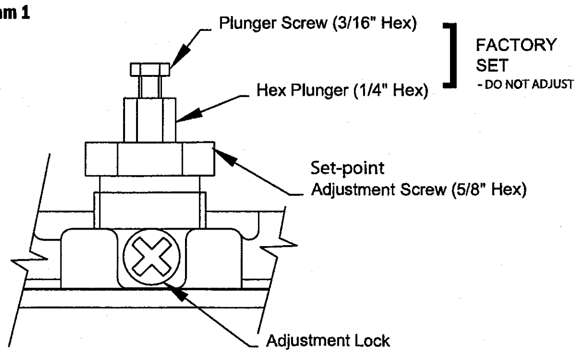
Adjustable Deadband Models

PSW-111, 113, 115 and 123 control types incorporate a snap switch with internal adjustment wheel. Turning this wheel raises or lowers the pressure rise set point. The fall set point remains constant.

Manual Reset Button

PSW-109 and 116 control types incorporate a snap switch which when actuated, remains actuated until the pressure drops sufficiently to allow the reset button (located on top of the control) to be manually depressed to reset the switch.

Diagram 1

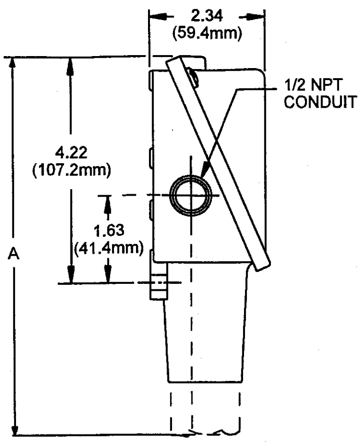


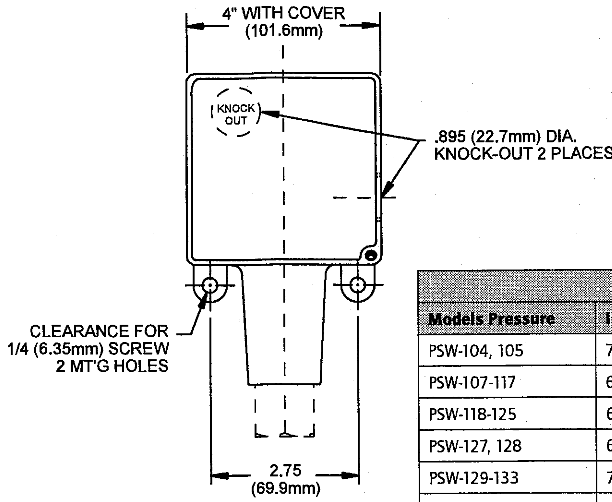
Re-Gapping (refer to Diagram 1)

1. Loosen adjustment lock.
2. Turn 5/8" hex adjustment screw clockwise (left), to approximately mid range. This puts a load on the sensor and exposes the plunger flats. Using a 1/4" wrench on the plunger and a 3/16" wrench on the plunger hex screw, turn hex screw counter-clockwise (right) from plunger until switch actuates. If switch is already actuated, turn plunger hex screw clockwise (left), until switch deactuates. Turn hex screw clockwise (left) from this point. (See chart 1 for Flats and approximate Gap.)
3. Check set point per above.
4. Connect wires and replace cover securely.

Chart 1		
Models	**Flats**	**Approx. Gap**
PSW-104 PSW-105	2-2 1/2	.0085 to .0105"
PSW-118-125	1-1 1/2	.004 to .006"
PSW-130 PSW-131	5-6	.020 to .025"
PSW-107-117	3 1/2 - 4	.014 to .017"
PSW-134-139	2-2 1/2	.0085 to .0105"

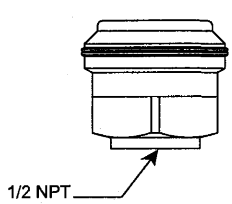
Dimensions



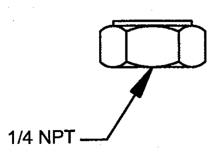


Dimension A			
Models Pressure	**Inches**	**mm**	**NPT**
PSW-104, 105	7.63	193.8	1/2"
PSW-107-117	6.63	168.4	1/4"
PSW-118-125	6.63	168.4	1/2"
PSW-127, 128	6.56	166.6	1/4"
PSW-129-133	7.00	177.8	1/4"
PSW-134-139	8.44	214.4	1/2"

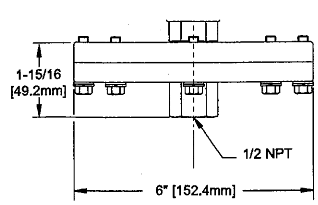
Pressure Connections



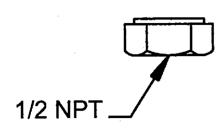
PSW-104, 105



PSW-107-117, 127-133



PSW-134-139



PSW-118-125

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.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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- Wire: Thermocouple, RTD & Thermistor
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- Displacement Transducers
- Instrumentation & Accessories

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- Flexible Heaters
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- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M0528/1011
IMPOM100-03

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SECTION 15: AERATION SYSTEM

P&ID: Item #: AE-0451

Unit Details: **EDI Fine Bubble Aeration System**

Manufacturer: **Environmental Dynamics**
5601 Paris Road
Columbia, MO 65202
Phone: (573) 474-9456
Fax: (573) 474-6988
www.wastewater.com

Local Distributor/Contact:

Environmental Dynamics
5601 Paris Road
Columbia, MO 65202
Phone: (573) 474-9456
Fax: (573) 474-6988
www.wastewater.com

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Aeration Requirements:

Two (duty and standby) positive displacement air blowers and a fine bubble aeration assembly shall be used to transfer dissolved oxygen to the wastewater and provide mixing in the aerobic reactor. Based upon the design criteria listed on page one of this document, approximately 8.2 lbs. of oxygen/hour (197 lbs/day) are required for efficient treatment of the wastewater based on the summer and winter seasons (calculations shown below). This oxygen requirement is derived using actual and standard oxygen requirement (AOR and SOR) calculations for wastewater treatment based on the fact that 1.5 lbs. and 4.6 lbs. of oxygen are required to oxidize each pound of BOD5 and ammonium respectively.

The air required to provide the necessary oxygen transfer can be determined by the following equations:

Mass of air (lbs./day) = (lbs. oxygen/day - SOR) / (.232*OTE)
= (675) / (.232*0.119) = 24,449 lbs/day

Volume of air (SCFM) = ((Mass of air) / (air density)) / (1440 minutes/day)
= (24,449) / (.075) / (1440) = **226 SCFM**

Where OTE is defined as the oxygen transfer efficiency and has been conservatively documented to be 1.9%/ft (@ 1.9% and 6.25 ft diffuser submergence = 11.9%) for fine bubble diffusers. The air density is approximately 0.075 lbs/ft^3. According to this equation, 226 SCFM @ 4.5 psig of air are required to transfer oxygen to the wastewater to satisfy the respiration needs of the biomass.

Two (2) 10 HP positive displacement blowers (duty/standby), each capable of providing 247 SCFM @ 4.5 psig shall be provided to maintain 2.0 mg/L residual DO. The blowers shall be controlled with VFD's and a PLC based DO control loop. In the following calculations a conservative value of 1.5 lb/O2/lb BOD-day is used as a safety factor.

- Actual Oxygen Rate (AOR)
  - = (1.5 lb O2/ lb BOD/day) + (4.6 lb O2/ NH3-N lb/day)
    = [(1.5)(65.7) +(4.6)(21.4)] lb/day O2
    = (98.6 + 98.4) lb/day O2
    = 197.0 lbs/day O2

- Standard Oxygen Rate (SOR)
  - $= AOR / \frac{(Alpha)\,((Beta * C_{walt} * D_c) - C_l) * Theta\hat{}(T_w-20)}{(C20 * Dc)}$

    $=197/\frac{(0.4)\,((0.95 * 7.25 * 1.06) - 2.0) * 1.024\hat{}(32-20)}{(9.09 * 1.06)}$

    = 197/.292
    = 675 lbs O2/day

- Where:
  - Alpha = 0.4
    Beta = 0.95
    Theta = 1.024
    Temp (T_S) = 32 deg. C
    Elevation = <200 ft.MSL

    Cwalt = 7.25 (based on 200’ elevation)
    Dc = 1.06 (based on 6.25’ submergence)
    C_1 residual DO = 2 mg/L
    C20 = 9.09

Environmental Dynamics International

EDI™ FlexAir® AERATION SYSTEM FOR AEROBIC TREATMENT

Customer:	bioprocess H2O Pete Annunziato, PE
Project:	North Redding, MA

Aeration System Design Summary:

Diffuser Type:	FLEXAIR® Tube
Area per Diffuser (in^2):	380
Total Membrane Area (in^2):	6080
# of Diffuser Membranes:	16
Diffuser Density (AT/AD):	2.37

System Operating Requirements

Condition		Redding
SOR	(lbs O_2/h)	28.1
System Airflow	(scfm)	228.9
Airflow per Diffuser	(scfm)	14.31
Avg. Subm. Depth	(ft)	6.25
SOTE	(%)	11.8
SOTE	(%/ft)	1.88
Recommended Blower Design Pressure	(psi)	4.73

Mixing Requirements

Airflow Required for Mixing Purposes (scfm):	12.0

Aeration design for one basin.

FINE BUBBLE DESIGN BRIEF - FLEXAIR® TUBE DIFFUSER

EDI™ FlexAir® AERATION SYSTEM FOR AEROBIC TREATMENT

Environmental Dynamics International
5601 Paris Road, Columbia, Missouri 65202
ph. 573-474-9456 fax 573-474-6988
email edi@wastewater.com http://www.wastewater.com

DB - North Redding

Date: June 15, 2012

Project:
North Redding, MA

Customer:
bioprocess H2O
Pete Annunziato, PE

DESIGN CALCULATIONS		English Units		Metric Units	
(1) Type Waste and Process - MBR					
(2) Design Flow		0.00	MGD	0	m^3/d
(3) BOD Raw Waste	a) concentration	0	mg/L	0	mg/L
	b) weight/d	0	lb/d	0	kg/d
(4) Primary Treatment (% BOD Removal)		0.0	%	0.0	%
(5) % BOD for biological process (100% - Item 4)		100.0	%	100.0	%
(6) ALPHA = Ratio of oxygen transfer in waste to transfer in tap water		1.00	Alpha	1.00	Alpha
BETA = Ratio of solubility of oxygen in wastewater to solubility in tap water		1.00	Beta	1.00	Beta
(7) Site Elevation		0	ft	0	m
(8) Operating ambient pressure, winter		14.70	psia	1013.36	millibar
Operating ambient pressure, summer		14.70	psia	1013.36	millibar
(9) Dissolved O_2 level in the aeration basin		0.00	mg/L	0.00	mg/L
(10) Temperature of waste in aeration basin:					
Winter Temperature		68.0	ºF	20.0	ºC
Summer Temperature		68.0	ºF	20.0	ºC
(11) Design BOD removal		100.0	%	100.0	%
(12) Carbonaceous BOD to the aeration basin (Item 3b) x (Item 5)		0.0	lb/d	0.0	kg/d
(13) Oxygen per unit of carbonaceous BOD removed		0.00	lb/lb	0.00	kg/kg
(14) Carbonaceous oxygen requirements for aeration at field conditions (Item 11)x(Item 12)x(Item 13)		0.0	lb O_2/d	0.0	kg O_2/d
(15) Ammonia to aeration basin	a) concentration	0.0	mg/L	0.0	mg/L
	b) weight/d	0.0	lb/d	0.0	kg/d
(16) Oxygen requirements for ammonia (Item 15b) x (4.6#O_2/#NH_4-N)		0.0	lb O_2/d	0.0	kg O_2/d
(17) Total oxygen requirements, SOR (Item 14 + Item 16) / 24		28.1	lb O_2/h	12.8	kg O_2/h
(18) Air supply for each EDI FlexAir™ diffuser tube		14.31	scfm	22.66	m^3_N/h
				24.31	m^3_S/h

			DB - North Redding	
(19) Active surface area per diffuser tube	380	in^2	2452	cm^2
(20) Air release depth of diffusers	6.25	ft	1.91	m
(21) Tank floor surface area	100	ft^2	9	m^2
(22) % Oxygen transfer, SOTE	11.8	%	11.8	%
(23) lb oxygen per h per tube, SOTR	1.76	lb O_2/h/unit	0.80	kg O_2/h/unit
(24) Winter surface saturation, Csmt	9.09	mg/L	9.09	mg/L
Summer surface saturation, Csmt	9.09	mg/L	9.09	mg/L
(25) Effective depth correction factor	0.40		0.40	
(26) Standard condition aerated O2 saturation in the tank, C^*_{20}=9.09*(29.92+0.8828*Item20*Item 25)/29.92	9.76	mg/L	9.76	mg/L
(27) Theta value=	1.024		1.024	
(28) AOR/SOR=ALPHA[BETA(C^*_{20})(C_{smt}/9.09)(P_{site}/P_{sc})-(Item 9)](THETA)^$^{(Item\ 10-20)}$/(C*20)				
Winter AOR/SOR	1.000		1.000	
Summer AOR/SOR	1.000		1.000	
(29) Number of EDI FlexAir™ tube membranes required for oxygen demand (Item 17) / [(Item 23) x (Item 28)]	16	units	16	units
(30) Air requirements for oxygenation (Item 18) x (Item 29)	229	scfm	363	m^3_N/h
			389	m^3_S/h
(31) Assumed Mixing Design Criteria (air requirements)	0.12	scfm/ft^2	2.05	
(32) Air requirements for mixing (Item 31) x (Item 21)	12	scfm	19	m^3_N/h
			20	m^3_S/h
(33) Number of tube membranes for mixing and/or proper distribution	16	units	16	units
(34) Airflow per tube (mixing only)	0.75	scfm per unit	1.19	m^3_N/h per unit
			1.27	m^3_S/h per unit
(35) Design diffuser air fluxrate based on oxygenation or mixing requirements, use the larger.	5.42	scfm per ft^2	92.4	$m^3_N/h/m^2$
			99.2	$m^3_S/h/m^2$
(36) Diffuser Density: (Area of Tank/Area of Diffusers) ratio [floor area/(# diffusers x active diffuser area)]	2.37		2.37	
(37) Estimated system operating pressure:				
(a) Static liquid head	6.25	ft	1.91	m
(b) Pressure loss at blower building and header (estimated)	1.50	ft	0.46	m
(c) Pressure loss lateral piping (estimated)	0.50	ft	0.15	m
(d) Pressure loss though FlexAir™ tube (estimated)	1.50	ft	0.46	m
(f) Normal compressor operating pressure (a+b+c+d)	9.75	ft	2.97	m
(38) Normal operating pressure (estimated)	4.23	psig	291.53	millibar
(39) Design over-pressure APPROXIMATE	0.50	psig	34.48	millibar
(40) Recommended blower design pressure	4.73	psig	326.01	millibar

Notes:

Aeration design for one basin.

EDI Aeration/Mixing Equipment
Installation, Operation & Maintenance

For:

North Reading, MA
EDI Project # 21944

Prepared For:

Wayne Botelho
BioProcessH2O, LLC
45 Highpoint Avenue
Portsmouth, RI 02871
401-683-5400
WayneBothelo@bioprocessh2o.com

45 Highpoint Avenue

Prepared By:

Mitch Pirtle
Environmental Dynamics
International
5601 Paris Road
Columbia, MO 65202

Date: November 18, 2013

Notice

Table of Contents

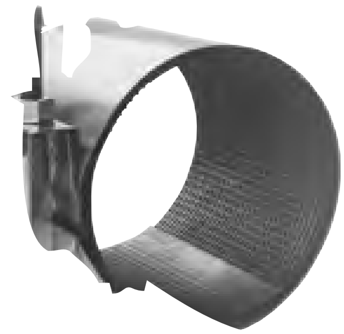
STYLE CR1

Single Section Normal Range

To Order: Determine desired range and length, then select corresponding catalog number.

Note: Other ranges and lengths not listed are available upon request. For higher pressures, clamp length should be equal to or in excess of pipe O.D.

Conductivity Strips available upon request.



Nominal Pipe Size (Inches)	Clamp O.D. Range (Inches)	Catalog Number	Length and Approximate Shipping Weight Lbs.							
			6"	8"	10"	12"	16"	20"	24"	30"
2	2.32-2.63	CR1 - 263 - Length	4	4	5	5	8	—	—	—
2 1/4	2.57-2.87	CR1 - 287 - Length	4	4	5	5	8	—	—	—
2 1/4-2 1/2	2.70-3.00	CR1 - 300 - Length	4	4	5	6	8	—	—	—
3	2.95-3.25	CR1 - 325 - Length	4	4	5	6	8	—	—	—
	3.40-3.70	CR1 - 370 - Length	4	5	6	7	9	—	—	—
3 & 4	3.71-4.00	CR1 - 400 - Length	—	5	6	8	9	—	—	—
4	4.45-4.75	CR1 - 475 - Length	—	5	7	8	10	14	—	—
	4.75-5.15	CR1 - 515 - Length	—	5	7	8	10	14	16	21
4 & 5	4.95-5.35	CR1 - 535 - Length	—	6	7	9	11	15	16	21
	5.20-5.60	CR1 - 560 - Length	—	6	7	9	11	15	17	22
6	5.95-6.35	CR1 - 635 - Length	—	6	7	9	11	15	18	23
	6.55-6.95	CR1 - 695 - Length	—	6	7	9	11	15	19	24
	6.84-7.24	CR1 - 724 - Length	—	7	8	10	12	16	20	25
	7.05-7.45	CR1 - 745 - Length	—	7	8	10	12	16	21	26
	7.45-7.85	CR1 - 785 - Length	—	7	8	11	13	17	22	28
8	7.95-8.35	CR1 - 835 - Length	—	7	9	11	14	17	23	29
	8.59-8.99	CR1 - 899 - Length	—	7	9	11	14	17	23	29
	9.00-9.40	CR1 - 940 - Length	—	8	10	12	15	18	24	30
	9.30-9.70	CR1 - 970 - Length	—	8	11	13	16	19	25	31
8 & 10	9.75-10.15	CR1 - 1015 - Length	—	10	12	14	17	23	26	35
10	10.65-11.05	CR1 - 1105 - Length	—	11	13	15	18	24	27	37
	11.04-11.44	CR1 - 1144 - Length	—	12	13	16	20	27	31	39
	11.35-11.75	CR1 - 1175 - Length	—	12	14	16	21	29	33	42
	11.75-12.15	CR1 - 1215 - Length	—	13	15	17	23	30	34	44
	11.95-12.35	CR1 - 1235 - Length	—	13	15	18	26	30	36	45
12	12.65-13.05	CR1 - 1305 - Length	—	14	16	19	28	31	37	46
	13.10-13.50	CR1 - 1350 - Length	—	15	17	20	28	32	38	47
	13.40-13.80	CR1 - 1380 - Length	—	15	18	21	29	33	39	48
12 & 14	13.70-14.10	CR1 - 1410 - Length	—	16	18	21	29	33	39	48
	14.00-14.40	CR1 - 1440 - Length	—	16	19	22	29	35	41	52

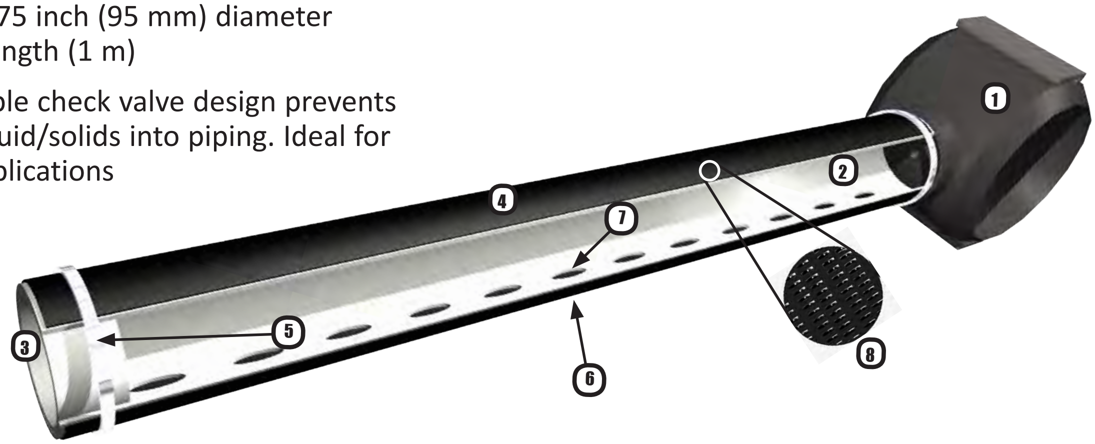
1170

EDI FlexAir® Magnum™ Diffuser

Fine Pore Flexible Membrane Technology

High Unit Capacity for Demanding Oxygenation and Mixing Applications

- Large perforated area for maximum air handling capacity - 380 in^2 (0.245 m^2)
- Efficient geometry supports high density installations of over 65% floor coverage
- Precision die cut openings for high oxygen transfer, uniform air release, and low operating pressure
- Micropore and high capacity membrane options engineered for optimized OTE, air handling, and operating pressure requirements
- Advanced technology premium quality membranes available in EPDM, urethane, special polymer blends, plus BioShield™ and BioCide™ technologies for reduced fouling and maintenance
- Nominal 3.75 inch (95 mm) diameter x 39 inch length (1 m)
- Integral triple check valve design prevents entry of liquid/solids into piping. Ideal for on / off applications
- Resistant to fouling and plugging for low maintenance
- ABS and PVC construction for maximum chemical, temperature, and UV resistance
- Available in bouyant and non-bouyant models
- Spectrum™ Saddle Mount for maximum mechanical integrity, ease of installation and maintenance, and ability to relocate or add diffusers for process modifications
- Spectrum™ Saddle Mount mounts on any pipe material (PVC, ABS, CPVC, SS, etc.)
- Available in 4, 6 and 8 inch sizes and 110 mm 160 mm pipe sizes



1. Spectrum™ Saddle Mount
2. Diffuser Body
3. Diffuser Plug for Bouyant Unit (*Non-Bouyant Design Available)
4. Flexible Membrane Media Featuring Full Circumferential Perforation
5. Membrane Retainer Clamp
6. Check Valve Feature
7. Air Inlet
8. Die Cut Perforations

PRODUCT SPECIFICATION SHEET

EDI FlexAir® Magnum™ is a fine pore, flexible membrane diffuser that provides maximum operational flexibility and aeration capacity.

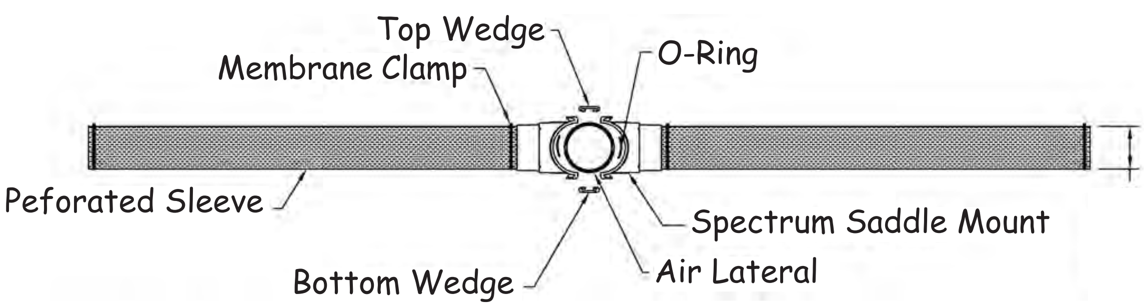
The Magnum diffuser features a full circumferential perforation design. This design produces optimum aeration capacity performance. A full 380 in^2 (0.245 m^2) of perforated area is provided with a single Magnum diffuser. The geometry of the diffuser supports high diffuser density applications over 65% floor coverage when the highest aeration capacity is desired.

Unique to the FlexAir product is the ability to configure the Magnum diffuser with a MicroPore or high capacity membrane for optimized aeration capacity and engineered operating pressure performance. All FlexAir diffusers are configured with premium quality membranes engineered by the Membrane Technologies division at EDI. Alternate membrane materials and perforation designs are available for non-standard industrial or municipal applications.

An integral triple check valve feature prevents the backflow of liquid into the diffuser and piping. The FlexAir Magnum diffuser is ideally suited for on/off applications and requires minimal maintenance for long-term performance.

The standard FlexAir Magnum membrane support tube is constructed of PVC for maximum chemical resistance and mechanical durability. ABS construction is recommended for high temperature applications or where cold temperature durability is required.

The FlexAir Magnum diffuser is ideally suited for a wide variety of aeration and mixing applications including tank and lagoon facilities. For rigid piping applications, the FlexAir Magnum diffuser is available with the Spectrum Saddle Mount for maximum mechanical durability and ease of installation and maintenance. Unique to the Spectrum Saddle Mount is the ability to expand, relocate, reconfigure or add diffusers to match process demands.



	Diffuser Type	Design Airflow		Overall Length		Active Surface Area		Dry Weight		Net Operating Buoyancy	
		scfm	m^3_N/h	in	mm	ft^2	m^2	lb	kg	lb	kg
84P	Micropore	0-50	0-79	92.9	2360	5.28	0.491	11	5.2	27	12
	High Cap	0-88	0-140	92.9	2360	5.28	0.491	11	5.2	27	12
42P	Micropore	0-25	0-40	53.4	1360	2.50	0.232	7.1	3.2	12	5.5
	High Cap	0-44	0-70	53.4	1360	2.50	0.232	7.1	3.2	12	5.5

- Optimum oxygen transfer efficiency is achieved when operating in the middle to low end of the airflow range. The approximate operating pressure of the diffuser at the mid-range is 13 to 16 inches (3.2-4.0 kPa).
- Operating the unit at the high end of the range will result in reduced performance and increased operating pressure. Use the maximum airflow value for short term operations such as peak loads or system maintenance.

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For Parts Information:
parts@wastewater.com
www.diffuserexpress.com

For System Information:
systems@wastewater.com
www.wastewater.com

Aeration/Mixing System Headloss and Orifice Calculations

Project Name: East Bridgewater, MA **Project #:** 17876 **Date:** 16-Nov-11

System Design Conditions

	Design Airflow (scfm)	
Total System:	389.00	
Per Diffuser Unit:	9.73	

Diffuser Submergence Depth:	6.75	(ft)
Quantity of Diffuser Units:	40	
Active Surface Area:	380	(in2)
Diffusers per Orifice:	1	
Orifice Diameter:	0.6250	(in)

Estimated System Pressures & Uniformity

		Design Airflow		
Liquid Depth		81.00		(in/wc)
Piping Loss		0.28		(in/wc)
Diffuser Loss		13.33		(in/wc)
Orifice Loss		3.11		(in/wc)
Total Headloss		97.72		(in/wc)
***Operating Pressure**		**3.53**		**(psig)**
Uniformity		97%		

* - at Top of Drop

Piping System Headloss Calculations

Basin: Aeration

Piping Segment	Type Of Piping	Equivalent Length (ft)	Diffusers Remaining			Design Total Airflow (scfm)	Design Total Loss (in/wc)		
Top of Drop - Clamp	SS 6" Sch5	5.0	40			389.00	0.0395		
Clamp - EL	PVC 6" Sch40	2.5	40			389.00	0.0264		
EL - F20	PVC 6" Sch40	16.2	40			389.00	0.1709		
F20 - F19	PVC 6" Sch40	0.5	38			369.55	0.0048		
F19 - F18	PVC 6" Sch40	0.5	36			350.10	0.0044		
F18 - F17	PVC 6" Sch40	0.5	34			330.65	0.0039		
F17 - F16	PVC 6" Sch40	1.0	32			311.20	0.0071		
F16 - F15	PVC 6" Sch40	0.5	30			291.75	0.0031		
F15 - F14	PVC 6" Sch40	0.5	28			272.30	0.0028		
F14 - F13	PVC 6" Sch40	1.0	26			252.85	0.0049		
F13 - F12	PVC 6" Sch40	0.5	24			233.40	0.0021		
F12 - F11	PVC 6" Sch40	0.5	22			213.95	0.0018		
F11 - F10	PVC 6" Sch40	1.0	20			194.50	0.0030		
F10 - F9	PVC 6" Sch40	0.5	18			175.05	0.0013		
F9 - F8	PVC 6" Sch40	0.5	16			155.60	0.0010		
F8 - F7	PVC 6" Sch40	1.0	14			136.15	0.0016		
F7 - F6	PVC 6" Sch40	0.5	12			116.70	0.0006		
F6 - F5	PVC 6" Sch40	0.5	10			97.25	0.0004		
F5 - F4	PVC 6" Sch40	1.0	8			77.80	0.0006		
F4 - F3	PVC 6" Sch40	0.5	6			58.35	0.0002		
F3 - F2	PVC 6" Sch40	0.5	4			38.90	0.0001		
F2 - F1	PVC 6" Sch40	0.5	2			19.45	0.0000		
Subtotals from Top of Drop to 1st diffuser:							**0.24**		
Subtotals from 1st diffuser to last diffuser:							**0.04**		

NOTES:
All calculations included in these tables are estimates and should only be used as a guideline for design of the system. Specific operating conditions such as initial start-up, aging of membranes, standby blowers started for emergency situations, etc., are **not** accounted for in these calculations. Provisions and/or safety factors to account for these conditions must be considered and added when designing the overall system. Also account for differences between positive displacement blowers and centrifugal blowers during design. Contact EDI for design assistance.

The piping segments analyzed had the path of highest resistance to airflow. "Equivalent Length" refers to the pipe segment length plus the equivalent length of pipe due to fittings/valves (based on Crane Company data).

A diffuser "unit" is defined as a single membrane or component; not a full diffuser assembly.
The **airflow capacity of each diffuser unit** in this application is 25 (scfm)
Operating the diffuser at the high end of the range will result in reduced performance and increased operating pressure. Use the maximum airflow range for short term operations such as peak loads or system maintenance.

Uniformity: At the Design airflow, this system will provide 97% of the initial airflow to the last diffuser.
Therefore, uniformity among diffusers on a common unvalved section is ± 1.3% .

calc by MAP template revised 13-Oct-11

Storage Instructions

Receiving Inspection

(FOB EDI only) Shipments shall be inspected for damage upon receipt. The recipient/receiver is responsible for all damages. EDI offers to act on behalf of the recipient / receiver in filing a claim for damage incurred during shipment. To file a claim against the freight company, a damage report must be submitted to EDI within 24 hours of delivery.

(FOB Jobsite only) Shipments shall be inspected for damage upon receipt. Any damages observed upon receipt must be reported to EDI within 24 hours of delivery. EDI will repair or replace damaged goods when notified within this notification period.

(Ex-Works only) Shipments shall be inspected for damage upon receipt. The recipient/receiver is responsible for all damages. To file a claim against the freight company, file a damage report directly with the shipping company.

A full inventory of shipped components shall be completed within 14 days of the receipt of shipment. Any deficiencies in the shipment that are clearly deemed to be the result of EDI will be reconciled by EDI when notified within this time period.

Pre-Installation Storage Requirements for Plastic Piping

PVC, CPVC and ABS piping components may be stored outdoors provided the ambient air temperature is below 140°F (60°C).

Pipe sections are furnished with end caps to minimize the entry of foreign materials (dirt, debris, etc.) into the pipe. Any foreign materials that are allowed to contaminate the pipe will need to be removed from the system prior to installation and start-up.

Piping shall be stored on a flat surface to avoid damaging the pipe sections.

If the pipe components are to be stored for more than 6 months, pipe sections are to be shaded from sunlight.

Accessories such as pipe supports, fasteners, etc., packaged in original boxes are to be protected from excessive moisture and rain. Outdoor storage is acceptable provided the ambient air temperature is below 140°F (60°C).

Small items should be stored in a secure location to avoid misplacement and theft.

Pre-Installation Storage Requirements for a Flexible Membrane System

Diffuser components packaged in original crates and/or cardboard boxes may be stored outdoors provided the ambient air temperature is below 100°F (40°C). In the case of components that are received in cardboard packaging, these packages must be protected against excessive moisture and rain to maintain package integrity.

If the ambient air temperature exceeds 100°F (40°C), then containers shall be shaded or stored indoors in which the ambient air temperature does not exceed 125°F (52°C).

Storage of diffuser membrane components shall be limited to one year.

Post-Installation Storage Requirements for a Flexible Membrane System

When the reactor is drained and the aeration system is exposed for a short period of time (less than 4 to 6 weeks), the system shall be protected from foreign objects including but not limited to paint or weld splatter, falling objects, etc.

- If the ambient air temperature is above 100°F (40°C), the system should be shaded to protect the system from UV light and excessive heat. A gray fabric tarp is recommended to shade the aeration components. The gray fabric tarp is to be suspended above the aeration system by approximately 6” (150 mm) to prevent damage to the system.

- **Note: Do not use any form of plastic to cover the aeration components. Plastic can create a hotter environment and/or fuse to the surface of the diffusers.**

When the aeration system is to be idle for an extended period time (greater than 4 to 6 weeks), the system should be submerged in approximately 4 feet of clean water provided the ambient air temperature is greater than 32°F (0°C).

- If the ambient air temperature is below 32°F (0°C), the water level may need to be increased so that the ice layer does not contact the aeration system.
- When reactivating a system where ice exists, operate the system at a minimum airflow to avoid movement of ice and maintain this airflow condition until the ice is no longer present.
- The water level should never be lowered if ice is present. The weight of the ice may damage the system.

When the aeration system is to be idle for an extended period time (greater than 4 to 6 weeks) and the units are going to be removed and stored, then the following storage conditions would apply.

- If the ambient air temperature is going to be less than 100°F (40°C), then a fabric tarp is recommended to cover the equipment.
- If the ambient air temperature exceeds 100°F (40°C), then the equipment shall be shaded or stored indoors in which the ambient air temperature does not exceed 125°F (52°C).

Installation Instructions

Air Piping Installation

The Contractor is to confirm that the air piping is clean during fabrication of laterals and should swab out any debris found in the pipe **before** installing the diffuser units. Dirt and debris may clog the diffuser unit requiring an extended start-up procedure and **MAY** require the Contractor to remove and replace diffuser unit at Contractor's expense. If piping requires further cleaning before diffuser installation, Contractor may elect to perform water flush or air purge procedures described at the conclusion of this section. **NOTE**: If this procedure is performed, do so before installing the diffusers.

Transition from the drop pipe to the air lateral piping is made by a stainless steel coupling clamp provided by EDI. The aeration system typically features a drop stub designed to be field cut to length and solvent welded to the air laterals by Contractor. The pipes must be aligned vertically prior to installing the coupling clamp or the clamp may leak. The clamp has limited ability to seal misaligned piping. Also, the gap between the drop pipe and drop stub shall be less than 0.25”(6.5 mm) to ensure proper sealing of the coupling clamp.

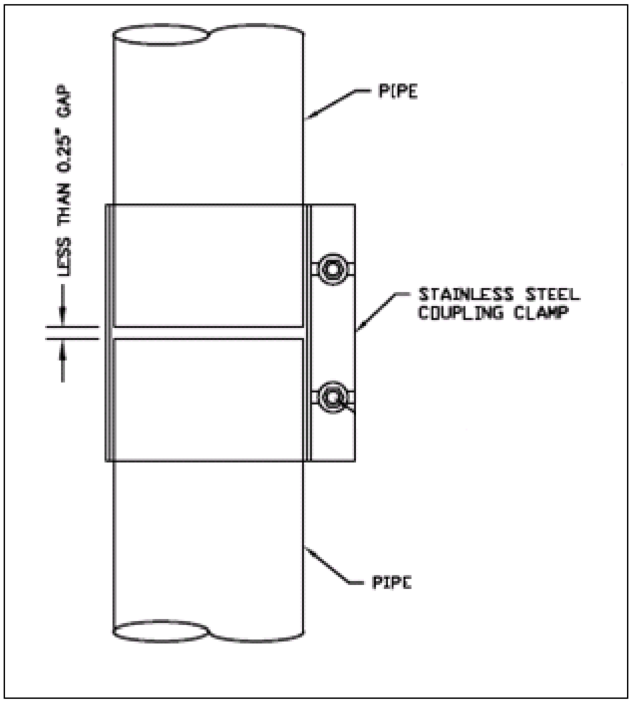
Assemble the aeration piping per the EDI layout drawing. Start with the drop pipe section to ensure proper drop pipe alignment. Pipe supports should be partially assembled with the bottom pipe strap, then placed under the drop pipe section for support. Pipe support assembly instructions are in the following section. See the EDI layout drawing for pipe support locations. Do not install the anchor bolts until the final alignment is established for the complete aeration grid. The remaining air lateral piping shall be installed using this same method. All piping segments will be labeled with a sequence number that indicates that segment’s position in the lateral run. Additionally, EDI will provide an arrow on the lateral piping. This arrow indicates the direction of airflow in the lateral segment. All arrows should point away from the header toward the lateral end at final installation.

Stainless Steel Coupling Clamp Installation

The stainless steel coupling clamp is provided by EDI to make the proper transition between two sections of pipe.

1) Make sure the pipe is clean. Remove any dirt or debris that would interfere with the complete sealing of the gasket around the pipe. Lubricate both the pipe and clamp gasket with soapy water. Do not use oil base pipe lubricant.

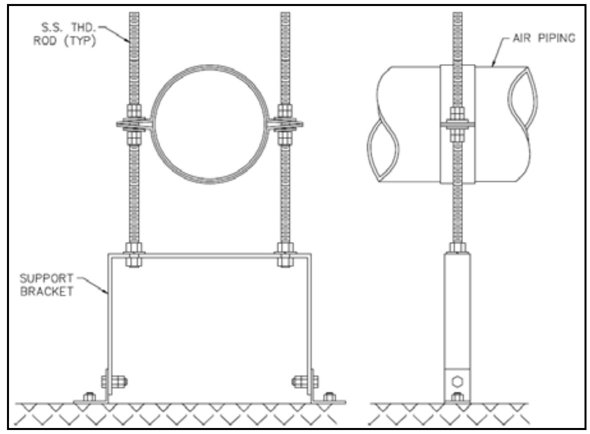
2) Ensure that the pipes are properly aligned prior to installing the clamp or the clamp may leak. If the clamp is to be installed on vertical pipe the pipes must be aligned vertically before installing the clamp. The clamp has limited ability to seal misaligned piping. Also, the gap between the two pipes shall be less than 0.25”(6.5 mm) to ensure proper sealing of the coupling clamp.



3) Place a reference mark on the pipe at a measured distance from the center of the pipe ends. This presents a visual mark to center the coupling clamp over the pipe transition.
4) Center the clamp over the two pipes. Loosen nuts to top of studs and wrap clamp around the pipe snapping the washer plate over the receiver bar.

5) Squeeze the clamp together, finger tighten the nuts down, and rotate clamp toward the threaded end of the studs to smooth out the gasket.

6) Torque nuts sufficiently to stop leaks. Recommended torque is 70 ft. lbs. for 2" through 8" coupling clamps and 85 ft. lbs. for 10" – 12" coupling clamps. Correct torque indicated by slight deformation of washer plate and nylon washers. Caution! Thin Wall Pipes may require less torque and may deform if over tightened.



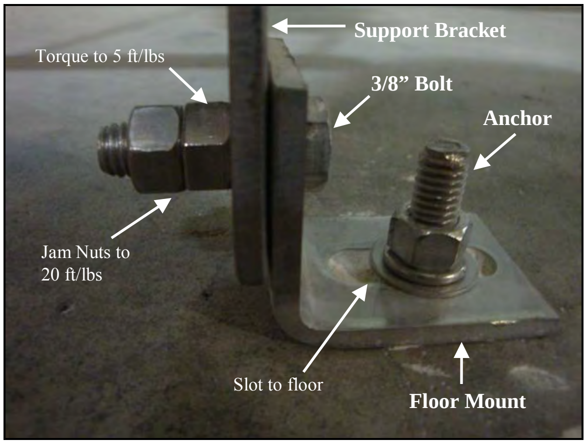
Note: A simple support is shown above. A rigid support is a simple support plus secondary stabilizer legs to prevent pivoting. See EDI layout drawings for rigid support locations.

To maintain proper clearance for the diffuser mount, EDI recommends a minimum distance of four inches between any outlet hole and a pipe strap. When a support must be relocated due to the support clearance indicated, shorten rather than lengthen the support spacing. See EDI layout drawing for proper pipe support spacing and locations.

Rigid & Simple Pipe Support Installation Instructions

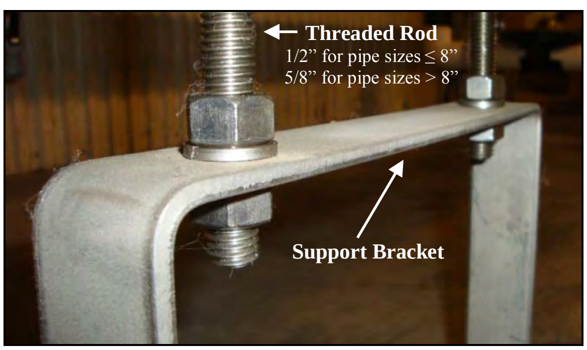
Air laterals are anchored to the basin floor by stainless steel (SS) pipe support assemblies. Depending on project specific forces and/or turbulence anticipated in the basin, EDI may include additional support features. Please review all details shown in the EDI construction drawings to ensure all features are properly installed.

1) Connect floor mount to support bracket with one SS bolt and double SS nuts (see following photo). The slotted side of the floor mount is against the floor when properly assembled. Rest the double nuts against the support bracket and lock against each other. Torque values must be adhered to unless specified otherwise. Floor mount must allow pivoting of the support. Repeat for other leg of pipe support.



Required Bolt/Nut Torque Values	
Bolt Sizes	Torque
3/8 in.(9.5 mm)	20 ft-lb (27 N-m)
1/2 in. (13 mm)	45 ft-lb (61 N-m)
5/8 in. (16 mm)	90 ft-lb (122 N-m)

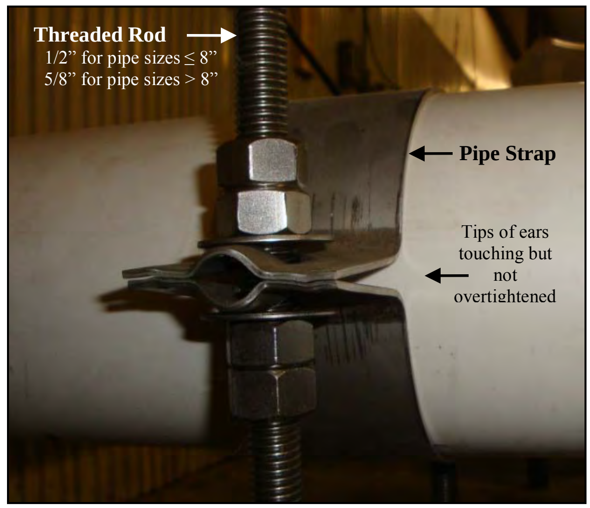
2) In the following order, place one nut and one lock washer onto threaded rod approximately 1" (25.4mm) from bottom. Thread bottom nut to secure rod. Repeat for second S.S. threaded rod (see following photo).



3) Place two SS nuts followed by one SS flat washer on the upper end of both SS threaded rods. Then place the bottom SS pipe strap onto the threaded rods.

4) Set the air piping on the bottom pipe strap and adjust the vertical height to the elevation indicated on EDI layout drawing. Sufficient amounts of threaded rod are provided on pipe supports to adjust the elevation of the piping. Pipe supports incorporate a ± 2" (51 mm) allowance for variations in the basin floor.

5) Place the top SS pipe strap onto threaded rods around the air piping. Install one SS flat washer followed by two SS nuts to upper end of rod over the top pipe strap.



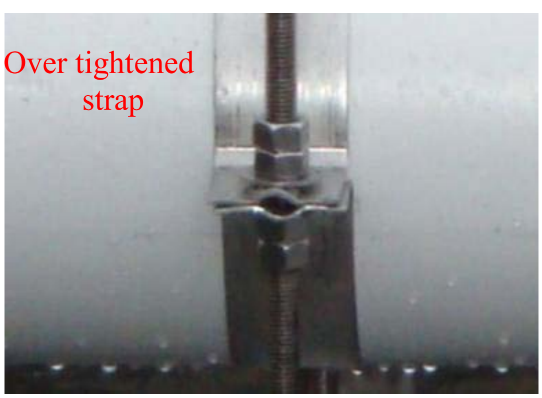
6) **Pipe straps shall be tightened until the ends of the straps touch (see photo above).** Equally tighten both sides until the tips of the upper and lower pipe straps touch on both sides. The straps must be aligned when tightened. Misalignment of the straps will hinder proper operation of the strap through the full range of motion the straps are designed to provide. It takes less than 1ft-lb to reach this position. Care should be taken to not over tighten the straps, as this can cause irreversible damage.

7) Thread the jam nut down to the first hex nut.

8) While securing the first hex nut, jam the second nut to the proper torque value indicated on the table above.

Example of properly tightened straps:

In the photo below, the hex nut must be loosened until the ends of the strap are just touching and aligned.

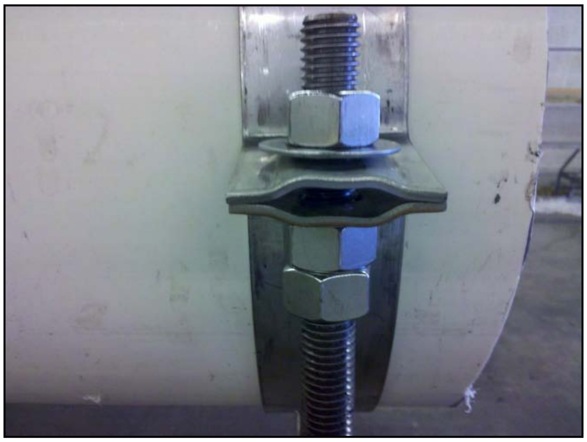


Warning! If the strap ends do not return to their original shape when the hex nut is loosened then the straps must be replaced. Bending the ends of the strap down is not an acceptable repair as this condition is an indication that the center of the strap has been crushed.

9) On pipe diameters greater than 8" the pipe strap design is different and the following instructions apply for proper installation.

10) **Pipe straps shall be tightened until the ends of the straps touch (see photos below).** Equally tighten both sides until the tips of the upper and lower pipe straps touch on both sides. The straps must be aligned when tightened. Misalignment of the straps will hinder proper operation of

the strap through the full range of motion the straps are designed to provide. Care should be taken to not over tighten the straps, as this can deform both the strap and the pipe. Deforming the pipe places high stress levels on the pipe and which can result in premature pipe failure



11) Thread the jam nut down to the first hex nut.

12) While securing the first hex nut jam the second nut to the proper torque value indicated on the table above.

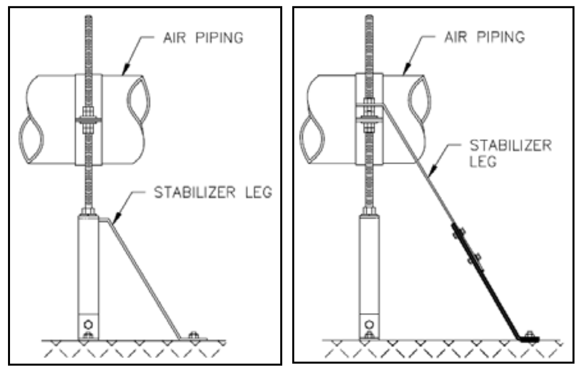
13) Assembled pipe supports MUST be vertical.

14) When each of the above steps has been completed, each floor mount must be secured to the basin floor by an anchor bolt, 3/8" flat washer, lock washer, and nut. Note: When installing anchors, drill the hole perpendicular to the work surface. To assure full holding power, do not ream the hole or allow the drill to wobble. Then clean the hole to ensure proper performance.

Rigid Stabilizer Legs

Rigid stabilizer legs are featured on all fixed grid aeration systems anchored to the basin floor. Rigid stabilizer legs are utilized to prevent rotation and established a fixed point for downstream expansion and contraction. Each rigid support identified on the EDI layout drawings will feature **two stabilizer legs per support** (one **on** each threaded rod).

Rigid stabilizer legs may be connected at the support bracket or at the pipe strap (see both examples below) depending on the calculated thrust for each specific project. See EDI detail drawings for specific stabilizer arrangement and assembly instructions.

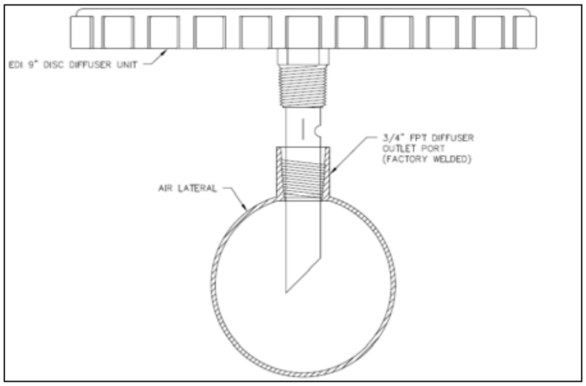


Note: Rigid stabilizer legs shall be positioned upstream of the support so they are in tension as the piping grid expands forward.

Leveling of Air Piping

Air distribution through the aeration system is a function of the relative elevation of the individual aeration units and the leveling tolerance of the air supply piping. As a guideline, EDI recommends that air piping not vary in elevation by more than 1/2" (13mm). Excessive variation in pipe elevation may result in poor air distribution during normal operation.

Installation of the Top-Mounted Continuous Flow Purge Assembly



A continuous flow purge assembly has been provided to remove accumulated condensation from the EDI aeration system.

The contractor is to thread the purge assembly into the 3/4" threaded outlet located on the piping until no male threads are visible on the assembly. Apply teflon pipe dope to the threads when making this connection.

Install the continuous flow purge assemblies in the locations shown on the EDI layout drawings.

Optional Water Flush and Air Purge Cleaning of Piping

These instructions cover the general procedure that may be used to clean the piping in a fine or medium bubble diffuser system prior to diffuser installation. Special pipe cleaning requirements outlined in the Engineer's specifications, contract documents, or instructions offered by EDI shall be supplementary to or take precedence over the general instructions outlined below.

Water Flush Cleaning

1) Water flush cleaning is the recommended method to clean assembled piping systems where pipe segments are too long for manual cleaning. This procedure can be used in conjunction with air purge cleaning and is recommended when fine debris is not removed prior to assembly of piping. When both water flush and air purge are used, the water flush procedure should be implemented first.
2) To water-flush the system, connect a water supply to the air header or make individual connections to each lateral. If flush water is piped to the header, it is imperative that the header be valved or stubbed such that water does not flood the blowers.
3) Clean water must be used. It is not necessary to use potable water, but the flush water must be free of silt or debris.
4) Flush header assembly prior to water flushing the laterals. To flush the header, fill it with water and open the end lateral to create a flush velocity in the header of at least two feet per second.
5) Next, the laterals are to be individually flushed at a recommended velocity of five to six feet per second. Opening one isolation valve will produce a significant flushing action in the lateral as water is pumped through the header. One or two drilled air outlet holes should be uncapped to allow water and debris to be flushed out of the piping.
6) The cleaning procedure in the previous step should be completed for each of the laterals. This is done by sequentially opening and closing the isolation valves on the individual laterals.
7) As an alternative to using the main header/lateral flush procedure, the individual laterals may be cleaned independently of the main header. For this operation, the laterals are disconnected from the main header and cleaned individually.

Air Purge Cleaning

1) Remove weights and cap from the pressure relief valve during initial start-up of the system. This prevents potential damage to the blowers from

blocked valves or obstructions in piping system. Cap and weights can be added back to the pressure relief valve as necessary to provide proper operating pressure capability.

2) NOTE: When a blow-off valve is provided for the blower system, it may be operated in lieu of using the pressure relief valve procedure listed above.

3) Open all lateral valves prior to start-up of the blowers. Provide an opening at the end of the air laterals to allow air and foreign materials to be discharged from the system. The opening may be made at the end of the air lateral by leaving the end cap off of the lateral or by removing two orifice/outlet plugs at the end of the lateral.

4) In order to increase the velocity of air through the header and air laterals, it may be desirable to operate at maximum blower capacity. In addition, it may be necessary to close some of the lateral throttling valves to achieve a high velocity through the balance of the laterals that are open to the atmosphere. A high velocity is required in order to blow out any accumulated foreign materials.

5) As laterals are consecutively cleaned, the isolation valves are operated in a manner that allows the remaining laterals to be cleaned by an air purge.

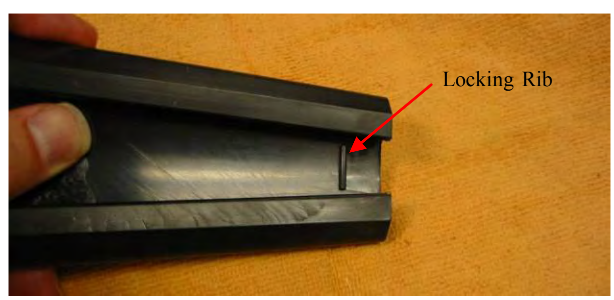
6) Upon completion of the air purge, the blowers are shut down and the laterals are capped. Diffuser units are installed on the laterals and all isolation valves are opened prior to filling the basin with water.

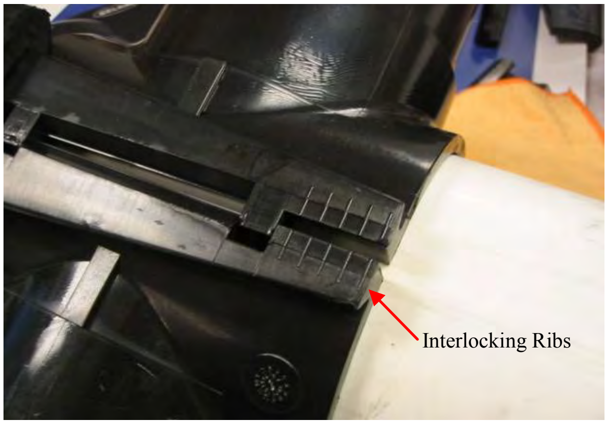
7) If only an air purge is used to clean the piping, the basins are now ready to be filled with water to check the operation of the diffuser units.

Installation Instructions for FlexAir® SDM Diffuser Units with locking rib on wedge.

Each duplex diffuser assembly consists of:

- One "Male" diffuser that has protruding alignment pins, a red “TOP” sticker applied near the wedge ramp, and wedge retaining ribs at small end of ramp.
- One "Female" diffuser that has alignment slots, a red “TOP” sticker applied near the wedge ramp, and wedge retaining ribs at small end of ramp.
- Two wedges with locking rib.
- Two o-rings.
- One alignment plug





Other standard materials/tools required for installation include:

- Non-metallic mallet (not included by EDI).
- Bubble/laser level (not included by EDI).

Preparation for installing diffusers on air lateral piping:

1) Insure that the air laterals are installed with the orifice holes horizontal.
2) Locate the 1.0 inch holes in the lateral and place the alignment plug up to and centered on the hole. Only one plug is required per pair of diffusers.

Note: The lateral will have two different sized holes. The smaller hole is the air flow orifice for one side of the duplex diffuser and the larger hole is for the alignment plug.

3) Tap the plug into the lateral using a soft blow hammer and a short piece of 1.0 inch diameter dowel (provided by EDI).

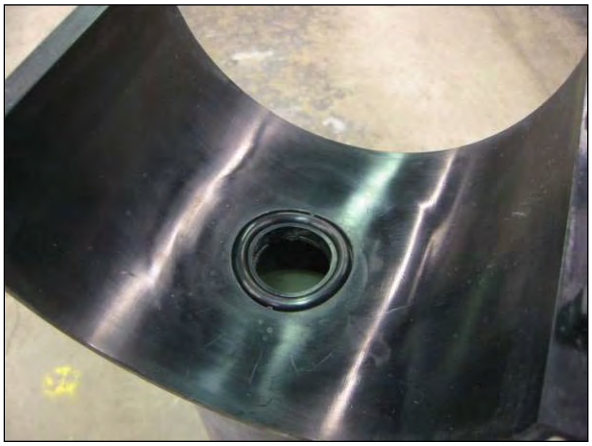
4) Ensure that the plug is correctly seated and was not damaged during the installation. Replace any plug if damage occurred.

Installing of diffusers on air lateral piping:

5) Install O-ring immediately before saddle is to be installed on lateral. The o-ring is placed in the internal groove. DO NOT USE ANY MASTIC OR OTHER ADHESIVE.

6) There are retaining bumps to hold the o-ring in place during installation. **Note:** The o-ring must be able to move to seal when pressure is applied. **Note:** During cold weather installation, below 40°F (4°C), it is advisable to keep the o-rings warm.

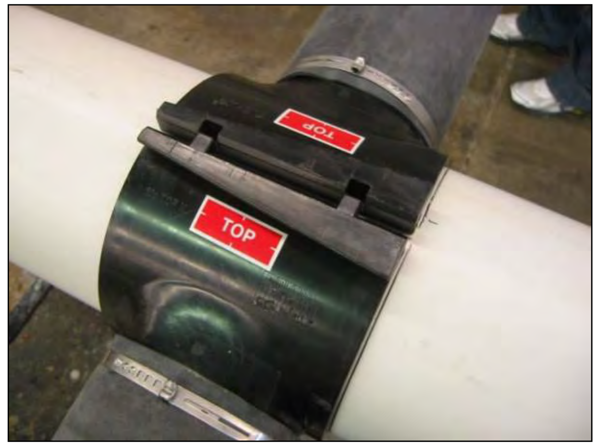
One method is to place the o-rings in a bucket of warm water.



7) Position the diffuser unit in the proper orientation (see table below) while positioning the alignment plug to the center hole in the saddle. The plug fits into the saddle.

Unit Type	Perforation	Ear of Clamp	RED "TOP" Sticker
MiniPanel	On Top	On Top	On Top
Magnum	On Sides	On Top	On Top

8) **Note:** Ensure that the saddles' alignment pins mate properly when installing the opposing saddle before sliding on the wedges. The red "TOP" stickers should face up.



9) Install the top wedge ¾ inch from being flush by hand.

10) Install the bottom wedge hand tight- approximately 3/4 inch (19mm) from being flush with the saddle.

11) Ensure that the diffuser assembly is in the correct location, level, and that each diffuser arm is in line with the rest of the diffusers on the shared lateral.

12) Tighten the top wedge and bottom wedge **EQUALLY** with a non-metallic mallet or rubber faced hammer. When properly tightened, each diffuser should be level and resist rotation. **Note:** Metal mallets or hammers may crack or shatter the wedge assembly or damage the unit. Do not use metal hammers directly. **Note:** Extra care is needed during cold weather installation, below 40°F (4°C). Plastic components become brittle and may fracture with excessive impact force.

13) Ensure that wedges are driven on as equally as possible while maintaining level on the diffusers. **The wedges should be flush with that saddle when complete.** Over-tightening wedges can cause irreversible damage to the diffuser saddle.

NOTE: Diffusers must be protected from the sun. Long term exposure to direct summer sunlight can cause failure. Diffusers need to either be protected from the sun or heat by covering them with clean water or shade over the basin.

Start-Up Instructions

General Aeration/Mixing Systems Start-Up Instructions

These instructions cover the general start-up requirements for the aeration system. Special start-up requirements outlined in the Engineer's specifications, contract documents, or instructions offered by EDI shall be supplementary to or take precedence over these general instructions.

An overview of start-up procedures is related below:

1) Confirm that piping and diffusers are level by filling the basin with water until the diffusers are 1" to 2" under water. Adjust supports or diffusers as required.
2) Activate the blower and introduce air to the aeration system. Check piping and diffusers for leaks, and repair if required. Open any manual purge valves to expel water that may be in the piping. Close the purge valves prior to placing the system into full service.
3) NOTE: Diffuser membranes may exhibit small leaks at the ends of the membranes at initial start-up. This is normal and can be expected until the membranes are submerged for a period of time. This is also true for uniformity of ceramic media. These small leaks will stop once the membranes are wetted for a period of time, especially for polyurethane membranes (up to 2-4 weeks). This allows the polymer to become less rigid, improve uniformity, and allow the specific clamping mechanism to seal the membrane to the support tube/holder.
4) While maintaining air to the system, continue filling the basin until the design depth is reached.

Blower Components

See the blower installation and start-up instructions to assure all blower components are mounted properly and ready for operation. When EDI provides the blower assemblies, detailed installation and start-up instructions are provided in the blower submittal package.

Blower components should be fully installed and fully serviced prior to making final electrical connections and starting up the aeration system.

Precautions should be taken throughout system installation to minimize the discharge of airborne particles to the aeration system. As a minimum, an air inlet filter should be installed and operated during blower servicing procedures. EDI recommends a filter efficiency of 93% of 10-microns. Any solvents used to clean blower should be bypassed from the aeration piping. The discharge of airborne particulate matter or solvent into aeration piping may result in damage to diffuser membranes.

Upon completion of blower manufacturer's recommended service, the subsequent start-up procedures may be followed.

General Air Piping

Contractor is to confirm the cleanliness of the air piping. If existing header piping is used, the air purge or water flush cleaning procedure is recommended prior to installation of diffuser units to remove any internal debris that may have accumulated in the header piping. Inspect air piping and diffuser connections for loose fittings or damaged pipe. Damaged piping sections and connections should be repaired prior to commencing system operations.

Initial System Start-Up

To start the system, completely open all valves in the air supply system, including blower shut-off valves, header valves and lateral isolation/throttling valves. This instruction assumes that uniform water level is present in all aerated basins served by a single blower. If varying water levels are present, basins with lower water levels will need to have the valve throttled back to avoid improper air distribution. Failure to completely open all valves may result in over-pressuring blower unit, release of pressure relief valve, motor overload, or poor air distribution in aeration system with the potential of overpressuring diffuser units and damaging the diffuser membranes.

Once valve positions have been confirmed, blower unit may be started. EDI does not recommend starting multiple blower units at initial system start-up. Subsequent blowers should be brought on-line after the system has equalized and uniform diffuser activity is observed throughout the system.

Use blower manufacturer's recommended start-up procedures. EDI recommends that initial pressure surge be reduced through PRV or blow-off valve.

Start-up procedures should follow the basic guidelines as listed below:

1) When starting initial blower, the PRV or blow-off valve should be used to reduce the start-up pressure surge. This is accomplished by removing weights and the cap from the PRV or by opening the blow-off valve.
2) When the basin has been filled, note the operating pressure at the blowers. The pressure relief valve should be adjusted to free-flow at approximately 1 psig above the normal operating pressure of the system.
3) To confirm the PRV operates, partially close blower shut-off valve until PRV releases air. Reopen the shut-off valve to confirm that PRV will reseat. If required, readjust the PRV to the recommended setting per instructions in the Blower IOM manual.
4) To properly assess the airflow distribution on the aeration system, the blower system must be operating at the design operating point. On dual blower systems, design airflow is typically achieved by operating one blower at 100%. On three-blower systems, design airflow is typically based on operating two blowers at 100%.
5) Airflow distribution adjustment between laterals should not be conducted until the full operating depth is obtained and the blower system has been in operation for several days. Small adjustments may be made to the isolation/throttling valves on the laterals receiving the most air. System balancing should be completed on an incremental basis. Changes in airflow distribution may require 2-8 hours to fully stabilize when fine-tuning a system. In addition, in situations where multiple basins are employed and varying water levels exist, adjustments of

lateral valves will be required to maintain air distribution in the tanks.

6) For units using membrane clamps, the clamp may become loose during shipment. If a small leak in the clamp area is noticed during the wet check, a simple tightening of the clamp should eliminate the leak.

EDI recommends that the system Operator contact EDI at 573-474-9456 prior to making any adjustments to the airflow distribution.

Safety Considerations

The diffused aeration system supplied on this project has no moving parts and poses little to no risk of injury to operations staff. However, routine maintenance may expose personnel to potential hazards. EDI has listed below potential hazards and recommended precautions when maintenance procedures are required for the aeration components.

Tanks at Full Liquid Depth

Hazards:

1) Turbulent liquid action.

Precautions:

1) Provide access to emergency throw rope or life ring.
2) Use "buddy system" during maintenance activities.

Tanks Empty

Hazards:

1) Falling into tank.
2) Objects falling onto maintenance personnel in the tank.
3) Slippery floor.

Precautions:

1) Avoid access ways without railings.
2) Provide emergency exit/access.
3) Appropriate personal safety equipment

Maintenance of Diffuser Units: Tanks Empty

Hazards:

1) Personnel falling into tank.
2) Objects falling in the tank.
3) Slippery basin floor.

Precautions:

1) Avoid access ways without railings.
2) Provide emergency exits/access.
3) Appropriate personal safety equipment.

Maintenance of Diffuser Units: Tanks Full

Hazards:

1) Dropping hardware
2) Personnel falling into tank.

Precautions:

1) Assure proper winch operation before securing cable to drop assembly.
2) Use buddy system and follow standard safety procedures.

Personal Protection Measures

Wastewater has a potential for health hazards because it may carry disease producing organisms and a variety of chemical wastes. It is important to employ good personal hygiene practices to prevent oral and skin contact with wastewater. The following is a list of methods to prevent direct contact entry of pathogenic organisms:

1) Wash hands frequently with soap and water after contacting wastewater, visiting restrooms, before eating, drinking, or smoking;

and at the end of jobsite visit. When soap and water are not available use anti-bacterial hand wash specifically formulated for use when soap and water is not convenient.

2) Promptly treat cuts and abrasions using appropriate first aid measures.

3) Handle sharp items with extra care to prevent accidental injuries.

4) Clean contaminated tools after use.

5) Follow good common sense and exercise extra caution whenever there is contact with contaminated water or sludge.

6) Never touch face, mouth, eyes, ears, or nose while working with wastewater or sludge.

Personal Protective Equipment

1) Wear heavy-duty gloves (or double gloving) and boots that are waterproof and puncture resistant. Wear gloves whenever practical when there is contact with wastewater or sludge.

2) When practical, use thin disposable latex gloves for light work. Use reinforced rubber gloves for heavy activities. Discard gloves that become torn and try not to submerge hand below top of glove during service activities. When it is not feasible to use gloves while installing or inspecting equipment, make sure to follow personal hygiene practice listed above.

3) Wear goggles in the presence of heavy aerosols, dust, or when splashing of wastewater might occur.

4) Wear protective clothing; if possible, shower and change clothes before leaving plant site. If work clothes are washed at home, separate from the family wash and use chlorine bleach.

Confined Space Hazard

1) Verify the designation of the tank before entering. If it is defined as a confined space follow plant directives for entry. Generally a confined space is defined as having limited or restricted means of entry or exit; is large enough for an employee to enter and perform assigned work; and is not designed for continuous worker occupancy. Typical confined spaces are silos, digesters, boilers, vaults, sewers, pipelines, pump pits, ducts and compartments.

2) Wastewater tanks or basins can also be confined spaces and contain potential hazards. Flammable, explosive, toxic, or other hazardous substances or the absence of sufficient oxygen could cause injury, acute illness, disability, or death. Particular care should be exercised to assure NO hydrogen sulfide, chlorine or other heavier than air gases have not accumulated in the basins or tanks. DO NOT ENTER ANY CONFINED SPACE until your supervisor has verified that proper safety precautions have been met. Do not enter a confined space without someone else present on the outside and do not enter a confined space without proper rescue equipment outside the confined space. Every confined space entry has a unique set of hazards, but atmospheric monitoring and proper entrance procedures can minimize the hazards entry personnel typically encounter.

Operation Instructions

Description of the Aeration-Mixing System

The aeration-mixing system employs a main air header and valved lateral piping system to distribute air throughout the basin. EDI normally designs the aeration system piping to provide uniform air distribution without adjustment to the isolation/throttling valves on the laterals. However, these valves are typically provided for direct control of airflow distribution on large aeration systems or for process control. Airflow distribution will be reviewed at the time of start-up by an EDI field service representative. If process demands dictate a revised airflow distribution pattern, contact EDI for guidance on modification to the system.

Normal Operation of the Aeration System

The following procedures should be followed on a regular basis to assure consistent and satisfactory performance of the aeration-mixing system.

The air rate to the system may be adjusted to maintain the desired dissolved oxygen levels in the basin. When adjusting the airflow rate, the diffusers should be operated within the normal operating range of the diffuser. Excessive airflow rates will result in high pressure drops across the diffuser and reduced oxygen transfer performance. Low airflow rates may result in incomplete utilization of the diffuser membrane and reduced air distribution.

The aeration-mixing system is designed to provide uniform aeration. Positive dissolved oxygen concentrations should be present throughout the entire system during normal operation. A dissolved oxygen profile analysis may be used to confirm the performance of the aeration system. Typically, the dissolved oxygen levels are measured at the inlet, the outlet, and the midpoint locations of each basin to determine the aeration system performance. In regulating the system airflow to control dissolved oxygen levels, the diffuser units should be operated within their minimum and maximum airflow limits.

In applications where water level variations may exist between aeration basins supplied by a single blower, the isolation valves may need to be adjusted to maintain adequate airflow distribution. This normally requires valving back the air to the basin with the reduced water level. NOTE: It is important to confirm the operating airflow range of the diffuser units before valving back any isolation valve. Damage could result to the aeration diffuser if airflow is above the recommendations noted in the Headloss Calculations. Please consult EDI Engineering Department to confirm operating procedure before adjusting any aeration isolation/throttling valve.

Normal Operation of the Blower System

The Aeration-Mixing System normally utilizes a centrifugal or positive displacement (PD) blower system consisting of one or more blower units for normal operation plus one on-line spare unit. All blower units including the spare unit must be operated on a regular basis to maintain their proper working condition. EDI recommends that blower units be operated sequentially with idle blower units brought on-line weekly. EDI does not recommend the simultaneous operation of on-line and spare blowers for an extended period. This operating condition may deliver airflows exceeding the air capacity of the diffuser units.

All blower components should be serviced on a regular basis. For additional information concerning proper blower operation, service requirements or service intervals, reference the Blower Operation and Maintenance manual.

Shutdown Conditions

If air service is interrupted at any time, it should be restored as soon as possible. When restarting positive displacement blower units, the start-up pressure surge should be reduced by down-weighting the pressure relief valve (PRV) or operating the blow-off valve. Once the blower is operational, reset the PRV or slowly close the blow-off valve over a five- to ten-minute period. The PRV must be set properly to prevent overloading of the blower system. Operate manual water purge devices if provided. If the PRV releases air for an extended period of time, the relief setting should be checked.

When diffusers are installed in basins or lagoons and are not going to be in operation for an extended time (4 to 6 weeks), the diffusers should be covered with approximately 4 feet of water.

- In the summer, this protects the diffusers from excessive heat and provides UV protection.
- In winter, EDI recommends that the diffusers be covered with a sufficient amount of water so that if ice forms there is always a minimum liquid clearance that measures approximately 4 feet between the bottom of the formed ice and the diffuser system. This water buffer will keep the ice and its possible damaging effects away from the diffuser system.

Furthermore, the system may be idle or remain active during this period. If the aeration system will be active, operate the system at a minimum air flow so as to avoid movement of ice.

The water level in the basin/lagoon should never be lowered if there is ice present. The weight of the ice or breaking into pieces will invariably cause severe damage to membranes and/or piping.

Slowly starting up the aeration system will aid in the melting of the formed ice. This is to be done with great caution as not to exert any undo forces on piping or equipment that penetrates or is entrapped in the ice surface, and to avoid damage from ice movement as blocks of ice become free to move.

If the basin is to be idle for a prolonged time period, the basin should be drained and cleaned. NOTE: Maintain the minimum airflow to the system during the drain-down procedure. For maximum protection of the aeration system, refill the basin to completely submerge the aeration system. This provides thermal protection in the event of severe cold or hot weather conditions.

Contact EDI for additional operation and maintenance information if it is necessary to decrease the system airflow during cold weather.

Operation of the Diffuser Unit

The diffuser unit has no moving parts and requires very little maintenance for long-term operation. EDI recommends that the air supply to the diffusers be maintained at all times for optimum performance. The airflow to the diffuser units must be kept within the ranges noted in the Headloss Calculations to maintain the structural and operating characteristics of the diffuser membrane. Continuous application of high airflows, greater than denoted for normal operation, may result in physical damage to the diffuser membrane. NOTE: Use caution when adjusting several lateral throttling valves in the same piping system. This procedure can result in elevated airflows in sections of the basin, exceeding the maximum allowable airflow to each diffuser unit.

Normal Operation of the Continuous Flow Purge Assembly

Condensation will accumulate in the subheader and lateral piping due to the cooling of the air when it reaches the EDI aeration system. EDI has provided a continuous flow purge assembly to remove this accumulation from the pipe while the system is in operation. This purge assembly is designed to operate on a continual basis thus eliminating the need for manual operation. The condensation in the piping will exit directly through the perforated membrane on the purge assembly. A regulatory orifice is factory installed in the purge assembly to ensure proper flow of the purge (2 scfm or .056 m^3/min.). The size of the regulatory orifice is calculated based on the design airflow of the aeration system.

Preventive Maintenance

Maintenance Schedule

EDI recommends accessing the FlexAir aeration system on a regular basis (annually) to visually inspect the overall system and clean the membranes to remove any accumulated foulants. This activity is beneficial to the Owner, as a reduction in the uniformity of air release or an increase in backpressure will impact the power use. The FlexAir aeration system is designed to allow the system to be accessed by dropping the water level in the basin being serviced. **Note: to prevent solids from entering the system, it is important to keep the air flowing through the system until the water level has dropped below the lateral piping**. The air to the basin being serviced should be turned off after the water has dropped below the lateral piping and diffusers to prevent the possibility of excessive airflows to the units or damage to the blower unit. The following items may be helpful in servicing the FlexAir aeration system during periodic inspections or maintenance procedures:

- Ladder to access the de-watered basin
- Protective gloves and clothing
- Crimping or nipper pliers
- Long-handled soft bristle brush for cleaning assembly for observation
- Spare FlexAir membranes and crimping clamps

FlexAir Aeration System Inspection

All system components should be inspected for general wear or damage. This includes but is not limited to:

- Pipe supports including anchor bolts, pipe straps and fasteners.
- Pipe connection including fasteners, shifts in alignment of pipes and joints.
- Diffuser assembly including position, membrane integrity, membrane clamps, etc.
- Purge assembly components including all connections, anchor points, and wear at any contact points.

Any worn or damaged components need to be repaired or replaced. Please contact EDI for assistance in identifying a root cause and solution.

In Situ Cleaning of Membrane

Typically rubber membrane diffuser units will require cleaning because of two common types of surface build-up: biological and inorganic scaling. The recommended cleaning procedures for both types of build-up are detailed below:

Biological build-up is a moss-like growth. The recommended cleaning procedure is to physically dislodge the growth either by gently brushing the substance off with a soft plastic bristle brush or by using low-pressure hosing. Care should be taken not to abrade the membrane surface during the cleaning procedure.

Inorganic scaling is a granular mineral-like precipitate that can form on the membrane surface. If brushing and hosing the diffuser membrane do not remove the scaling, contact EDI for further instructions.

Membrane Protection

The diffuser membranes should be protected from chemicals that may be harmful to the material. If using a cleaning aid or other substance on or around the membranes, please contact EDI for chemical compatibility.

Good air filtration is required with all FlexAir units. The blower system should be equipped with inlet filters having a performance efficiency of 93% removal of 10-micron particles to prevent clogging of the diffuser membrane. Follow blower manufacturer's recommendations regarding care and maintenance of inlet filters.

Corrective Maintenance

Troubleshooting

The FlexAir aeration system requires very little maintenance for long-term operation. Periodic visual inspection of the system should allow the Operator to determine if the system is performing at optimum levels. For example, diffuser unit elevation variations greater than the design tolerance (refer to Headloss Calculations) will reduce the uniformity of air distribution in the system. In addition, operating airflows below the design condition will also reduce the uniformity of air distribution. If operating conditions warrant airflow rates below the design condition, contact EDI for additional operational guidelines.

Below are symptoms and procedures to follow if inspection of the aeration system reveals abnormal operating characteristics:

Large volume of air in localized area.

Possible Cause:

1) Air leak in aeration piping.
2) Diffuser membrane damaged or missing.

Procedure:

1) Access area in question. Inspect joints for evidence of breakage.
2) Inspect diffuser units for membrane damage. Repair as required.

Decreased diffuser activity and increased back pressure noted at blower.

Possible Cause:

1) Diffusers becoming fouled or deformed.
2) Reduced blower discharge air volume.
3) Restriction in air header.

Procedure:

1) Access diffusers and inspect for external or internal fouling or deformation.
2) Confirm blower operating point and rpm reading.
3) Confirm isolation valve position on header and drops.

Dissolved oxygen profile not satisfactory throughout basin.

Possible Cause:

1) Increased loading to system.
2) Reduced blower discharge air volume.
3) Improper distribution of air in system.
4) Air leak in system.
5) Excessive foulant accumulated on diffuser.

Procedure:

1) Confirm loading to system.
2) Confirm blower operations.
3) & 4) See items 1 and 2 above.
5) Access diffusers and inspect for external fouling.

Replacing FlexAir Diffuser Membranes

If it becomes necessary to replace rubber membranes, the guidelines below should be followed:

1) Remove the stainless steel (S.S.) crimping clamps. This is easily

accomplished by bending back the small tab on the clamp with a crimping tool or screwdriver. The operator should not attempt to snip or cut the ear of the clamp because S.S. material is very strong and excessive force is required to shear the material.

2) Gently pull the rubber membrane off the support to avoid breaking or damaging the support.

3) Gently install new membrane ensuring the non-perforated area is installed centered over the air discharge holes.

4) S.S. crimping clamps should be fully compressed with outside edge of the clamp located 1/4" (6mm) from the edge of the membrane. For EPDM membranes, the ear of clamp shall be placed on top of unit. For PU membranes, the ear of clamp shall be placed 45-degrees from the top of unit.

Replacing Saddle Mounted Diffuser Assembly

If it becomes necessary to remove an entire diffuser assembly, the general procedures outlined below should be followed:

1) Use a rubber or plastic mallet to remove sliding wedges from the saddle body.

2) Remove the saddle body from the lateral piping. Be careful not to damage the lateral near the predrilled holes. The Spectrum diffuser mount forms a tight seal to the lateral with compressed O-rings. Heavy scratches in the lateral near the O-rings could break the pressure seal.

3) Re-install the diffuser assembly by following the Installation Instructions.

4) NOTE: A properly installed wedge may not be flush with the saddle body due to manufacturing tolerances. Use of a non-rubber mallet may crack or shatter wedge assembly. As the diffuser mount tightens, the diffuser assembly may rotate and it would then become necessary to realign in the original, marked position.

Questions regarding the aeration-mixing system operation, maintenance, etc. should be forwarded to Environmental Dynamics International, 5601 Paris Road, Columbia, Missouri 65202. (573) 474-9456.

Diffuser *Express*®

a division of

Environmental Dynamics Inc.

5601 Paris Rd., Columbia, MO 65202, Tel: 573-474-9456, Fax: 573-474-6988
e-mail: sales@DiffuserExpress.com, website: www.DiffuserExpress.com

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Diffuser *Express®* is a special operating division of Environmental Dynamics Inc. (EDI) that handles replacement component purchases for EDI Aeration-Mixing Systems. Diffuser *Express* also offers a wide variety of diffusers, replacement membranes and aeration-mixing products for use in the water and wastewater treatment industry.

EDI and Diffuser *Express* offer replacement membranes for most types of tube and disc diffusers. Significant resources have been invested in developing and engineering diffuser membrane compounds and products. The advanced technology required to produce premium quality membranes incorporated in the EDI diffusers is the result of years of intensive investment, research, engineering, and product refinement. In developing and controlling the total membrane product from compounding through extrusion and perforation, EDI is able to offer high efficiency products that require less energy to operate and last longer in the field, which results in reduced operation and maintenance costs.

Diffuser *Express* offers a variety of tube and disc diffusers products to meet the needs of your specific application. EDI diffusers employ the latest technology available in membrane diffusers. Both tube and disc diffusers are designed for use in new installations or as replacements. Conversion kits are available for upgrading your system from coarse bubble to fine bubble and from ceramic to more efficient flexible membranes. Specialty items include diffuser mounting options, stainless steel membrane clamps, crimping tools, as well as many other commodity items and accessories.

Diffuser *Express* is committed to providing quality products with superior customer service. Visit our website at www.DiffuserExpress.com to view the Diffuser *Express* catalog. Contact Diffuser *Express* at 573-474-9456 to incorporate our quality products into your treatment application.

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- Chuck Tharp, PE
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PRODUCT SPECIFICATION SHEET

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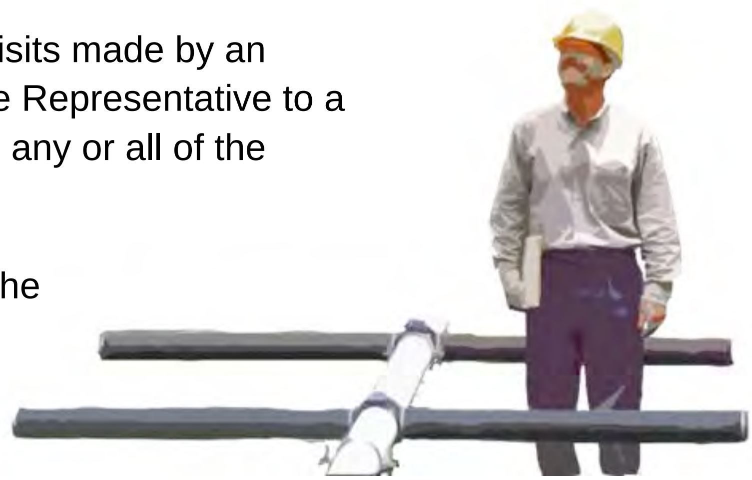
EDI provides Field Services directly from the EDI Headquarters in Columbia, Missouri, as well as having local Authorized Field Services offices Worldwide.

Field Services can include visits made by an Authorized EDI Field Service Representative to a project site and may provide any or all of the following:



- Train on-site personnel in the proper installation and assembly of all EDI equipment.
- Inspect and certify that the EDI equipment has been installed properly and in accordance with EDI specifications and requirements
- Provide startup services to certify that the equipment is operating satisfactorily after installation.

- Train plant Owners/Operators in the long term Operation and Maintenance procedures for the EDI equipment that has been installed.
- Provide investigation or inspection for any reason deemed necessary by the customer, with regards to EDI equipment installed.

In addition to the highest quality products and services, EDI is pleased to offer superior Field Services. EDI strives to provide these services in the most convenient and cost effective manner to ensure the greatest benefit to its customers. EDI is able to provide these services directly with its Field Service personnel located within the EDI Headquarters in Columbia, Missouri, as well as having localized Authorized Field Services offices Worldwide.

EDI *highly* recommends the purchase of field service with any EDI system purchase. Our experience has shown that an inspection provided by an Authorized EDI Field Service Representative can eliminate potential costs incurred by the customer from failures due to **preventable installation errors**.

In order to allow reasonable scheduling and to ensure an EDI representative is available, at least a three week notice is needed when requesting service.

Should you have any questions regarding EDI Field Services or if you would like to request a project specific quote, please feel free to contact the Field Service Manager, Ms. April Heywood at 573-474-9456.

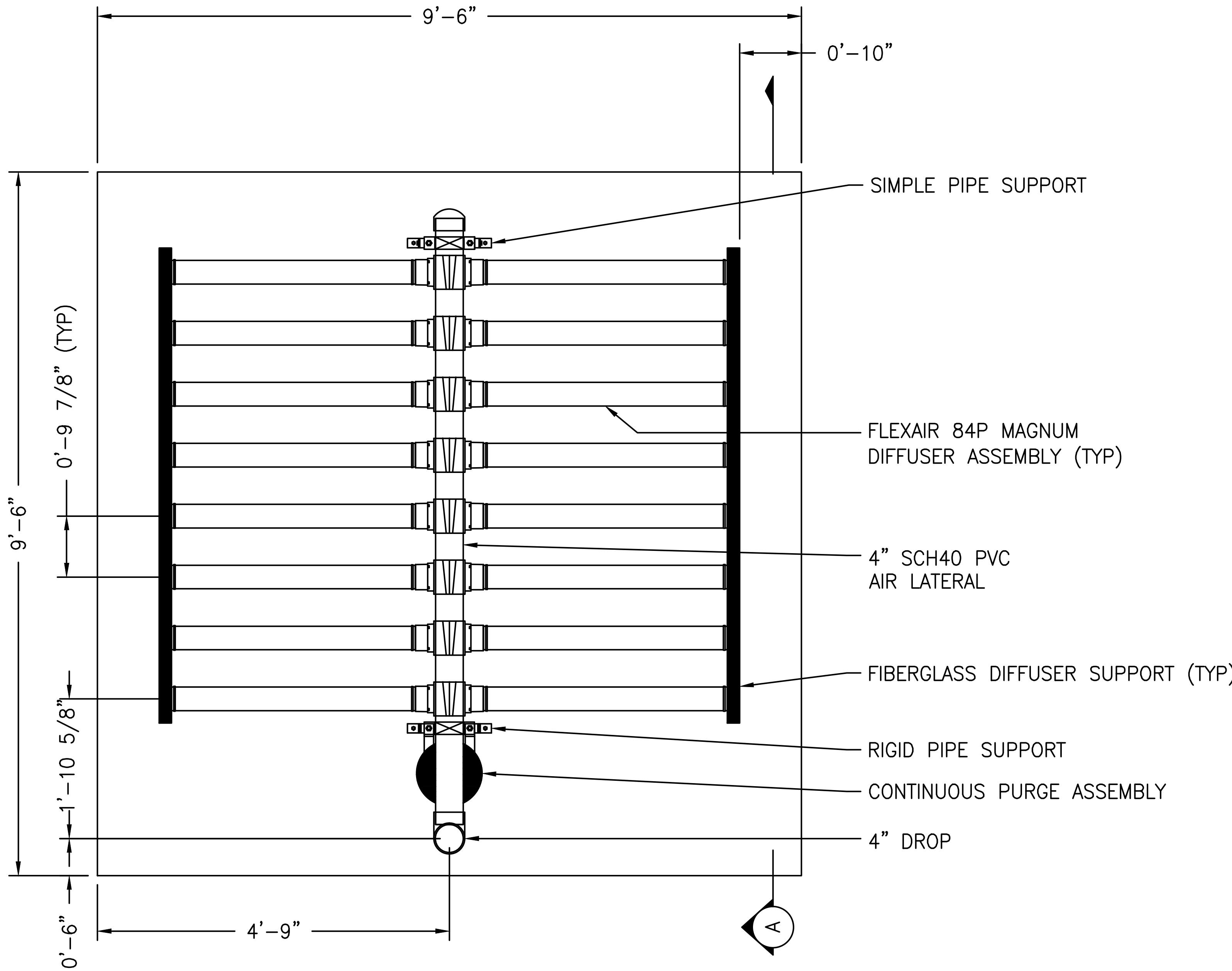
As always, EDI provides telecommunication and email support at any time at no additional charge.

Environmental Dynamics Inc.
5601 Paris Road
USA
Columbia, MO 65202
+1.573.474.9456

For Parts Information
Parts@wastewater.com
www.diffuserexpress.com

For System Information
systems@wastewater.com
www.wastewater.com

REVISION HISTORY			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	10/21/13	MAP
B	FINAL CONSTRUCTION	10/22/13	MAP
C	BASIN UPDATES	11/18/13	MAP



NOTES:

1. AERATION–MIXING BY EDI FLEXAIR 84P MAGNUM DIFFUSER ASSEMBLIES.
2. LIQUID DEPTH IS 7.25 FT.
   DIFFUSER DEPTH IS 6.25 FT.
3. AIR LATERALS ARE 4" SCH40 PVC.
4. TOTAL= 8 FLEXAIR 84P MAGNUM DIFFUSER ASSEMBLIES.
5. SEE SHEET 2 FOR PIPE SUPPORT LAYOUT.
   SEE SHEET 3 FOR SECTION VIEW.
6. 1 OF 1 BASIN SHOWN.

NOTE: CONTRACTOR TO CONFIRM EDI LAYOUT IS SUITABLE FOR INSTALLATION AND WILL NOT CONFLICT WITH OTHER PROCESS PIPING AND/OR STRUCTURAL COMPONENTS.

PROJECT NAME
NORTH READING, MA

PROJECT DESCRIPTION
LAYOUT

EDI FLEXAIR® AERATION-MIXING SYSTEM

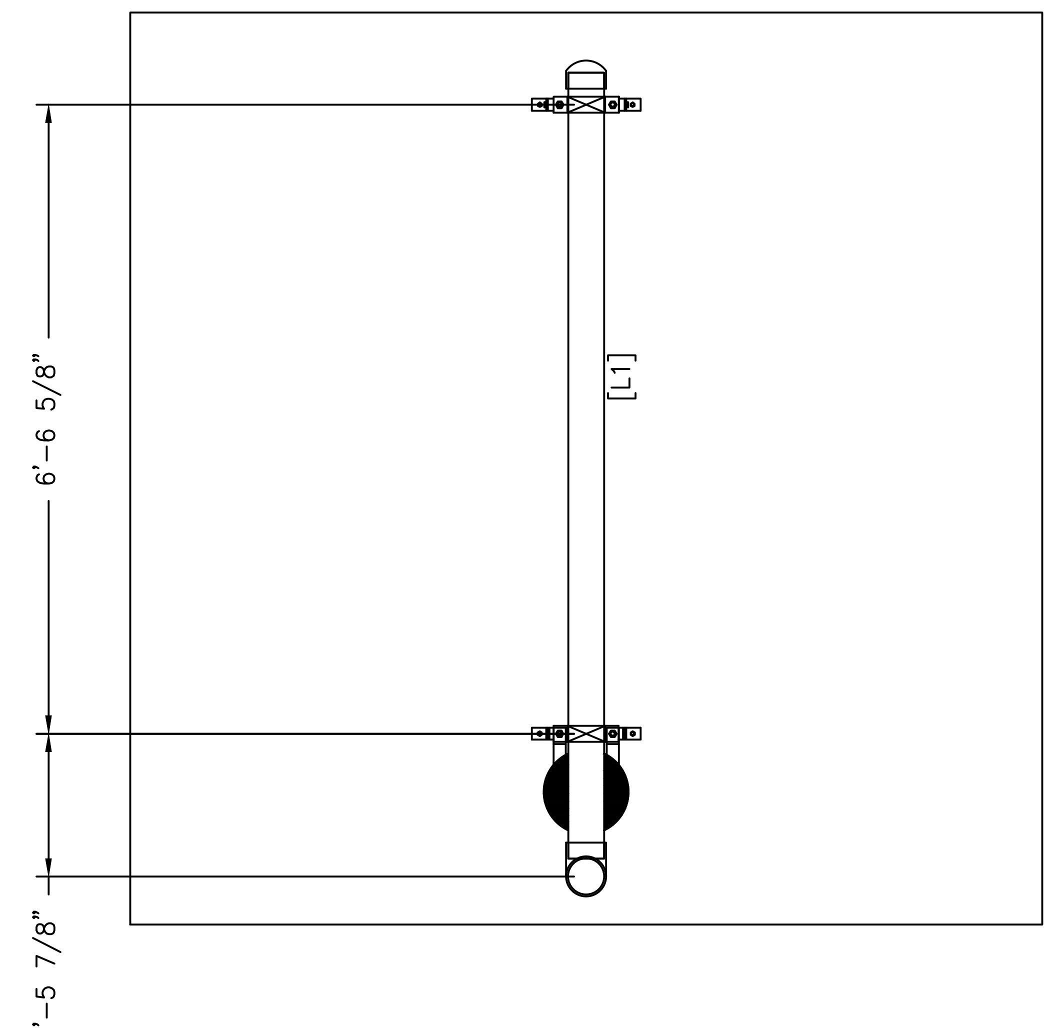
FOR:	BY:	DATE:	SCALE:
MAP	VJG	10/14/2013	1/2"=1'-0"

Environmental Dynamics International
P: +1 573.474.9456
F: +1 573.474.6988
wastewater.com
Worldwide Headquarters:
5601 Paris Road
Columbia, MO USA 65202

PROJECT NUMBER	SHEET NUMBER	DWG NUMBER
21944	1 OF 3	112306

REVISION HISTORY

REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	10/21/13	MAP
B	FINAL CONSTRUCTION	10/22/13	MAP
C	BASIN UPDATES	11/18/13	MAP



NOTE: CONTRACTOR TO CONFIRM EDI LAYOUT IS SUITABLE FOR INSTALLATION AND WILL NOT CONFLICT WITH OTHER PROCESS PIPING AND/OR STRUCTURAL COMPONENTS.

PROJECT NAME
NORTH READING, MA

PROJECT DESCRIPTION
PIPE SUPPORT LAYOUT
EDI FLEXAIR® AERATION-MIXING SYSTEM

FOR:	BY:	DATE:	SCALE:
MAP	VJG	10/14/2013	1/2"=1'-0"

Environmental Dynamics International
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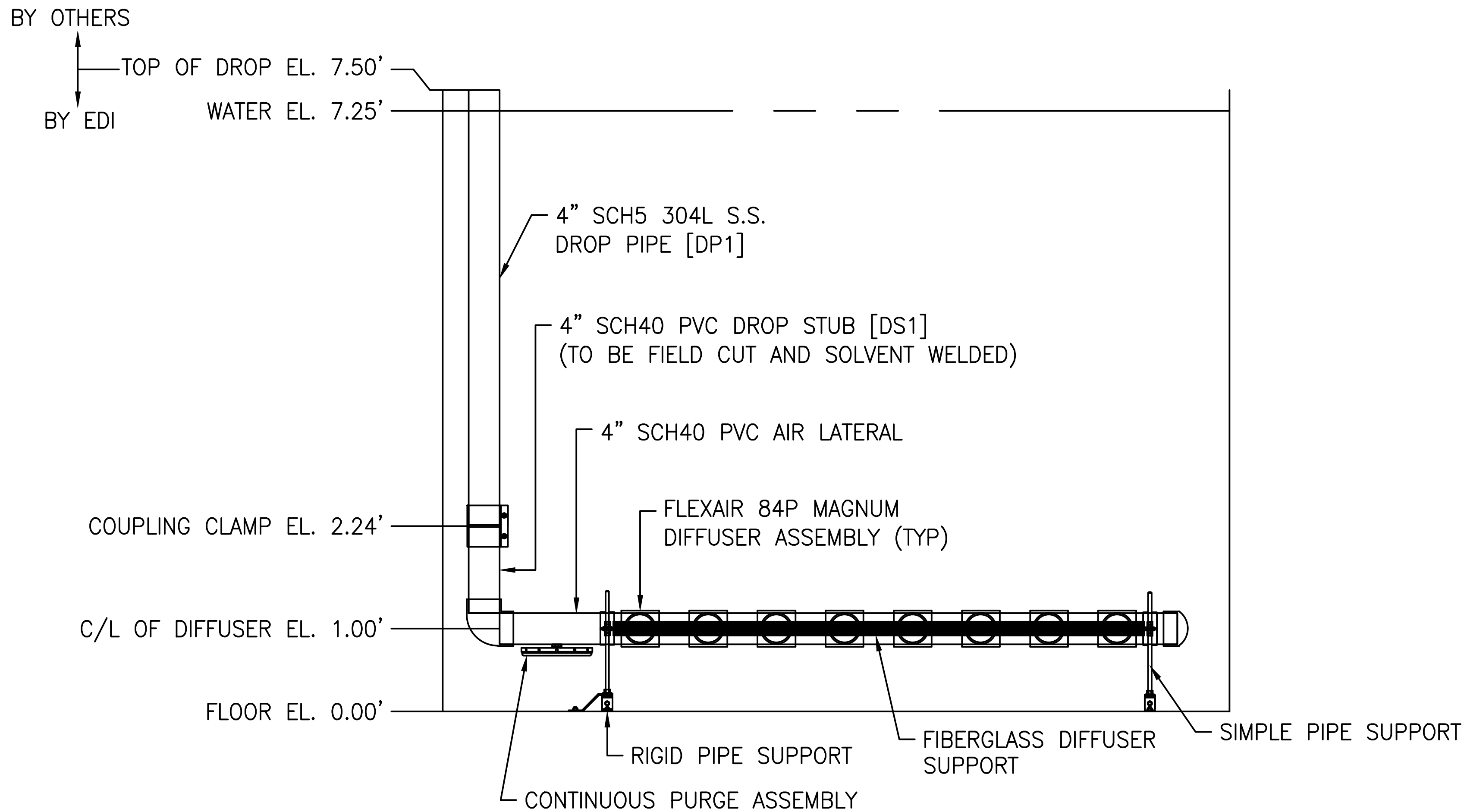
F: +1 573.474.6988
wastewater.com
Worldwide Headquarters:
5601 Paris Road
Columbia, MO USA 65202

PROJECT NUMBER	SHEET NUMBER	DWG NUMBER
21944	2 OF 3	112306

REVISION HISTORY

REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	10/21/13	MAP
B	FINAL CONSTRUCTION	10/22/13	MAP
C	BASIN UPDATES	11/18/13	MAP



A SECTION

NOTE: CONTRACTOR TO CONFIRM EDI LAYOUT IS SUITABLE FOR INSTALLATION AND WILL NOT CONFLICT WITH OTHER PROCESS PIPING AND/OR STRUCTURAL COMPONENTS.

PROJECT NAME: NORTH READING, MA

PROJECT DESCRIPTION: SECTION VIEW

EDI FLEXAIR® AERATION-MIXING SYSTEM

FOR:	BY:	DATE:	SCALE:
MAP	VJG	10/14/2013	1/2"=1'-0"

Environmental Dynamics International

P: +1 573.474.9456
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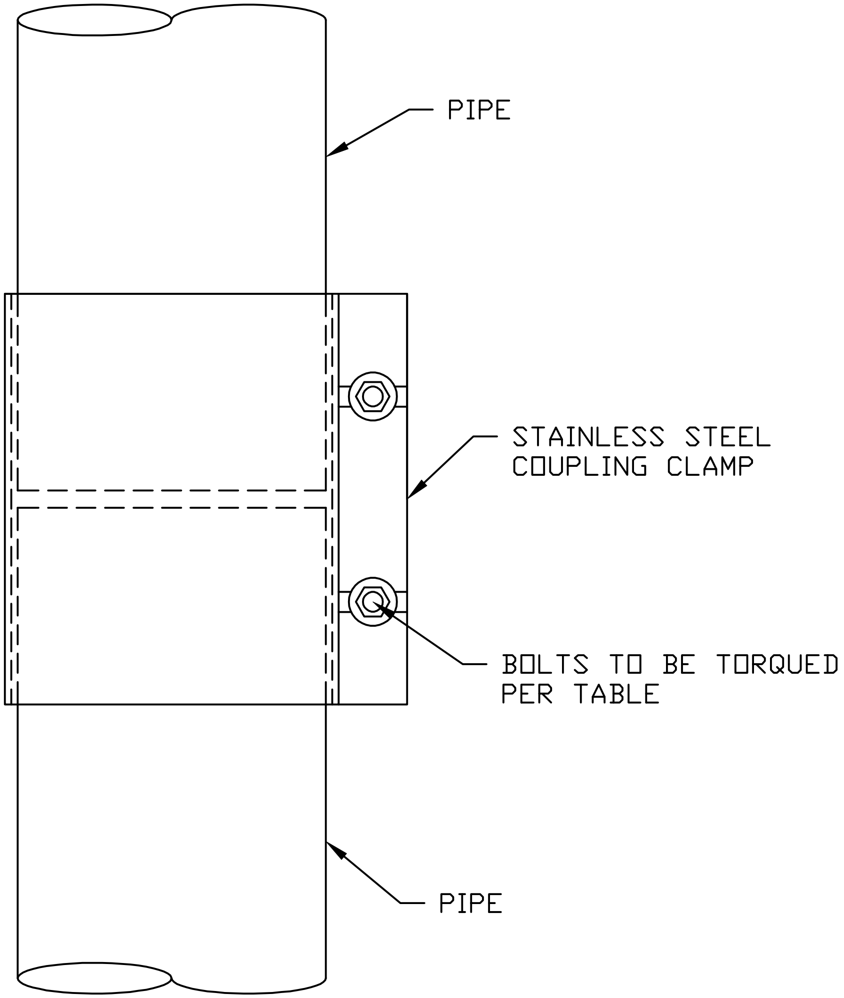
wastewater.com

Worldwide Headquarters:
5601 Paris Road
Columbia, MO USA 65202

PROJECT NUMBER	SHEET NUMBER	DWG NUMBER
21944	3 OF 3	112306



NOTES:

1. COUPLING CLAMP TO BE INSTALLED MIN. OF 2FT. BELOW WATER LEVEL.
2. GAP BETWEEN PIPES MUST BE LESS THEN 0.25".
3. REFER TO IO&M MANUAL/ SUBMITTAL FOR DETAILED CUT SHEET/ INSTRUCTIONS.
4. SEE TABLE FOR ADDITIONAL COUPLING CLAMP INFORMATION.
5. MATING PIPES SHALL HAVE THE SAME OUTSIDE DIAMETER.

COUPLING CLAMPS

NOMINAL PIPE SIZE (INCHES)	CLAMP O.D. RANGE (INCHES)	TORQUE (FT-LBS)
2	2.32-2.63	70
3	3.40-3.70	70
4	4.45-4.75	70
6	6.55-6.95	70
8	8.59-8.99	70
10	10.65-11.05	85
12	12.65-13.05	85
14	14.00-14.40	85

S.S. COUPLING CLAMP

TYPICAL INSTALLATION DETAIL

DATE: 1/17/2007

SCALE: N.T.S.

ENG. BY: WCF

DWG. BY: MLB

REV: C

DATE: 5/1/13

DWG NO: 25945

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5601 PARIS ROAD
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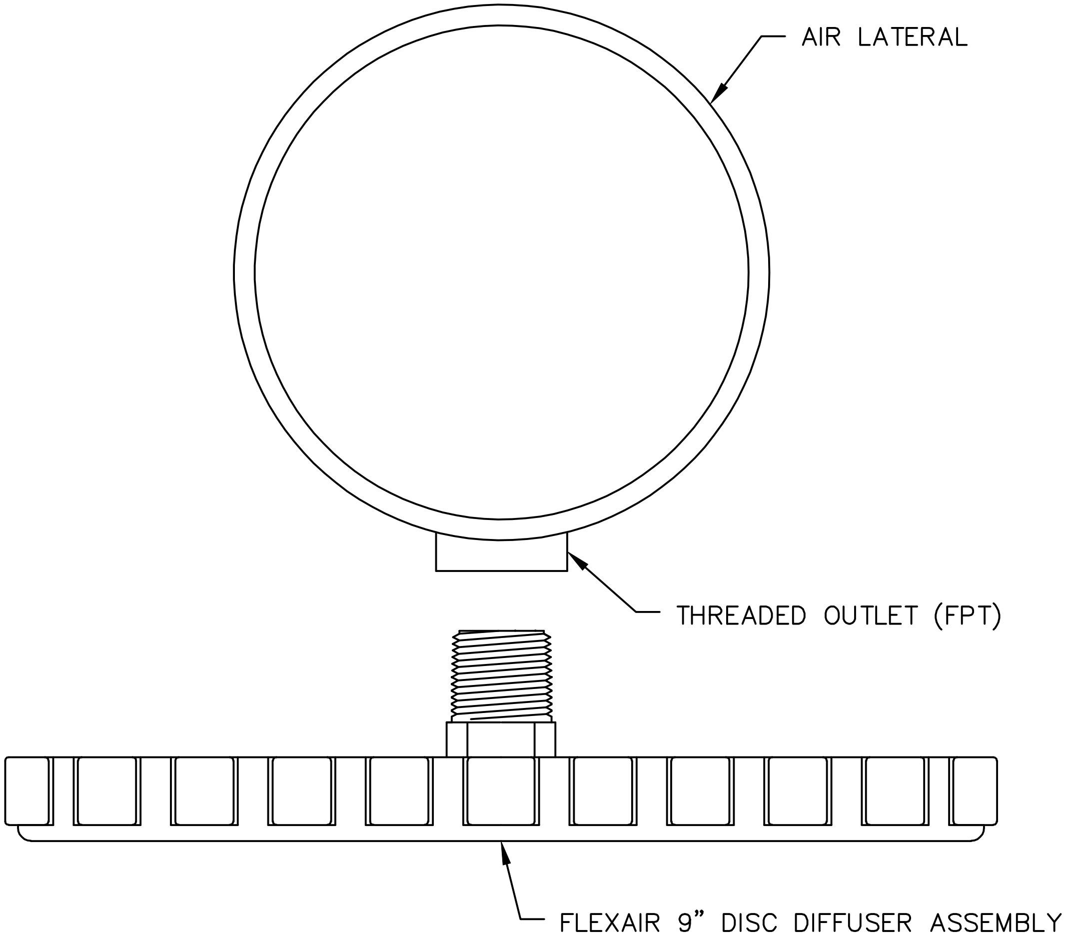
WWW.WASTEWATER.COM



INSTALLATION NOTES:

A. SCREW DIFFUSER INTO THREADED OUTLET. USE PIPE DOPE ON THREADED CONNECTION.

B. TIGHTEN DIFFUSER INTO THREADED OUTLET UNTIL HAND TIGHT. DO NOT OVER TIGHTEN OR STRIP THREADS.

EDI 9" DISC AUTOMATIC PURGE ASSEMBLY		ENG. BY: SVH	DWG. BY: MLB
TYPICAL INSTALLATION DETAIL		REV	DATE
DATE: 1/17/2007	SCALE: N.T.S.	DWG NO: 27162	

ENVIRONMENTAL DYNAMICS INC.
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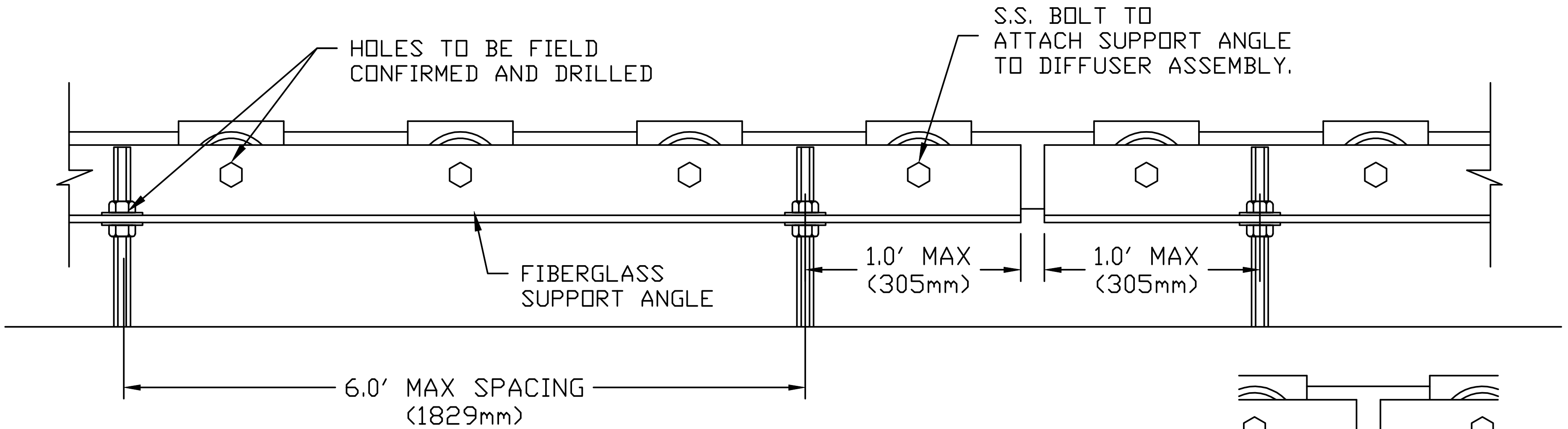

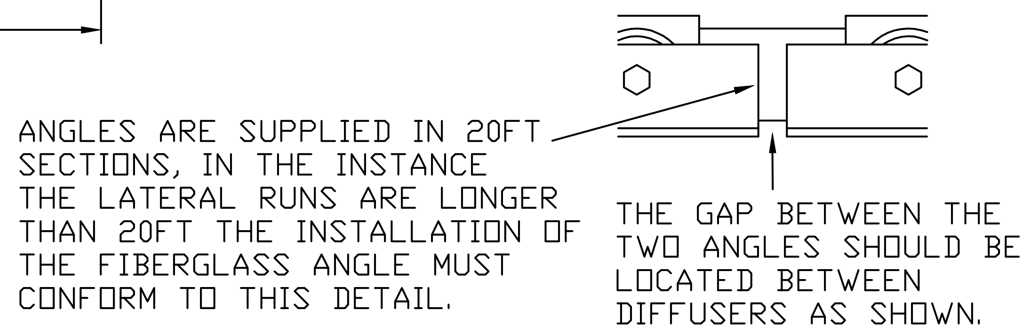

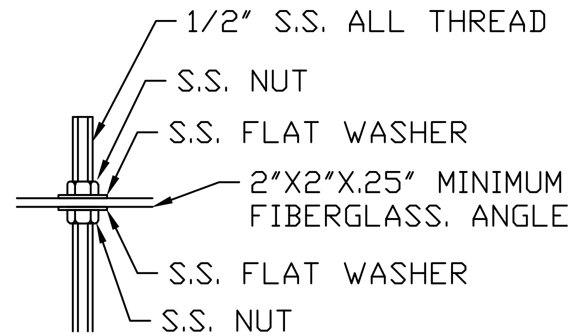

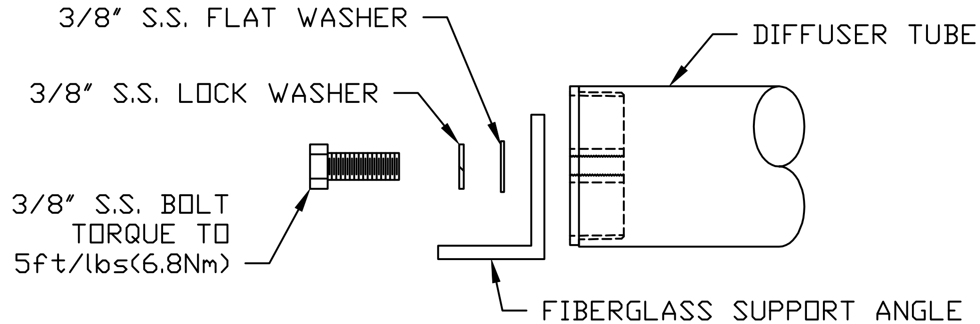

NOTES:

1. ABS ADAPTER WILL BE FACTORY INSTALLED INTO THE END OF DIFFUSER TUBES.

2. THREADED ROD SUPPORTS ARE REQUIRED FOR EACH PIECE OF FIBERGLASS SUPPORT ANGLE.

3. FIBERGLASS SUPPLIED WILL BE OF STANDARD ASTM-D570 TO ALLOW FIELD DRILLING WITHOUT SEALING OF EXPOSED EDGES.

FIBERGLASS DIFFUSER SUPPORT BRACKET

WITH SDM DIFFUSER ASSEMBLIES

TYPICAL INSTALLATION DETAIL

DATE:	SCALE:	ENG. BY:	DWG. BY:
3/21/2008	N.T.S.	SVH	MLB
		REV: D	DATE: 10/8/13
		DWG NO: 33213	

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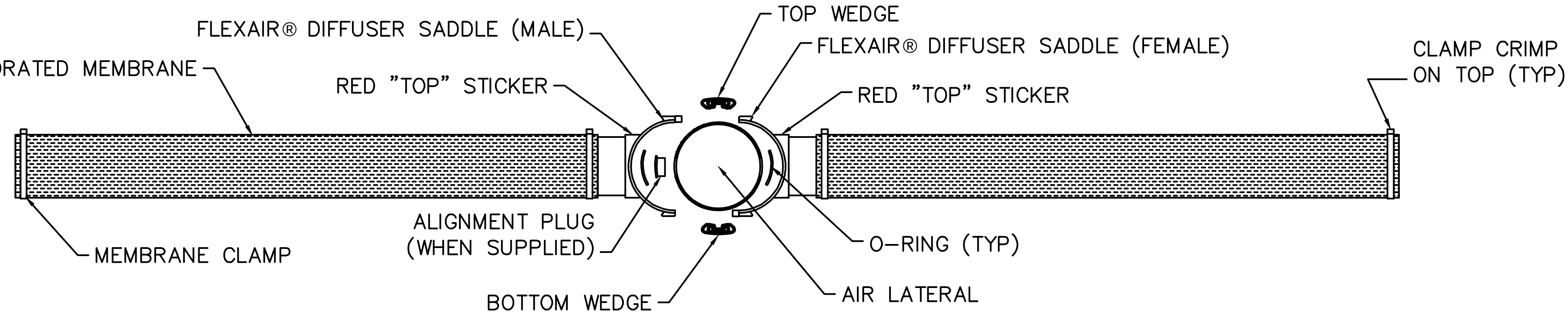

INSTALLATION NOTES:

NOT ALL SYSTEMS ARE SUPPLIED WITH ALIGNMENT PLUGS. IF ALIGNMENTS PLUGS ARE NOT SUPPLIED, THEN SKIP TO STEP 4.

1) LOCATE THE 1.0 INCH HOLES IN THE LATERAL AND PLACE THE ALIGNMENT PLUG UP TO AND CENTERED ON THE HOLE. ONLY ONE PLUG IS REQUIRED PER PAIR OF DIFFUSERS.
2) TAP THE PLUG INTO THE LATERAL USING A SOFT BLOW HAMMER AND A SHORT PIECE OF 1.0 INCH DIAMETER DOWEL (PROVIDED BY EDI).
3) ENSURE THAT THE PLUG IS CORRECTLY SEATED AND WAS NOT DAMAGED DURING THE INSTALLATION. REPLACE ANY PLUG IF DAMAGE OCCURRED.
4) INSTALL O-RING IMMEDIATELY BEFORE SADDLE IS TO BE INSTALLED ON LATERAL. THE O-RING IS PLACED IN THE INTERNAL GROOVE. **DO NOT USE ANY MASTIC OR OTHER ADHESIVE**.
5) POSITION THE DIFFUSER UNIT IN THE PROPER ORIENTATION (SEE TABLE BELOW) WHILE POSITIONING THE ALIGNMENT PLUG TO THE CENTER HOLE IN THE SADDLE. THE PLUG FITS INTO THE SADDLE.

UNIT TYPE	PERFORATION	EAR OF CLAMP	RED "TOP" STICKER
MINIPANEL	ON TOP	ON TOP	ON TOP
MAGNUM	ON SIDES	ON TOP	ON TOP

6) **NOTE:** ENSURE THAT THE SADDLES' ALIGNMENT PINS MATE PROPERLY WHEN INSTALLING THE OPPOSING SADDLE BEFORE SLIDING ON THE WEDGES. THE RED "TOP" STICKERS SHOULD FACE UP.
7) INSTALL THE TOP WEDGE ¾ INCH FROM BEING FLUSH BY HAND.
8) INSTALL THE BOTTOM WEDGE HAND TIGHT-APPROXIMATELY 3/4 INCH (19MM) FROM BEING FLUSH WITH THE SADDLE.
9) ENSURE THAT THE DIFFUSER ASSEMBLY IS IN THE CORRECT LOCATION, LEVEL, AND THAT EACH DIFFUSER ARM IS IN LINE WITH THE REST OF THE DIFFUSERS ON THE SHARED LATERAL.
10) TIGHTEN THE TOP WEDGE AND BOTTOM WEDGE **EQUALLY** WITH A NON-METALLIC MALLET OR RUBBER FACED HAMMER. WHEN PROPERLY TIGHTENED, EACH DIFFUSER SHOULD BE LEVEL AND RESIST ROTATION. **NOTE:** METAL MALLETS OR HAMMERS MAY CRACK OR SHATTER THE WEDGE ASSEMBLY OR DAMAGE THE UNIT. DO NOT USE METAL HAMMERS DIRECTLY. **NOTE:** EXTRA CARE IS NEEDED DURING COLD WEATHER INSTALLATION, BELOW 40°F (4°C). PLASTIC COMPONENTS BECOME BRITTLE AND MAY FRACTURE WITH EXCESSIVE IMPACT FORCE.
11) ENSURE THAT WEDGES ARE DRIVEN ON AS EQUALLY AS POSSIBLE WHILE MAINTAINING LEVEL ON THE DIFFUSERS.
12) THE WEDGE SHOULD BE FLUSH WITH THE SADDLE WHEN COMPLETE. OVER TIGHTENING WEDGES CAN CAUSE IRREVERSIBLE DAMAGE TO THE DIFFUSER SADDLE. **NOTE:** DIFFUSER MUST BE PROTECTED FROM THE SUN. LONG TERM EXPOSURE TO DIRECT SUMMER SUNLIGHT CAN CAUSE FAILURE. DIFFUSERS NEED TO EITHER BE PROTECTED FROM THE SUN OR HEAT BY COVERING THEM WITH CLEAN WATER OR SHADE OVER THE BASIN.
13) REFERENCE EDI I.O.M MANUAL

FLEXAIR® 84P MAGNUM DIFFUSER ASSEMBLY
WITH SDM SADDLE
TYPICAL INSTALLATION DETAIL

DATE: 6/3/11	SCALE: N.T.S

ENG. BY: BLM	DWG. BY: TSP
REV: B	DATE: 5/4/12
DWG NO: 52141	

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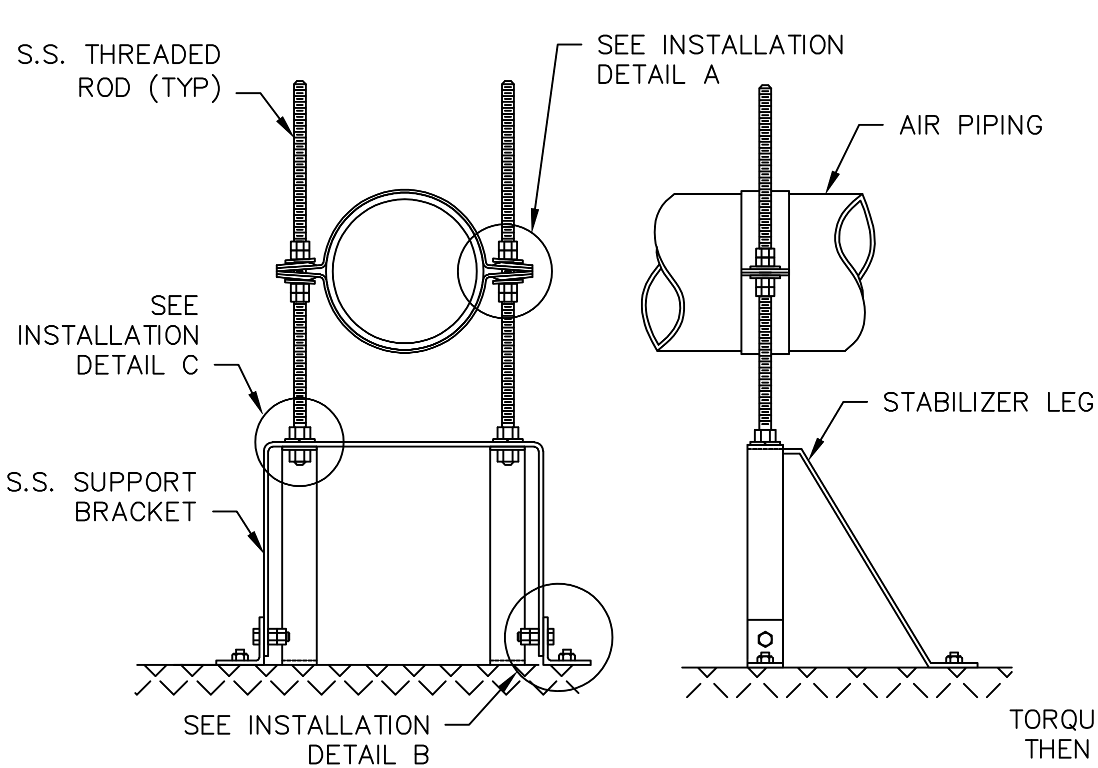
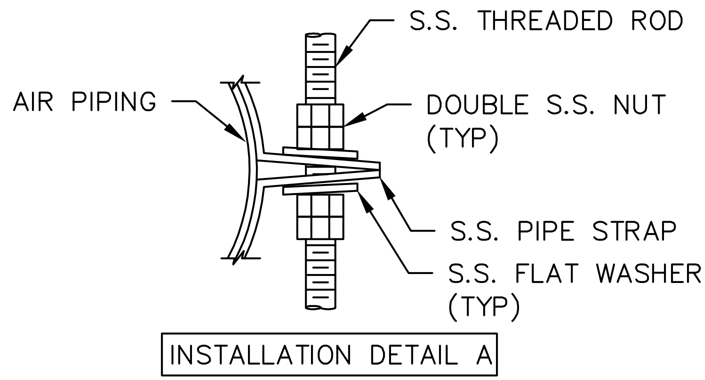
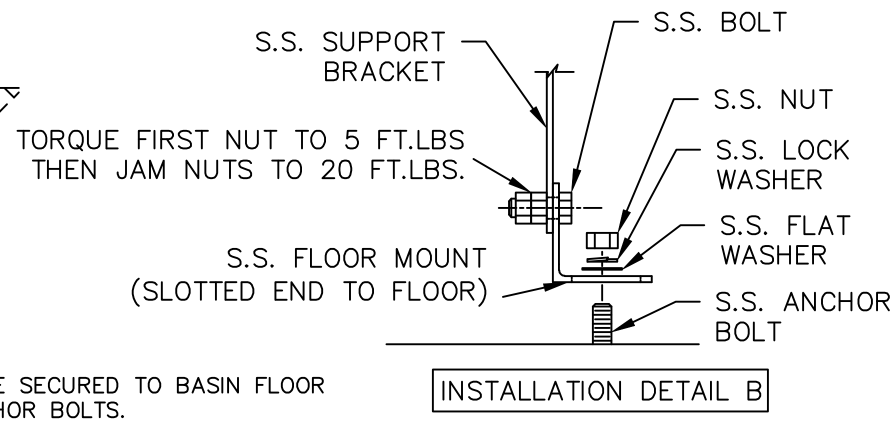
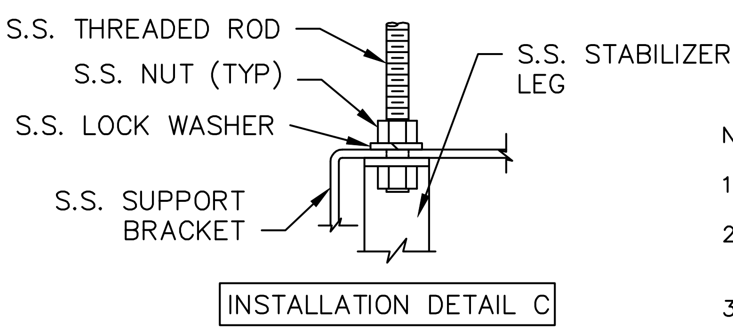
WWW.WASTEWATER.COM





INSTALLATION DETAIL A
NOTES:
1. LEVEL PIPE
2. TIGHTEN STRAP UNTIL EARS TOUCH





NOTES:

1. FLOOR MOUNTS ARE SECURED TO BASIN FLOOR BY CONCRETE ANCHOR BOLTS.
2. A COMMERCIAL GRADE ANTI SEIZE LUBRICANT MUST BE USED ON ALL STAINLESS STEEL THREADED CONNECTIONS.
3. REFER TO EQUIPMENT SUPPLY LIST TO DETERMINE PROVIDER OF ANCHOR HARDWARE.
4. SEE INSTALLATION INSTRUCTION FOR PROPER TORQUE VALUES.

S.S. RIGID PIPE SUPPORT	
TYPICAL INSTALLATION DETAIL	
DATE: 1/11/2007	SCALE: N.T.S

ENG. BY: BLM	DWG. BY: TSP
REV F	DATE 8/5/13
DWG NO: 22497	

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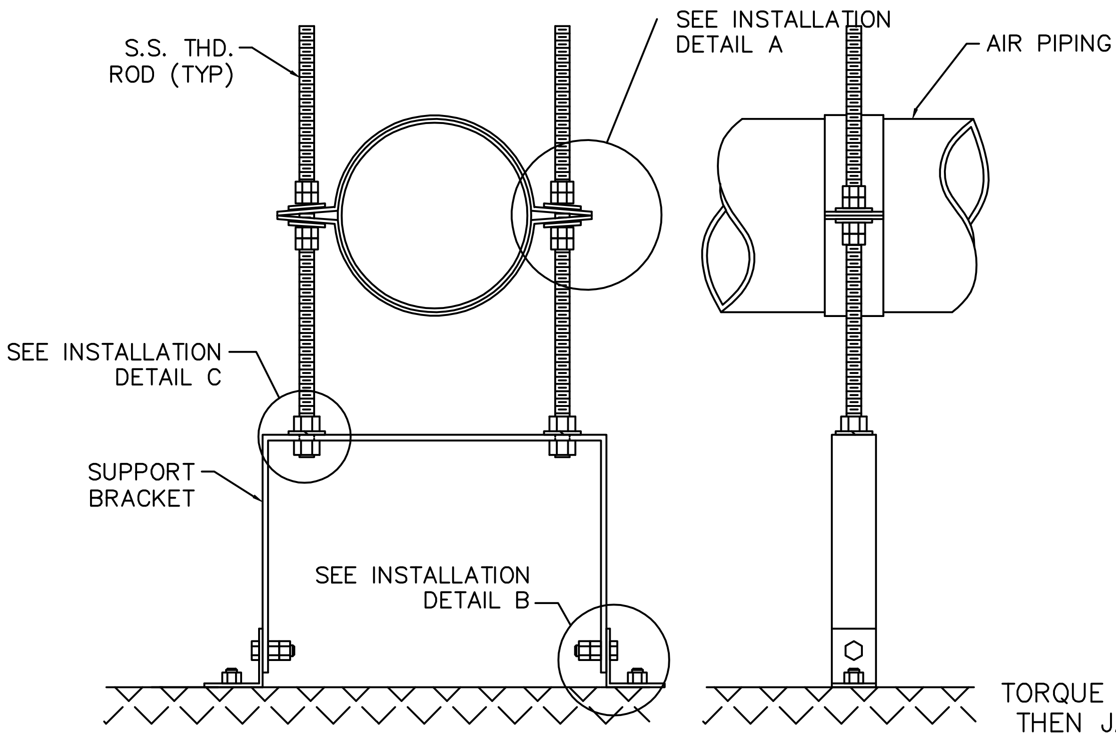
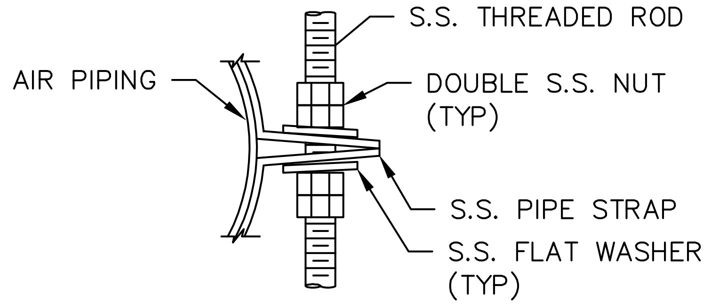
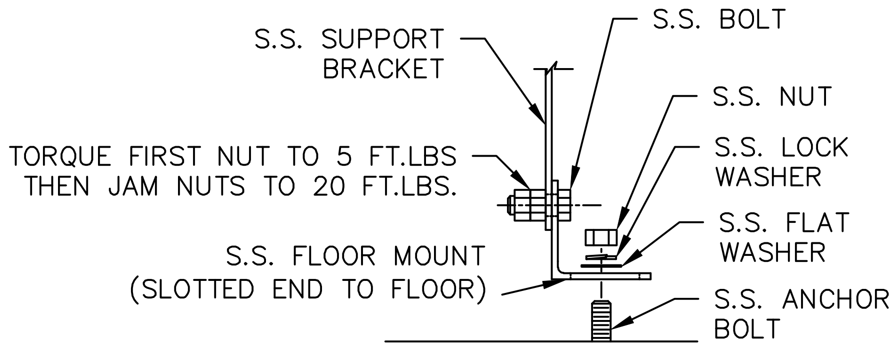


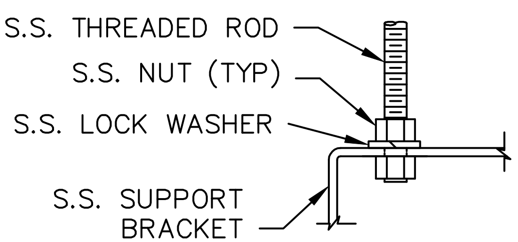


INSTALLATION DETAIL A

INSTALLATION DETAIL A
NOTES:
1. LEVEL PIPE
2. TIGHTEN STRAP UNTIL EARS TOUCH



INSTALLATION DETAIL B



INSTALLATION DETAIL C

NOTES:

1. FLOOR MOUNTS ARE SECURED TO BASIN FLOOR BY CONCRETE ANCHOR BOLTS.
2. A COMMERCIAL GRADE ANTI SEIZE LUBRICANT MUST BE USED ON ALL STAINLESS STEEL THREADED CONNECTIONS.
3. REFER TO EQUIPMENT SUPPLY LIST TO DETERMINE PROVIDER OF ANCHOR HARDWARE.
4. SEE INSTALLATION INSTRUCTION FOR PROPER TORQUE VALUES.

S.S. SIMPLE PIPE SUPPORT		ENG. BY: BLM	DWG. BY: TSP
TYPICAL INSTALLATION DETAIL		REV F	DATE 8/5/13
DATE: 1/11/2007	SCALE: N.T.S	DWG NO: 22496	

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WWW.WASTEWATER.COM

SECTION 16: MBR MEMBRANES

P&ID: Item #: UF-0701, UF-0702, UF-0703

Unit Details: **Norit X-Flow Membranes**

8” Airlift Membrane Modules

5.2 MM membrane elements

Manufacturer: **X-Flow BV**
7500 AS Enschede
The Netherlands
Phone: +31 (0)53 4287350
Fax: +31 (0)53 4287351
www.aquatechtrade.com

US Distributor/Contact:

X-Flow North America
1330 Anvil Drive
Rockford, IL 61115
Phone: (815)-986 0391
Fax: (815)-639-1135
www.x-flow.com

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Wastewater Treatment

Wastewater Treatment

Challenge

Due to more stringent requirements for wastewater discharge, the disposal cost of municipal and industrial wastewater is increasing. In addition, in some areas, the use of groundwater is being limited to prevent dehydration of the soil, which could have a destructive influence on nature's flora and fauna. With these factors in mind, the need for a closed water cycle is increasing rapidly. For efficient wastewater treatment, the Membrane BioReactor (MBR) has been developed.

Solution

The Norit Airlift™ MBR is a compact-built purification system combining the biological degradation step with a membrane separation step. This combination offers several significant advantages over a conventional activated sludge system, including higher biomass concentration and less sludge carryover. The higher biomass concentration results in a more compact system. The decrease in sludge carryover reduces the need of post-treatment of the effluent.

The Norit Airlift™ MBR configuration offers an ultrafiltration (UF) membrane solution placed outside the reactor allowing the maintenance of the plant to be simple and clean. The side stream setup allows easy expansion of existing wastewater treatment plants. Energy consumption is at the same level of submerged membranes or even less, due to the efficient use of process conditions for flux enhancement. Norit X-Flow's tubular 5 mm UF membrane allows a bioreactor to run up to 15 g/l MLSS biomass.

MBR

Norit X-Flow

leading in purification

Wastewater Treatment

Benefits

• Membrane placement	Outside the bioreactor
• Permeate quality	True ultrafiltration Turbidity < 0.1 NTU Silt Density Index < 3
• Maintenance & cleaning	Accessible & clean environment Fully automated cleaning Use of low cost chemicals
• Airlift filtration Low energy	< 0.25 kWh/m3 Simple layout High flux rates Low TMP
• Fully automatic operation	Logging of operating parameters
• Atmospheric system	Fully enclosed No operator exposure to fumes or aerosols Small footprint

Applications

- Municipal (typical application)
- Industrial (only for specific applications)
  - ○ Beverage industry, where high COD loads need to be reduced
    - breweries
    - dairy plants
    - malt houses
  - ○ Leachate, effluent coming from landfill sites
  - ○ Other industries
    - automotive
    - chemical
    - textile

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E info@xflow.com • **I** www.xflow.com

Please visit our website to obtain information about your local support!

X-Flow BV reserves the right to make changes in the technical specifications at any time.

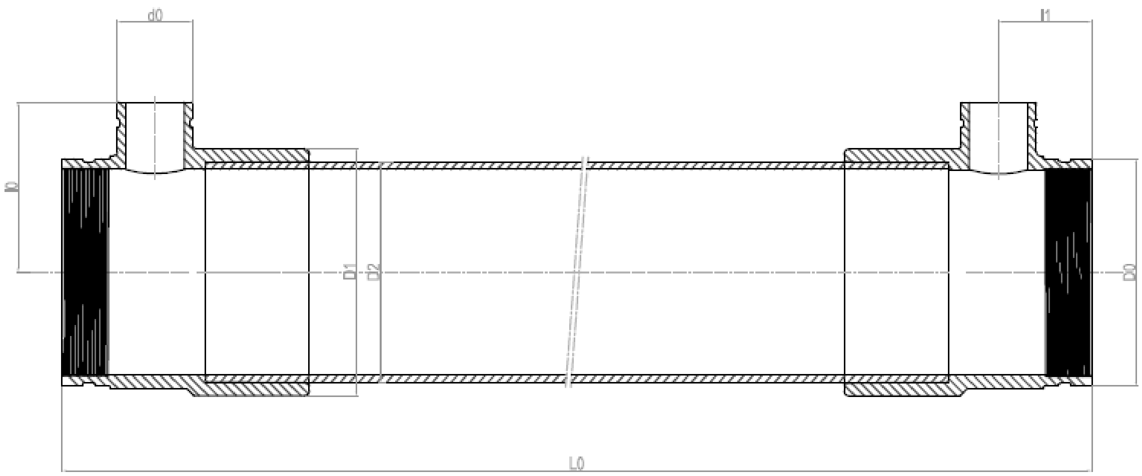
WWT E 1-2008

MBR

Norit leading in purification X-Flow

Norit X-Flow
leading in purification

8” COMPACT MEMBRANE MODULE PVC



MODULE SPECIFICATIONS

module type	hydraulic membrane diameter [mm]	memb. area [m^2]	feed connection D_0 (*) [mm]	module length L_0 [mm] (±1)	saddle diameter D_1 [mm]	module diameter D_2 [mm]	permeate connection d_0 (*) [mm]	permeate length l_0 [mm] (±1)	permeate position l_1 [mm] (±1)
38PRV-XLT	5.2	33	220.0	3000	240	213	73.0	165	90

(*) groove dimensions are according to the dimensions specified by Victaulic®

MATERIALS OF CONSTRUCTION

- housing : PVC, drinking water quality
- potting : epoxy
- membrane : see membrane data sheets

CONNECTION SPECIFICATIONS

- Feed side
  standard 8" (219.1 mm) Victaulic® clamps (Style 75) with FlushSeal® gaskets
  NB. maximal internal diameter connection part = 188 mm
- Permeate side
  standard 2½" (73.0 mm) Victaulic® clamps (Style 75) with FlushSeal® gaskets
  (see also data sheet for connection parts)

OPERATING SPECIFICATIONS (water)

module type	hydraulic membrane diameter [mm]	maximum feed pressure [kPa]	maximum permeate pressure [kPa]	maximum transmembrane pressure [kPa]	maximum operating temperature [℃]
38PRV-XLT	5.2	20 ℃ – 40 ℃ 800	20 °C 650 30 °C 550 40 °C 400	20 ℃ – 40 ℃ 500	40 (*)

(*) **final maximum operating limits are determined by the lowest values of the membrane and module pressure and temperature specifications (see also membrane data sheet) !**

- Backwash water should be free of particulates and should be of permeate quality or better.
- Backwash pumps should be made of non-corroding materials: plastic or stainless steel. If compressed air is used to pressurize the backwash water, do not allow a two-phase air/water mixture to enter the module.
- To avoid mechanical damage, do not subject the membrane module or element to sudden temperature changes, particularly decreasings. Do not exceed 40 ℃ process temperature. Bring the module or element back to ambient operating temperature slowly (typical value 1 ℃/min). Failure to adhere to th is guideline can result in irreparable damage.

PROCESS CHARACTERISTICS (water, 25 ℃)

module type	hydraulic membrane diameter [mm]	cross-flow flow rate (*) [m^3/h]	pressure-drop across module (laminar flow) (**) [kPa]	pressure-drop across module (turbulent flow) (**) [kPa]
38PRV-XLT	5.2	53.5 x v	1.2 x L_0 x v	3.6 x L_0 x $v^{1.75}$

(*) superficial velocity (v) in m/s
(**) module length (L_0) in m

For more information please write or call to:

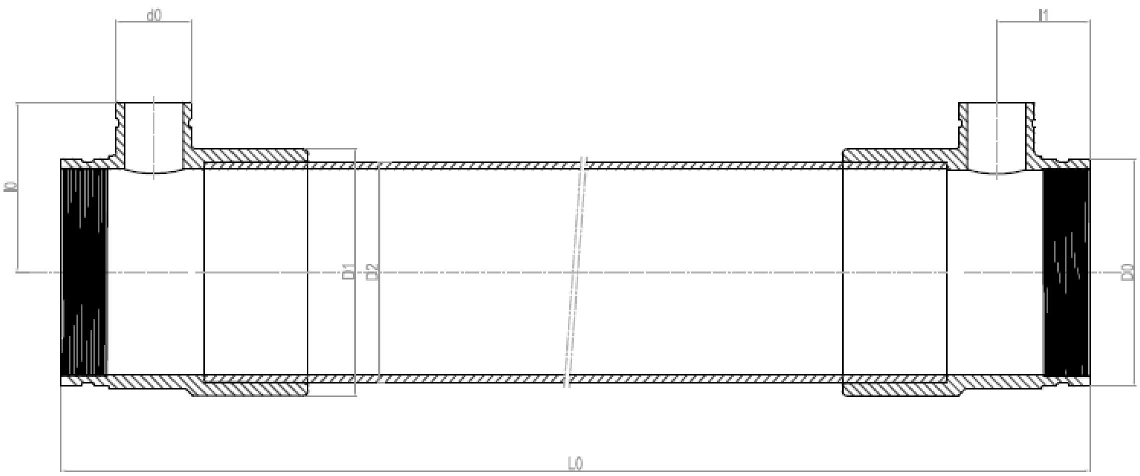
X-Flow B.V.
P.O. Box 739
7500 AS Enschede
The Netherlands

Phone: + 31 (0)53 4287350
Fax: + 31 (0)53 4287351
E-mail: info@xflow.nl
Web site: www.x-flow.com

Airlift Membranes IO&M

Table of Contents

8” COMPACT MEMBRANE MODULE PVC



MODULE SPECIFICATIONS

module type	hydraulic membrane diameter [mm]	memb. area [m^2]	feed connection D_0 (*) [mm]	module length L_0 [mm] (±1)	saddle diameter D_1 [mm]	module diameter D_2 [mm]	permeate connection d_0 (*) [mm]	permeate length l_0 [mm] (±1)	permeate position l_1 [mm] (±1)
38PRV-XLT	5.2	33	220.0	3000	240	213	73.0	165	90

(*) groove dimensions are according to the dimensions specified by Victaulic®

MATERIALS OF CONSTRUCTION

- housing : PVC, drinking water quality
- potting : epoxy
- membrane : see membrane data sheets

CONNECTION SPECIFICATIONS

- Feed side
  standard 8" (219.1 mm) Victaulic® clamps (Style 75) with FlushSeal® gaskets
  NB. maximal internal diameter connection part = 188 mm
- Permeate side
  standard 2½" (73.0 mm) Victaulic® clamps (Style 75) with FlushSeal® gaskets
  (see also data sheet for connection parts)

OPERATING SPECIFICATIONS (water)

module type	hydraulic membrane diameter [mm]	maximum feed pressure [kPa]	maximum permeate pressure [kPa]	maximum transmembrane pressure [kPa]	maximum operating temperature [℃]
38PRV-XLT	5.2	20 ℃ – 40 ℃ 800	20 °C 650 30 °C 550 40 °C 400	20 ℃ – 40 ℃ 500	40 (*)

(*) **final maximum operating limits are determined by the lowest values of the membrane and module pressure and temperature specifications (see also membrane data sheet) !**

- Backwash water should be free of particulates and should be of permeate quality or better.
- Backwash pumps should be made of non-corroding materials: plastic or stainless steel. If compressed air is used to pressurize the backwash water, do not allow a two-phase air/water mixture to enter the module.
- To avoid mechanical damage, do not subject the membrane module or element to sudden temperature changes, particularly decreasings. Do not exceed 40 ℃ process temperature. Bring the module or element back to ambient operating temperature slowly (typical value 1 ℃/min). Failure to adhere to th is guideline can result in irreparable damage.

PROCESS CHARACTERISTICS (water, 25 ℃)

module type	hydraulic membrane diameter [mm]	cross-flow flow rate (*) [m^3/h]	pressure-drop across module (laminar flow) (**) [kPa]	pressure-drop across module (turbulent flow) (**) [kPa]
38PRV-XLT	5.2	53.5 x v	$1.2 \times L_0 \times v$	$3.6 \times L_0 \times v^{1.75}$

(*) superficial velocity (v) in m/s
(**) module length (L_0) in m

For more information please write or call to:

X-Flow B.V.
P.O. Box 739
7500 AS Enschede
The Netherlands

Phone: + 31 (0)53 4287350
Fax: + 31 (0)53 4287351
E-mail: info@xflow.nl
Web site: www.x-flow.com

COMPACT ULTRAFILTRATION MEMBRANE

F 4385

BASIC CHARACTERISTICS

- Hydrophilic tubular polyvinylidene fluoride membrane cast on a polyester carrier
- Tubular membrane available in 5.2 mm
- Structure asymmetric
- Developed for use in large-scale processes for water purification
- High performance and a very good anti-fouling behaviour
- Membranes are supplied in a standard range of elements
- Membrane elements can be backflushed for efficient membrane cleaning resulting in a higher average product flux

APPLICATIONS

- Pre-treatment RO and NF
- Surface water
- Drinking and process water production
- Recovery of sandfilter backwash water
- Effluent treatment
- Membrane bioreactor
- Waste water treatment
- Treatment of oil-in-water emulsions

MEMBRANE COMPOSITION

- Membrane material composed of polyvinylidene fluoride
- Membrane carrier is a composite polyester woven/non-woven

PERFORMANCE DATA

parameter	unit	F 4385	remarks
Clean water flux	l/m^2.h.100 kPa	> 1000	RO-water at 25℃
Transmembrane pressure	kPa	-100 .. + 500	
Mean pore size	nm	30	
pH		2 - 10	at 25℃
Chlorine exposure	ppm.h	250000	at 25℃
Temperature	℃	1 - 70	pH 7 and 100 kPa

Operation of membranes at any combination of maximum limits of pH, concentration, pressure or temperature, during cleaning or production, will severely influence the membrane lifetime.

SOLVENT RESISTANCE

Since the resistance of the membrane to solvents strongly depends on the actual process conditions, the indications given below should only be considered as guidelines.

Acids, pH > 2	+
Bases, pH < 11	+
Organic esters, ketones, ethers	––
Aliphatic alcohols	++
Aliphatic hydrocarbons	++
Halogenated hydrocarbons	++
Aromatic hydrocarbons	+
Polar organic solvents	––
Oils	++

CLEANING

Depending on the nature of the feed solution the following cleaning agents can be chosen:

Chemical	: NaOCl (active chlorine)	500 ppm max.
	: H_2O_2	1000 ppm max.
	: NaOH	pH $\leq$ 11
	: Nitric acid	pH $\geq$ 1
	: Phosphoric acid	pH $\geq$ 1
	: EDTA	pH $\leq$ 11
	: Citric acid	
	: Enzymatic compounds	

It is recommended to keep the pH between 1 and 11 and not to exceed a temperature of 40 °C during cleaning and/or disinfection.
If those standard cleaning techniques fail to remove the foulants, more concentrated cleaning solutions can be tried. Please contact X-Flow for recommendations.
It has to be stressed, however, that no warranty can be given on the efficiency of any cleaning nor on the membrane performance after such cleaning attempts.

STORAGE

New membrane modules can be stored as supplied.
Membrane modules should be stored in a dry, normally ventilated place, away from sources of heat, ignition and direct sunlight. Store between 0 and 40 °C.
The membrane modules should not be subjected to any freezing temperatures.
After use, UF membranes need to be stored wet at all times.
To avoid biological growth during shutdowns or storage, wet membranes should be treated with a compatible biocide. The membrane is compatible with many common disinfecting agents or biocidal preservatives. For short-term shutdowns, a daily flush with permeate quality water containing up to 2.0 ppm free available chlorine for 30 to 60 minutes may be adequate for bacteria control.
In case of long-term storage, membranes should be cleaned before the disinfection step is carried out. For disinfection, a 1% sodium metabisulfite solution can be used. In either situation, modules should be stored hydraulically filled.

For more information please write or call to:

X-Flow B.V.	Phone:	+ 31 (0)53 4287350
P.O. Box 739	Fax:	+ 31 (0)53 4287351
7500 AS Enschede	E-mail:	info@xflow.nl
The Netherlands	Web site:	www.x-flow.com

Note: The information and data contained in this document are based on our general experience and are believed to be correct. They are given in good faith and are intended to provide a guideline for the selection and use of our products. Since the conditions under which our products may be used are beyond our control, this information does not imply any guarantee of final product performance and we cannot accept any liability with respect to the use of our products. The quality of our products is guaranteed under our conditions of sale. Existing industrial property rights must be observed.

3. Pre-Installation Storage Conditions

The membranes can be stored in their original packaging for a maximum of 9 months after date of shipment from manufacturer. During the initial storage period before installation they must be kept between 1 and 40 degrees C. The membranes should be stored inside and protected from direct sunlight, rain, moisture, freezing conditions, and dust.

During the initial storage period mold growth may occur. This mold formation will have no influence on the performance of the membranes. Prior to installation they can be cleaned using an active chlorine solution (max 200 ppm). During long term storage the temperature has to be monitored and logged on an hourly basis. Without data logging all warranties are void.

Checklist prior to commissioning

Note: Perform as much of the commissioning as possible with dummy membranes in place to reduce the risk of harming the membranes.

- Does the plant match up to the P&ID's.
- Is the plant mechanically and electrically complete.
- Have I/O tests been performed and 4-20ma signals verified for each piece of equipment.
- Has the PLC program been tested.
- Have the tanks and piping been cleaned.
- Is there sufficient clean water (<1 NTU) to fill the appropriate tanks and to complete commissioning.
- Is there tankage ready to receive the waste water and the permeate flow. Is there enough tank storage or a means to remove water to finish commissioning.

Flushing of Piping

Flushing of the piping is done to remove any dirt or debris left in the system. It is recommended to flush the pipes to a waste tank so any debris removed does not find its way back in to the system. In order to flush the process piping, the tank where the membrane recirculation takes suction must be filled with clean water (<1 NTU) and it must be clean.

Open the valves to allow the system to fill up slowly by gravity until it reaches the concentrate return header. Once the system is full of water open the membrane drain valve. This will help flush any solids that were in the piping in to the membrane drain sump. If solids are seen in the system, repeat this process until no residual solids are seen.

Clean and fill the Backwash tank (RO Feed Tank #1) with clean water. Disconnect the piping on the permeate line to allow clean water to flow through this fitting to a waste tank. Let water flow through the permeate piping to waste. Let water flow through the piping until it is thoroughly flushed.

4. Commissioning (with membranes uninstalled)

When beginning the commissioning process it is recommended to have the membranes uninstalled. During the commissioning process when testing certain sequences if the programming is incorrect it is possible to damage the membranes. Having the membranes uninstalled while finding and addressing these issues greatly reduces the risk of damaging the membranes.

One of the most important parameters to set before membrane installation is the ramping speed of the membrane recirculation pump. Setting the recirculation pump to ramp up and ramp down appropriately reduces the risk of pressure surges or water hammer in the line. **NOTE:** The set points that control the pump ramping down should apply even if a fault were to shut the system down.

Another important test to perform before membrane installation is to verify that while the system is in auto the correct valves are opening during each sequence and to verify the timing on when the valves are closing. If the program shuts automatic valves before the pump has ramped down and there is still significant flow through the line, there will be a pressure spike in the system. These pressure spikes can irreparably damage the membranes.

Perform any additional testing that can be done with the membranes uninstalled. Locating and correcting any program errors while the membranes are uninstalled will lead to a much smoother and safer commissioning with the membranes.

Checklist prior to installation

- Complete clean of any process equipment. Any process tanks or piping in the system should be cleaned thoroughly. Any solids left in the system could irreparably damage the membranes.
- Visual inspection of the tanks and the piping. Ensure all fittings are tight and all bolts are torqued down appropriately.
- Flush the process lines to remove any dirt or residue left in the system.
- Flush the air lines. On first start up air should not pass through the aerators as they have 3 mm holes. Take note of air temperature as the max allowable temperature is 60 degrees C.
- Ensure there is enough water to flush the membranes, perform any testing, and leave the system wetted.

- Any system functionality that can be tested prior to installation has been performed.
  - Pump ramping speeds are set.
  - All scaling of 4-20 setpoints.
  - Valve limit switches are working for both open and closed. Mufflers on the valves on working to control speed of opening and closing. Alarm timer for valve to reach setpoint is set correctly.
  - Verify sequencing of valves in automatic mode for all sequences.
  - Verify readings that are to be data logged.
  - Verify Emergency Stop.
  - Power failure procedures and structured startup when power returns.
  - Set minimum tank levels for pumps to operate and verify they work.
  - Verify instrument air supply switch fault is working.

6. Commissioning (with membranes)

Once the membranes are installed, they will need to be flushed of the preservation chemicals. The membranes are stored in a chemical solution of Sodium bisulphite/glycerine which is very high in BOD. Be aware of the BOD and where this water is being deposited. When the flushing consists of recirculating flow through the membranes there may be enough dilution that there would only be a trace BOD reading.

When initially filling the membranes with water open the appropriate valves (make sure the permeate valve is open) that will allow the system to fill up slowly by gravity. Do not turn the pump on until the membranes have filled with water.

Be cautious when flushing the membranes. If pumps have not been set to ramp up and ramp down slowly then there is potential for water surges in the system. This rapid pressure change within the piping can harm the membranes. Take care to always start the pump up slowly and ramp the pump down slowly. Check the PID settings for the pumps and adjust accordingly.

Once the pumps are ramping appropriately the functional description control logic can be tested. This includes the following sequences:

- Filtration
- Backwash
- Drain/Flush
- CEB (chemically enhanced Backwash)
- Relax/Drain Fill
- Idle A
- Idle B

Testing for each of these sequences should include:

- Verify correct valves open and shut.
- Verify timing on system parameters on the OIT.
- Test any potential fault for each sequence being tested and verify that the PLC reacts accordingly.
- All counters are working and the system reacts appropriately when it reaches the counter set-points.
- Verify all calculations

Once this testing has been completed, run the system in automatic mode and monitor. This may require a pump to return permeate to the process tanks. Take caution that any tank that handles process water should be thoroughly cleaned. Once the system has run in automatic mode and all sequences have been triggered automatically by the PLC, the membranes should be cleaned. Determine how long the membranes are going to be out of service and then refer to the shutdown procedures for the membranes to determine appropriate cleaning procedure.

7. Process Guidelines

The wastewater treatment system at Wayland High School was designed to treat 12,154 gallons per day at 12 degrees C. The design parameters for the Airlift UF system are as follows:

- Recirculation flow - 200 GPM
- Membrane airflow - 6 CFM
- Design Flux - 21 GFD
    - Permeate flow = 10.4 GPM
- Filtration TMP Range - 1.5 – 4.5 PSI
- BW Flux - 177 GFD
    - BW Flow = 88 GPM
- BW TMP Range - 7 – 14 PSI
- BW Timing
    - Occurs every 7-10 min for 10-20 seconds at a time
- Membrane Drain - occurs approximately 4-5 times per day
- Membrane CIP - occurs approximately every 4 weeks
- pH Range
    - 6.5-7.5 within system
    - 1 – 12 during a cleaning

Note: These values are guidelines and operational values will vary greatly depending on how the system is run. System set-points on the OIT should be set by operator to optimize system performance based on actual flow characteristics in to the plant.

8. Shut Down Procedures

Once a membrane system has been commissioned and the membranes have been wetted they have to remain wet or the membranes will be irreparably damaged. During the operation of waste water treatment plants it may become necessary for a plant shutdown. During the time the plant is shutdown the membranes will have to go through a shutdown procedure. The procedure will be dependent on the projected length of the shutdown. Each shutdown procedure that follows is designed to keep the membranes wet and prevent biological growth. Take care to protect membranes from freezing temperatures or direct sunlight during shutdown.

Short Term Shutdown (<24 Hours)

For a shutdown of less than 24 hours it is sufficient to perform a backwash on the membranes with permeate and leave the membranes full.

Start-up: Perform a backwash before putting in filtration mode.

Medium Term Shutdown (1-7 days)

For any shutdown of 1-7 days backwash the membranes daily with clean water.

Start-up: Perform a CEB before putting in to filtration mode.

Long Term Shutdown (>7 days)

Perform a CEB to thoroughly clean the membranes. Once the membranes have been cleaned they need to be flushed with a 0.5% sodium meta-bisulphite solution. This solution will be flushed in and stored in the membranes. This solution has to be refreshed every 30 days during shutdown.

Start-up: Perform a CEB before putting in to filtration mode.

External Membrane Storage

If the membranes ever need to be removed from the piping system and stored they should be cleaned with a CEB prior to removal. Once removed the membranes need to be capped to ensure they remain wet. They should be stored with a 5 ppm chlorine solution that has to be refreshed every day they are in storage.

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SECTION 17: ULTRAVIOLET DISENFECTION UNITS

P&ID: Item #: UV-0851, UV-0852

Details:

Double Star U.V. System
Model IVM-15 H0 complete with Manual Wiper and UV Intensity Monitor with 4-20 ma feedback

Manufacturer:

Aqua Azul Corporation
West Coast:
13704 Hanford Armona Road., Suite A5
Hanford, CA 93230
Phone: (559) 589-1430
Fax: (559) 589-1185
East Coast:
P.O. Box 298
326 Lafayette Ave.
Hawthorne, NJ 07507
Phone: (973) 427-6516
Fax: (973) 427-9883
www.aquaazul.com

Local Distributor/Contact:

Regional:
Double Star Ultraviolet Systems
326 Lafayette Ave., Suite 2
P.O. Box 298
Hawthorne, NJ 07507
Tel: (973) 427-6516
Fax: (973) 427-9883
www.doublestaruv.com

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SUBMITTAL DATA

ULTRAVIOLET DISINFECTION EQUIPMENT:

MODEL: IVM-15-HO

PROJECT:

BIOPROCESS H2O

DATE: November 25, 2013

CONTRACTOR:
Bio Process H2O

PREPARED BY:

Tony Martin

SUPPLIER:
Aqua Azul Corporation
13701 6th Street, Suite C1
Armona, CA 93202

MANUFACTURES OF INDUSTRIAL AND WASTE WATER ULTRAVIOLET EQUIPMENT

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SECTION 1

SECTION 2

***COMPONENTS SUBJECT TO CHANGE WITHOUT NOTICE. ***

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Section 1

ULTRAVIOLET DISINFECTION EQUIPMENT:

MODEL: IVM-15-HO

PROJECT:

BIOPROCESS H2O

SUPPLIER:

Aqua Azul Corporation

13701 6th Street, Suite C1

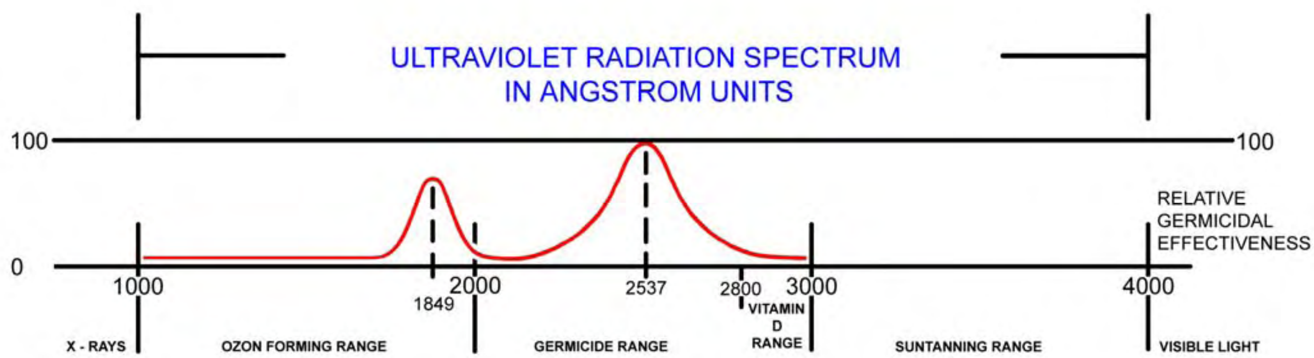
Armona, CA 93202

PURIFICATION BY ULTRAVIOLET RADIATION

aquaazul

UNDERSTANDING ULTRAVIOLET RADIATION IN WATER OR LIQUIDS

Ultraviolet Radiation: Ultraviolet (UV) light is invisible radiation within a range of the solar spectrum. UV is similar to the wavelengths that are produced by visible light, but much shorter. UV radiation is measured in millionths of a millimeter, i.e., Angstrom units (one Angstrom unit wave-length equals one hundred-millionth of a centimeter), and like visible light, it primarily has a surface effect. Within the UV radiation spectrum, there are three main groups.



Ultraviolet lamp radiation of 2537-Angstrom units (or 254 nanometers) wavelength must hit the microorganism to inactivate it, and each microorganism must absorb a specific amount of energy to be destroyed.

Proteins and nucleic acid, which all microorganisms contain as their main constituents, absorb UV radiation energy. After absorption, the UV energy destroys or inactivates the DNA (deoxyribonucleic acid), thus preventing the microorganisms from reproducing.

Sterilization of water implies that all life, i.e., bacteria, mold, virus, algae, and protozoa, are destroyed. Table I gives the absolute amount of UV necessary to kill many of the common types. Aqua Azul can also supply an 1849A (185NM) ultraviolet lamp that produces ozone (03) disinfection residuals, and in most cases this lamp interchanges with our standard 2537A ultraviolet lamp.

Complete sterilization is not necessary for the production of potable water. However, the water must conform to the drinking water standards of the Public Health Service or those of the agency governing your supply. Normally, the water must contain less than 2.2 coliforms per 100 ml to be considered safe to drink. The coli form groups of microorganisms are generally associated with fecal matter and indicate that pathogenic (disease-causing) organisms, such as typhoid, may be present. As will be explained later, a different sizing formula must be used for purification if 100% sterilization is required.

Energy and Exposure: The germicidal spectrum of the ultraviolet wavelength is from 2000 to 3000 Angstroms, with the peak at 2537 Angstroms. The total UV energy emitted from all sides of the UV lamp is expressed in watts. The total exposure of the liquid is expressed in microwatt-seconds per square centimeter, which is a product of energy, time, and area. The same number of microwatt seconds per square centimeter can be accomplished with a short exposure at a high intensity of UV or a long exposure at a low intensity of UV. Table II gives the UV energy data on the high intensity ultraviolet lamps used in Aqua Azul purifiers.

Transmission: The amount of energy available to any microorganism from a given ultraviolet source is dependent on the UV transmission of the liquid. The transmission is dependent on the depth of the liquid and the absorption coefficient of the liquid. The absorption coefficient is dependent on the quantity and types of dissolved and suspended matter in the liquid. Generally, iron salts and organic matter have the greatest effect on absorption, while alkali salts (such as common salts) do not absorb these radiations. The physical requirements of less than 10 NTU of turbidity, 15 TCU of color, and 0.2 ppm of iron should be met before an Aqua Azul's UV water purifier is installed. Prefiltration of all suspended matter to at least 5 microns in size is recommended for all private water supplies, as the efficiency of the purifier is determined by the transmission of the water or liquid. Table III illustrates the percent of transmission of the ultraviolet for water of various absorption coefficients. The absorption coefficient of the average tap water varies between 0.12 and 0.07 with highly polished DI or distilled water at 0.008 and cloudy water from a private source, such as a pond, well, or spring, at 0.50 or less. The absorption coefficient of the liquid to be purified must be known for proper sizing.

Other Factors Affecting Ultraviolet Purification: The ultraviolet output of the UV lamp is also dependent upon the primary voltage output and the lamp wall temperature. Table IV shows the effect of line voltage on UV output, and Table V shows the effect of temperature. It will be noted that at 56.6 F (12C) the lamp will be only 22% efficient in generating bactericidal radiation. Aqua Azul uses only high intensity ultraviolet lamps inside a high-transmission clear fused quartz jacket so that an optimum temperature of 104 F (40C) can be obtained for 100% UV output. The liquid does not come in contact with the lamp.

Another factor that must be considered is the useful life of the UV lamp. The performance of the various types of lamps is indicated in Table II. It is recommended that spare ultraviolet lamps be kept on hand at all times, and that accurate records be kept of lamp use and replacement. The ultraviolet output gradually decreases over the life of the lamp, and the lamp must be replaced as indicated by hours of use or by a UV monitor.

SIZING OF ULTRAVIOLET LIQUID PURIFICATION EQUIPMENT:

The various factors that must be considered were discussed above. Assuming a proper voltage source, the Aqua Azul ultraviolet liquid purifier can be sized properly if the following are known.

(a) Peak flow rate required in gpm, gph, gpd or m3/h.
(b) Transmission and physical make-up (absorption coefficient) of the liquid to be treated.
(c) Ultraviolet energy level required for microorganism destruction (see Table I).

The Public Health Service requires that UV disinfection equipment have a minimum UV dosage of 16,000 uW sec./cm sq. (microwatt-seconds per square centimeter). Aqua Azul purifiers are manufactured in standard sizes from 1 to 2600 gpm to impart a dosage of 30,000 uW sec./cm sq. All significant waterborne pathogenic micro-organisms are destroyed by under 10,000 uW sec./cm sq. Industrial high purity water may require higher radiation levels depending on the type of microorganism to be destroyed.

Suggested flow rates of the various models with different liquid transmission are indicated in figures 1 and 2. If 100% sterilization is required, the flow rate through the purifier can be computed, depending on the energy level required. For a particular problem or application, consult Aqua Azul's technical staff.

AQUA AZUL

aquaazul

Section 2

ULTRAVIOLET DISINFECTION EQUIPMENT:

MODEL: IVM-15-HO

PROJECT:

BIOPROCESS H2O

SUPPLIER:

Aqua Azul Corporation

13701 6th Street, Suite C1

Armona, CA 93202

MANUFACTURES OF INDUSTRIAL AND WASTE WATER ULTRAVIOLET EQUIPMENT

AQUA AZUL CORPORATION

SCOPE OF SUPPLY

DATE: June 12, 2012 ATTENTION: Peter Annunziato

GENERAL:
The contractor shall provide all labor, equipment and material necessary to furnish , install and test an ultraviolet light system for the disinfecting of waste water as shown on the drawings or specified.

The system shall be furnished complete with UV lamp chambers, power control center, UV lamps, UV monitoring system, and accessories.

PROJECT: BIO PROCESS H2O

SPECIFICATIONS:

EQUIPMENT SUMMARY:

Model No.	**Description**	**QTY.**
IVM – 15 HO	UV PURIFIER / CHAMBER	2

Water Characteristics:
The water to be disinfected shall have the following minimum quality characteristics.

Suspended Solids:	30 mg/l or less
BOD:	30 mg/l or less
Percent Transmission:	65% at 253.7 nm through 1 cm
Temperature Range:	34 F to 96 F

FLOW RATE:
Each UV disinfecting chamber shall be designed to treat a maximum effluent flow of:

PEAK FLOW: 25 GPM

PERFORMANCE:
The ultraviolet system shall be capable of meeting the fecal coliform limit set at <100 MPN/100ml. The system shall supply a minimum dosage of 30,000 Plus microwatt-seconds per square centimeter at the end of lamp life.

EQUIPMENT:
All wetted metal parts shall be constructed of Type 304 stainless steel, Quartz, Teflon and EPR and Vertical mounted.

DESIGN:
Number of UV Vertical Chambers: 2
Number of UV lamps/UV Chamber: 2
Number of UV Control Panels: 2
Number of Intensity Monitors: 2
Number of Manual Wipers: 2

GERMICIDAL LAMPS:
The UV system shall utilize low pressure high output mercury slim line lamps of the hot cathode instant start design in which the coiled filamentary cathodes are heated by the arc current. The filament shall be the clamped design, sufficiently rugged to withstand shock and vibration. Each lamp shall produce ultraviolet light with at
least 90 percent of the emission within the wavelength of 254 nanometer. The lamps shall be rated to produce zero level of ozone.

ELECTRICALS:
All electrical components are to be housed in a remote NEMA rated enclosure. The power supply shall be 120 VAC.1 phase, 60 Hz. The system shall be protected by a ground-fault circuit interrupter and design for INDOOR.

4 - 20 MA Output.

MANUAL WIPER SYSTEM:
A manual wiper system shall be provided to clean the quartz sleeve.

ULTRAVIOLET LAMP MONITORING:
An array of green LED lights in the pattern of the system shall provide visual indication of the operating status of each UV lamp. In the event of a lamp failure the green light shall go out indicating which lamp has failed.

A non-resettable elapsed time indicator shall be provided to record hours of operation.

ULTRAVIOLET INTENSITY MONITOR:
An ultraviolet intensity monitor with a remote sensor shall be provided. Monitor shall indicate intensity from 0 -100%.

FACTORY TESTING:
The Ultraviolet System shall be totally factory assembled and tested as a system prior to site delivery. The electrical shall have been tested for at least 4 hours and noted on the elapsed time indicator.

AQUA AZUL

TABLE 1

Ultraviolet Energy Levels at 2537 Angstrom Units Wave-length Required for 99.9% Destruction of Various Micro-organisms

UV Energy in Microwatt-seconds per Square Centimeter

BACTERIA			
Agrobactrium tumefaciens	8500	MOLD SPORES	
Bacillus antharacis	8700		
Bacillus megaterium *(vegetative)*	2500	Aspergillus flavus *(yellowish green)*	99000
Bacillus megaterium *(spores)*	52000	Aspergillus glaucus *(bluish green)*	88000
Bacillus subtillis *(vegative)*	11000	Aspergillus niger *(black)*	330000
Bacillus subtillis *(spores)*	58000	Mucor ramosissimus *(white gray)*	35200
Clostridium tetani	22000	Penicillum digitatum *(olive)*	88000
Corynebacterium diphtheriae	6500	Penicillum expensum *(olive)*	22000
Escherichia coli	7000	Penicillum roqueforti *(green)*	26400
Legionella bozemanii	3500	Rhizopus nigricans *(black)*	220000
Legionella dumoffii	5500		
Legionella gormarii	4900	ALGAE	
Legionella micdadei	3100		
Legionella longbeachae	2900	Chlorella vulgaris *(algae)*	22000
Legionella pneumophila	3800		
Leptospira interrogans *(Infectious Jaundice)*	6000	PROTOZOA	
Mycobacterium tuberculosis	10000		
Neisseria catarrhalis	8500	Nematode eggs	92000
Proteus vulgaris	6600	Paramecium	200000
Pseudomonas aeruginosa *(laboratory strain)*	3900		
Pseudomonas aeruginosa *(envir. Strain)*	10500	VIRUSES	
Rhodospirllum rubrum.	6200		
Salmonella enteritidis	7600	Bacteriophage *(E. coli)*	6600
Salmonella paratyphi *(Enteric fever)*	6100	Hepatitis virus	8000
Salmonella typhimurium	15200	Influenza virus	6600
Salmonella typhosa *(Typhoid fever)*	6000	Polio virus *(Poliomyelitis)*	21000
Sarcina lutea	26400	Rota virus	24000
Seratia marcescens	6200	Tobacco mosaic virus	440000
Shigella dysenteriae *(Dysentery)*	4200		
Shigella flexneri *(Dysentery)*	3400	YEAST	
Shigella sonnei	7000		
Staphylococcus epidermidis	5800	Baker's yeast	8800
Staphylococcus aureus	7000	Brewer's yeast	6600
Staphylococcus faecalis	10000	Common yeast cake	13200
Streptococcus hemolyticus	5500	Saccharomyces var. ellipsoideus	13200
Streptococcus lactis	8800	Saccharomyces sp	17600
Viridans streptococci	3800		
Vibrio cholerae	6500		

TABLE II

Technical Data on High Intensity Mercury Vapor Ultraviolet Lamps Use for Air and Water Purification

LAMP NO.	LAMP LENGTH	ARC LENGTH	LAMP WATTS	RATED LIFE (HR)	UV OUTPUT* (WATTS)	INTENSITY (Microwatts per CM Sq.)***			
						Through Air		Through Water **	
						At 1"	At 3"	At 1"	At 3"
L-1-806	17"	11"	16.0	9000	5.3	8800	3400	7040	3920
L-1-809	17"	11"	16.0	9000	5.3	8800	3400	7040	3920
L-1-803	36"	30"	39.0	9000	13.8	8800	3400	7040	3920
L-1-807	36"	30"	39.0	9000	13.8	8800	3400	7040	3920
L-1-804	64"	58"	65.0	9000	26.7	8800	3400	7040	3920
L-1-808	64"	58"	65.0	9000	26.7	8800	3400	7040	3920

* Output of 2537 Angstroms with new lamps at 80 ° F, still air, ambient.
** With an absorption coefficient of 0.10.
*** Ultraviolet lamp intensity at 2537 Angstrom units wavelength at a given distance. Variations in voltage, temperature and tube material will cause the lamp output to vary. The intensity through water is based on a 0.10 absorption coefficient.

TABLE III

Percent Transmission of 2537A for Water Absorption Coefficients*

ABSORPTION COEFFICIENT	TRANSMISSION		ABSORPTION COEFFICIENT	TRANSMISSION	
	At 1"	At 3"		At 1"	At 3"
0.008	99%	95%	0.12	75%	40%
0.02	95%	87%	0.15	72%	34%
0.03	92%	80%	0.16	70%	29%
0.04	90%	74%	0.17	68%	28%
0.05	88%	68%	0.18	65%	25%
0.06	87%	64%	0.20	60%	23%
0.07	85%	59%	0.25	56%	16%
0.08	82%	55%	0.30	54%	11%
0.09	81%	50%	0.35	50%	8%
0.10	80%	46%	0.40	40%	5%
0.11	78%	44%	0.50	30%	2%

***As a measured percent of transmission with GL – 100 monitor. (Note: Monitor meets US Bureau of Standards requirements)**

TABLE IV

Effect of line Voltage on Ultraviolet Output, Relative Percent of 2537A*

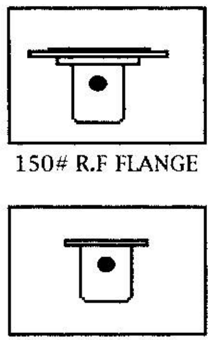
PRIMARY VOLTS	OUTPUT
90	68%
95	73%
100	78%
105	84%
110	90%
115	96%
120	102%
125	108%

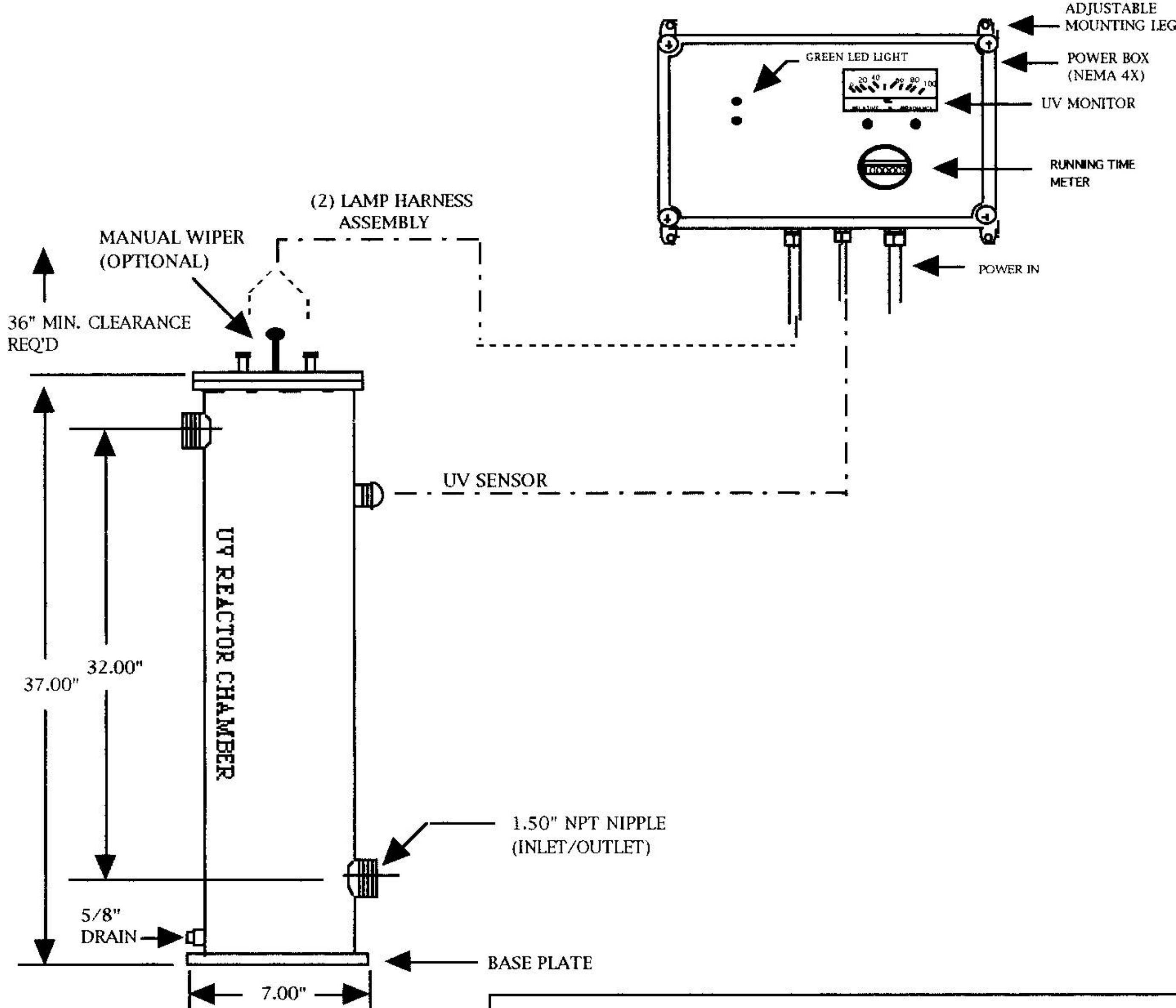
*Optimum = 118 VAC/60 HZ

TABLE V

Relative percent Output of 2537A Radiation at various UV Lamp Temperatures

TEMPERATURE		OUTPUT	TEMPERATURE		OUTPUT
F°	C°		F°	C°	
56.6	12	22%	104.0	40	100%
60.8	16	30%	111.2	44	98%
68.0	20	40%	118.4	48	93%
75.2	24	53%	125.6	52	85%
82.4	28	68%	132.8	56	75%
89.6	32	85%	140.0	60	66%
96.8	36	95%	147.2	64	58%





SPECIFICATIONS:

1. APPLICATION: WASTE WATER
2. FLOW RATE: 25 GPM
3. UV DOSAGE: 30,000 PLUS MW SEC. / CM2
4. OPERATING PRESSURE: 150 PSIG MAX.
5. ELECTRICAL BOX: REMOTE
6. ELECTRICAL: 120 VAC / 60 HZ
7. LAMP: 254 NM

AQUA AZUL CORPORATION
13701 6TH STREET, ARMONA, CALIFORNIA 93202
(PH) 559-589-1185 (FAX) 559-589-1185

MODEL: IVM-15 HO		MATERIAL: 304L SS
DATE: 10/13	DRAWN: DA	PROJECT:

1245

Hoffman®
A Pentair Company

Rev. A October 2004

QLINE® I Polycarbonate and ABS Type 4X Enclosures

Industry Standards

Polycarbonate Enclosure

UL 508A, 508 File No. E61997: Type 4, Type 4X, Type 12, and Type 13
NEMA/EEMAC Type 4, Type 4X, Type 12, and Type 13
CSA File No.LR42186: Type 4, Type 4X, Type 12, and Type 13
Enclosure flammability rating per UL 508
IEC 60529, IP66

ABS Enclosure

NEMA/EEMAC Type 4, Type 4X, Type 12, and Type 13
Enclosure flammability rating UL94-HB
IEC 60529, IP66

Accessories

Bottom Cover Kit
Brass Insert Kit
Cover Screw Kit
Extension Ring (see table)
Hardware Kit
Hinge Kit
Mounting Bracket Kit
Panel Depth Fitting

Application

Designed for use as insulated electrical junction boxes, terminal wiring boxes, instrument housings, electrical control boxes, and pushbutton housings in wet, dusty, and corrosive environments. Clear cover provides easy visual inspection of interior components.

The ABI series of enclosures provides the same features and similar physical properties as its polycarbonate counterpart, the PCI enclosure, but at a lower cost.

See Chapter 11, EMC Enclosures, for information on a related EMC-shielded product.

Construction

- Body is impact-resistant polycarbonate for PCI series and ABS for ABI series
- Opaque and clear covers are impact-resistant polycarbonate for PCI, opaque covers are ABS for ABI series
- Polycarbonate and ABS material is easily punched, drilled, filed, or sawed
- Mounting holes molded directly under cover screws
- Molded internal pads for mounting optional panels, rails, and other components
- Molded internal rails for mounting adjustable depth panel kit
- Screws provided for mounting optional panel
- Optional extension rings are molded polycarbonate
- Cover includes a molded-in hole for wire lead
- Seamless foam-in-place gasket assures watertight and dust-tight seal

Screw Cover Enclosures have easily removable covers attached to body with strong, durable polyamide cross-point cover screws.

Enclosures with Quick-Release Latches have polycarbonate hinges and polyester latches with a spring-loaded monel bail.

Finish/Color

Optional panels are zinc-plated steel. Polycarbonate and ABS enclosure material is RAL 7035 light gray inside and out.

Modification Services Program

You can customize this product to your unique requirements by specifying from these options:

- Colors
- Holes and cutouts in body, doors, subpanels
- Doors
- Subpanels
- Standard accessories

For details, see Modification Services at hoffmanonline.com.
To order, contact your local Hoffman sales representative.

NOTE: For information about modifications outside the scope of the Modification Services program, contact your Hoffman sales representative.

Standard Sizes QLINE® I Polycarbonate and ABS Type 4X Screw Cover Enclosures

Enclosure Catalog Number Opaque Cover	Clear Cover	External Dimensions L x W	Internal Dimensions A x B x C	*Panel Catalog Number	Panel Size D x E	* Extension Ring Catalog Number	Mounting G x H	F	P	Q	R	S	T	U	Y	Z
Q202013PCI Q202013ABI	Q202013PCICC Q202013ABICC	200 x 200 (7.87 x 7.87)	188 x 188 x 123 (7.40 x7.40 x 4.84)	Q2020PI	160x160 (6.30x6.30)	Q2020EXTI	180x180 (7.09x7.09)	115 (4.53)	150 (5.91)	150 (5.91)	140 (5.51)	140 (5.51)	120 (4.72)	110 (4.33)	100 (3.94)	100 (3.94)
Q302013PCI Q302013ABI	Q302013PCICC Q302013ABICC	300 x 200 (11.81 x 7.87)	288 x 188 x 123 (11.34x7.40 x 4.84)	Q3020PI	260x160 (10.24x6.30)	Q3020EXTI	280x180 (11.02x7.09)	115 (4.53)	150 (5.91)	250 (9.84)	140 (5.51)	240 (9.45)	120 (4.72)	210 (8.27)	100 (3.94)	200 (7.87)
Q402013PCI Q402013ABI	Q402013PCICC Q402013ABICC	400 x 200 (15.75 x 7.87)	388 x 188 x 123 (15.28x7.40 x 4.84)	Q4020PI	360x160 (14.17x6.30)	Q4020EXTI	380x180 (14.96x7.09)	115 (4.53)	150 (5.91)	350 (13.78)	140 (5.51)	340 (13.39)	120 (4.72)	310 (12.20)	100 (3.94)	300 (11.81)
Q303013PCI Q303013ABI	Q303013PCICC Q303013ABICC	300 x 300 (11.81 x 11.81)	288 x 288 x 123 (11.34x11.34 x 4.84)	Q3030PI	260x260 (10.24x10.24)	Q3030EXTI	280x280 (11.02x11.02)	115 (4.53)	250 (9.84)	250 (9.84)	240 (9.45)	240 (9.45)	220 (8.66)	210 (8.27)	200 (7.87)	200 (7.87)
Q403013PCI Q403013ABI	Q403013PCICC Q403013ABICC	400 x 300 (15.75 x 11.81)	388 x 288 x 123 (15.28x11.34 x 4.84)	Q4030PI	360x260 (14.17x10.24)	Q4030EXTI	380x280 (14.96x11.02)	115 (4.53)	250 (9.84)	350 (13.78)	240 (9.45)	340 (13.39)	220 (8.66)	310 (12.20)	200 (7.87)	300 (11.81)
Q603013PCI Q603013ABI	Q603013PCICC Q603013ABICC	600 x 300 (23.62 x 11.81)	588 x 288 x 123 (23.15x11.34 x 4.84)	Q6030PI	560x260 (22.05x10.24)	Q6030EXTI	580x280 (22.83x11.02)	115 (4.53)	250 (9.84)	550 (21.65)	240 (9.45)	540 (21.26)	220 (8.66)	510 (20.08)	200 (7.87)	500 (19.69)
Q604013PCI Q604013ABI	Q604013PCICC Q604013ABICC	600 x 400 (23.62 x 15.75)	588 x 388 x 123 (23.15x15.28 x 4.84)	Q6040PI	560x360 (22.05x14.17)	Q6040EXTI	580x380 (22.83x14.96)	115 (4.53)	350 (13.78)	550 (21.65)	340 (13.39)	540 (21.26)	320 (12.60)	510 (20.08)	300 (11.81)	500 (19.69)
Q202018PCI Q202018ABI	Q202018PCICC Q202018ABICC	200 x200 (7.87 x 7.87)	188 x 188 x 173 (7.40x7.40 x 6.81)	Q2020PI	160x160 (6.30x6.30)	Q2020EXTI	180x180 (7.09x7.09)	165 (6.50)	150 (5.91)	150 (5.91)	140 (5.51)	140 (5.51)	120 (4.72)	110 (4.33)	100 (3.94)	100 (3.94)
Q302018PCI Q302018ABI	Q302018PCICC Q302018ABICC	300 x 200 (11.81 x 7.87)	288 x 188 x 173 (11.34x7.40 x 6.81)	Q3020PI	260x160 (10.24x6.30)	Q3020EXTI	280x180 (11.02x7.09)	165 (6.50)	150 (5.91)	250 (9.84)	140 (5.51)	240 (9.45)	120 (4.72)	110 (4.33)	100 (3.94)	200 (7.87)
Q402018PCI Q402018ABI	Q402018PCICC Q402018ABICC	400 x 200 (15.75 x 7.87)	388 x 188 x 173 (15.28x7.40 x 6.81)	Q4020PI	360x160 (14.17x6.30)	Q4020EXTI	380x180 (14.96x7.09)	165 (6.50)	150 (5.91)	350 (13.78)	140 (5.51)	340 (13.39)	120 (4.72)	310 (12.20)	100 (3.94)	300 (11.81)
Q303018PCI Q303018ABI	Q303018PCICC Q303018ABICC	300 x 300 (11.81 x 11.81)	288 x 288 x 173 (11.34 x11.34 x 6.81)	Q3030PI	260x260 (10.24x10.24)	Q3030EXTI	280x280 (11.02x11.02)	165 (6.50)	250 (9.84)	250 (9.84)	240 (9.45)	240 (9.45)	220 (8.66)	210 (8.27)	200 (7.87)	200 (7.87)
Q403018PCI Q403018ABI	Q403018PCICC Q403018ABICC	400 x 300 (15.75 x 11.81)	388 x 288 x 173 (15.28x11.34 x 6.81)	Q4030PI	360x260 (14.17x10.24)	Q4030EXTI	380x280 (14.96x11.02)	165 (6.50)	250 (9.84)	350 (13.78)	240 (9.45)	340 (13.39)	220 (8.66)	310 (12.20)	200 (7.87)	300 (11.81)
Q603018PCI Q603018ABI	Q603018PCICC Q603018ABICC	600 x 300 (23.62 x 11.81)	588 x 288 x 173 (23.15x11.34 x 6.81)	Q6030PI	560x260 (22.05x10.24)	Q6030EXTi	580x280 (22.83x11.02)	165 (6.50)	250 (9.84)	550 (21.65)	240 (9.45)	540 (21.26)	220 (8.66)	510 (20.08)	200 (7.87)	500 (19.69)
Q604018PCI Q604018ABI	Q604018PCICC Q604018ABICC	600 x 400 (23.62 x 15.75)	588 x 388 x 173 (23.15 x 15.28 x 6.81)	Q6040PI	560x360 (22.05x14.17)	Q6040EXTI	580x380 (22.83x14.96)	165 (6.50)	350 (13.78)	550 (21.65)	340 (13.39)	540 (21.26)	320 (12.60)	510 (20.08)	300 (11.81)	500 (19.69)

Standard Sizes QLINE® I Polycarbonate Type 4X Enclosures with Quick-Release Latches

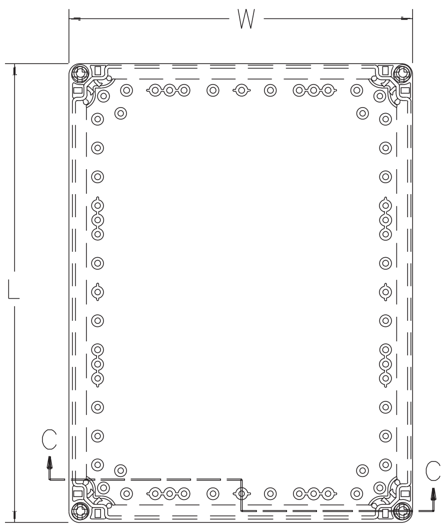
Enclosure Catalog Number Opaque Cover	Clear Cover	External Dimensions L x W	Internal Dimensions A x B x C	* Panel Catalog Number	Panel Size D x E	Mounting G x H	F	P	Q	R	S	T	U	Y	Z
Q202013PCIQR	Q202013PCIQRCC	200 x 200 (7.87 x 7.87)	188 x 188 x 123 (7.40 x7.40 x 4.84)	Q2020PI	160x160 (6.30x6.30)	180x180 (7.09x7.09)	115 (4.53)	150 (5.91)	150 (5.91)	140 (5.51)	140 (5.51)	120 (4.72)	110 (4.33)	100 (3.94)	100 (3.94)
Q302013PCIQR	Q302013PCIQRCC	300 x 200 (11.81 x 7.87)	288 x 188 x 123 (11.34x7.40 x 4.84)	Q3020PI	260x160 (10.24x6.30)	280x180 (11.02x7.09)	115 (4.53)	150 (5.91)	250 (9.84)	140 (5.51)	240 (9.45)	120 (4.72)	210 (8.27)	100 (3.94)	200 (7.87)
Q402013PCIQR	Q402013PCIQRCC	400 x 200 (15.75 x 7.87)	388 x 188 x 123 (15.28x7.40 x 4.84)	Q4020PI	360x160 (14.17x6.30)	380x180 (14.96x7.09)	115 (4.53)	150 (5.91)	350 (13.78)	140 (5.51)	340 (13.39)	120 (4.72)	310 (12.20)	100 (3.94)	300 (11.81)
Q303013PCIQR	Q303013PCIQRCC	300 x 300 (11.81 x 11.81)	288 x 288 x 123 (11.34x11.34 x 4.84)	Q3030PI	260x260 (10.24x10.24)	280x280 (11.02x11.02)	115 (4.53)	250 (9.84)	250 (9.84)	240 (9.45)	240 (9.45)	220 (8.66)	210 (8.27)	200 (7.87)	200 (7.87)
Q403013PCIQR	Q403013PCIQRCC	400x300 (15.75 x 11.81)	388 x 328 x 123 (15.28x11.34 x 4.84)	Q4030PI	360x260 (14.17x10.24)	380x280 (14.96x11.02)	115 (4.53)	250 (9.84)	350 (13.78)	240 (9.45)	340 (13.39)	220 (8.66)	310 (12.20)	200 (7.87)	300 (11.81)
Q603013PCIQR	Q603013PCIQRCC	600 x 300 (23.62 x 11.81)	588 x 288 x 123 (23.15x11.34 x 4.84)	Q6030PI	560x260 (22.05x10.24)	580x280 (22.83x11.02)	115 (4.53)	250 (9.84)	550 (21.65)	240 (9.45)	540 (21.26)	220 (8.66)	510 (20.08)	200 (7.87)	500 (19.69)
Q604013PCIQR	Q604013PCIQRCC	600 x 400 (23.62 x 15.75)	588 x 388 x 123 (23.15x15.28 x 4.84)	Q6040PI	560x360 (22.05x14.17)	580x380 (22.83x14.96)	115 (4.53)	350 (13.78)	550 (21.65)	340 (13.39)	540 (21.26)	320 (12.60)	510 (20.08)	300 (11.81)	500 (19.69)
Q202018PCIQR	Q202018PCIQRCC	200 x200 (7.87 x 7.87)	188 x 188 x 173 (7.40x7.40 x 6.81)	Q2020PI	160x160 (6.30x6.30)	180x180 (7.09x7.09)	165 (6.50)	150 ((5.91)	150 (5.91)	140 (5.51)	140 (5.51)	120 (4.72)	110 (4.33)	100 (3.94)	100 (3.94)
Q302018PCIQR	Q302018PCIQRCC	300 x 200 (11.81 x 7.87)	288 x 188 x 173 (11.34x7.40 x 6.81)	Q3020PI	260x160 (10.24x6.30)	280x180 (11.02x7.09)	165 (6.50)	150 (5.91)	250 (9.84)	140 (5.51)	240 (9.45)	120 (4.72)	110 (4.33)	100 (3.94)	200 (7.87)
Q402018PCIQR	Q402018PCIQRCC	400 x 200 (15.75 x 7.87)	388 x 188 x 173 (15.28x7.40 x 6.81)	Q4020PI	360x160 (14.17x6.30)	380x180 (14.96x7.09)	165 (6.50)	150 (5.91)	350 (13.78)	140 (5.51)	340 (13.39)	120 (4.72)	310 (12.20)	100 (3.94)	30 (11.81)
Q303018PCIQR	Q303018PCIQRCC	300 x 300 (11.81 x 11.81)	288 x 288 x 173 (11.34x11.34 x 6.81)	Q3030PI	260x260 (10.24x10.24)	280x280 (11.02x11.02)	165 (6.50)	250 (9.84)	250 (9.84)	240 (9.45)	240 (9.45)	220 (8.66)	210 (8.27)	200 (7.87)	200 (7.87)
Q403018PCIQR	Q403018PCIQRCC	400 x 300 (15.75 x 11.81)	388 x 288 x 173 (15.28x11.34 x 6.81)	Q4030PI	360x260 (14.17x10.24)	380x280 (14.96x11.02)	165 (6.50)	250 (9.84)	350 (13.78)	240 (9.45)	340 (13.39)	220 (8.66)	310 (12.20)	200 (7.87)	300 (11.81)
Q603018PCIQR	Q603018PCIQRCC	600 x 300 (23.62 x 11.81)	588 x 288 x 173 (23.15x11.34 x 6.81)	Q6030PI	560x260 (22.05x10.24)	580x280 (22.83x11.02)	165 (6.50)	250 (9.84)	550 (21.65)	240 (9.45)	540 (21.26)	220 (8.66)	510 (20.08)	200 (7.87)	500 (19.69)
Q604018PCIQR	Q604018PCIQRCC	600 x 400 (23.62 x 15.75)	588 x 388 x 173 (23.15 x 15.28 x 6.81)	Q6040PI	560x360 (22.05x14.17)	580x380 (22.83x14.96)	165 (6.50)	350 (13.78)	550 (21.65)	340 (13.39)	540 (21.26)	320 (12.60)	510 (20.08)	300 (11.81)	500 (19.69)

Inch dimensions in ( ).

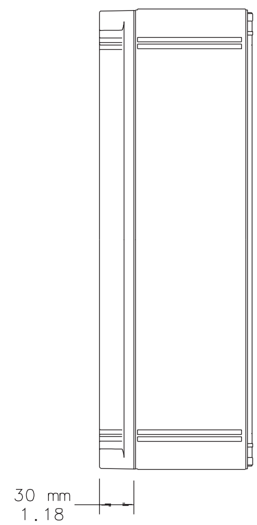
* Panels and Extension Rings must be ordered separately.

QLINE® I Polycarbonate and ABS Type 4X Enclosures

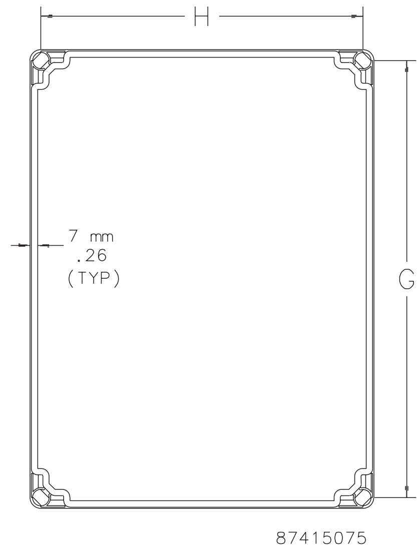
Screw Cover Enclosures



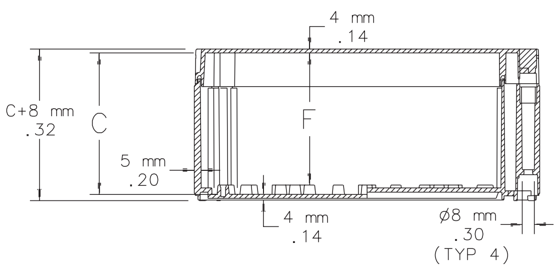
TOP VIEW



SIDE VIEW

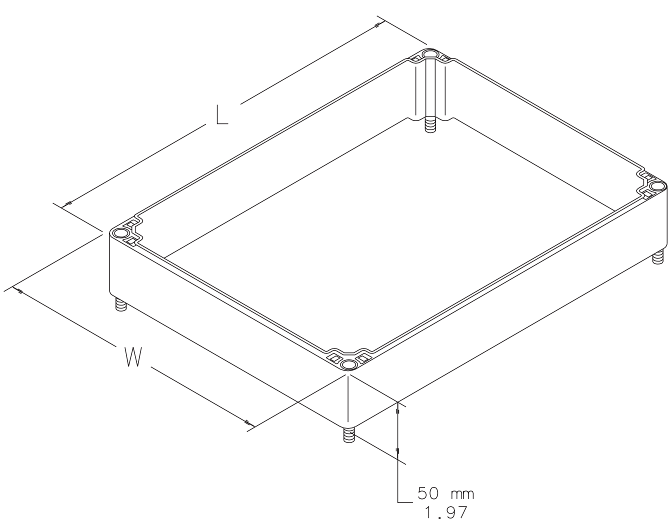


BOTTOM VIEW

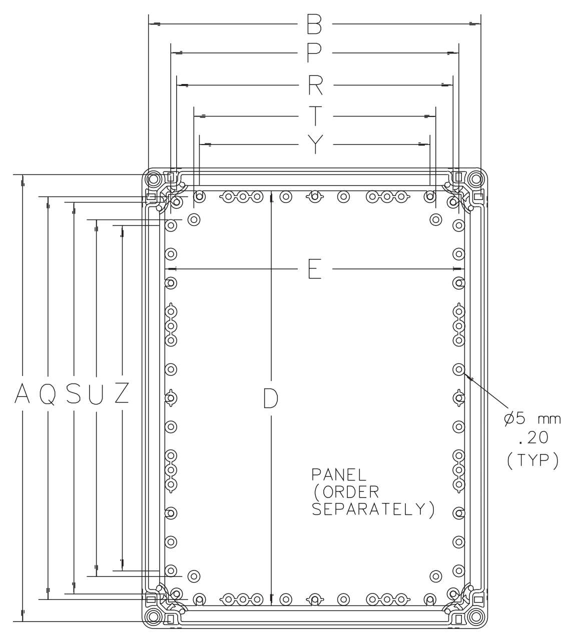


SECTION C-C

NOTES: 1. Panel screws are MS pan head.
2. Enclosures with C = 173mm (6.81 in.) include 50mm (1.97 in.) extension ring.



OPTIONAL EXTENSION RING



TOP VIEW WITH
COVER REMOVED

FP-301 Tubing

Flexible Polyolefin

Data Sheet

Product Description

3M™ FP-301 Tubing offers an outstanding balance of electrical, physical and chemical properties for a wide variety of industrial and military applications. Rated for 135°C continuous operation, all FP-301 Tubing is split resistant, mechanically tough, easily marked and resists cold flow.

FP-301 Tubing meets MIL-DTL-23053/5 Class 1 & 2 and AMS-3636, AMS-3637 requirements. It is ULRecognized and CSACertified at 600 volts @ 125°C (UL File Nos. E-39100 and E-69751; CSANo. 38227).

FP-301 Tubing is rated for continuous operation from –55°C (–67°F) to 135°C (275°F) and withstands elevated temperatures to 300°C (572°F) for short periods. Minimum shrink temperature for all FP-301 Tubing is 100°C (212°F).

Typical Applications

FP-301 Tubing is typically used as a shrink-fit electrical insulation over cable splices and terminations. It is also used for lightweight wire harness covering, wire marking, wire bundling, component packaging and fire-resistant covering.

Shrink Ratio

FP-301 polyolefin tubing has a 2:1 shrink ratio. When freely recovered, the tubing will shrink to 50% of its as-supplied internal diameter. The recovered wall thickness of the tubing is proportional to the degree of recovery.

High expansion-ratio FP-301 Tubing meeting MIL-DTL-23053/5 Class 1 requirements for overexpansion is available subject to factory quotation.

Standard Colors

FP-301, Class 1 (flame retardant)–black, white, red, blue, green (1/16 "-1" green only) and yellow. FP-301, Class 2 (non-flame retardant)–clear. Other colors available subject to factory quotation.

Standard Packaging

Four-foot lengths, large spools (21" diameter) and small spools (8-1/2" diameter).

Ordering Information

Order FP-301 by product name, size equivalent to expanded inside diameter, package type and color. Always order the largest size that will shrink snugly over the item to be covered.
Example: FP-301, 1/4", 4 ft., white.

Standard Sizes and Dimensions

Ordering Size	Expanded ID Minimum in.	(mm)	Recoverd ID Maximum in.	(mm)	Recoverd Wall Thickness (Nominal) in.	(mm)
3/64	.046	(1,17)	.023	(0,58)	.016	(0,41)
1/16	.063	(1,60)	.031	(0,79)	.017	(0,43)
3/32	.093	(2,36)	.046	(1,17)	.020	(0,51)
1/8	.125	(3,18)	.062	(1,57)	.020	(0,51)
3/16	.187	(4,75)	.093	(2,36)	.020	(0,51)
1/4	.250	(6,35)	.125	(3,18)	.025	(0,64)
3/8	.375	(9,53)	.187	(4,75)	.025	(0,64)
1/2	.500	(12,70)	.250	(6,35)	.025	(0,64)
3/4	.750	(19,05)	.375	(9,53)	.030	(0,76)
1	1.000	(25,40)	.500	(12,70)	.035	(0,89)
1-1/2	1.500	(38,10)	.750	(19,05)	.040	(1,02)
2	2.000	(50,80)	1.000	(25,40)	.045	(1,14)
3	3.000	(76,20)	1.500	(38,10)	.050	(1,27)
4	4.000	(101,60)	2.000	(50,80)	.055	(1,40)

Typical Properties

Applicable Specification
MIL-DTL-23053/5, Class 1, 2; AMS-3636, AMS-3637; UL File E-39100, E-69751; CSALR38227; ABS

Physical

Tensile Strength	2400 PSI
Ultimate Elongation	400%
Longitudinal Change	±5%
Secant Modulus (2%)	13,000 PSI
Specific Gravity	1.3(Black) .93 (Clear)
Heat Aging (336 hrs. @ 175°C)	Elongation 175%
Heat Shock (4 hrs. @ 250°C)	No dripping, cracking, passes mandrel wrap test
Low Temperature Flexibility (4 hrs. @ –55°C)	No cracking
Flammability	Self-extinguish meets UL 224 All-Tubing Flame Test (Class 1 only)

Electrical

Dielectric Strength	900 V/mil
Volume Resistivity	10^{15} ohm-cm

Chemical

Corrosive Effect	Non-corrosive
Solvent Resistance	
Tensile Strength	1000 PSI
Dielectric Strength	400 V/mil
Water Absorption	0.2%
Fungus Resistance	Non-nutrient

Technical information provided consists of typical product data and should not be used for specification purposes. Unless otherwise noted, all tests are performed at room temperature.

HOOK-UP WIRE

Featuring:

Harbour INDUSTRIES

alpha

Inventory

Three stocking locations of military and commercial spec product. Off the shelf products include discrete wire and finished cables with shield and jacket

Traceablitity

- All product goes through quality inspection and is marked with lot number
- Test data is available upon request

Supplier Support

- Partnering relationships with all suppliers to guarantee support to you, our customer

Specialized Inventory

- With partnering relationship, we will carry any special inventory you request

Standard Inventory Specifications

- MIL-W-16878
- MIL-C-24643
- MIL-C-55021
- BMS-13-48
- MIL-W 22759
- MIL-C-27500
- MIL-W-81044
- MIL-C-17
- MIL-W-47206
- MIL-C-27072
- MIL-W-81822
- MIL-W-25038

Process Input Signal Conditioner DRF-PR

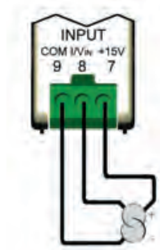
1 YEAR WARRANTY CE

- Process Signals up to 10 Vdc and up to 50 mA
- Accuracy 0.2%
- Response Time <70 mS
- Excitation Voltage for Transducers +15 Vdc (20 mA)
- Galvanic Isolation between Input, Output and Power

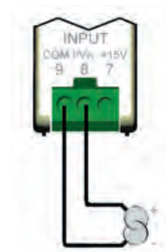
The DRF-PR signal conditioner accepts a dc process signal input and provides an isolated 0 to 10 Vdc or 4 to 20 mA output. Models are available with three different power options, 24 Vdc, 120 Vac and 240 Vac.

The DRF-PR are ideally suited for industrial applications. All models mount on a standard 35 mm DIN rail and provide galvanic isolation between input, output and power up to 3500 Veff (model specific). Module response time is 70 ms or less.

2 Wire Input



3 Wire Input



Voltage or Current Generator

DRF-PR-24VDC-0/10C-4/20, shown larger than actual size

Specifications

Accuracy: <0.2% full scale
Linearity: <0.1% full scale
Thermal Drift: 150 ppm/°C typical (max <200ppm/°C)
Response Time (DC Signal Input Models): < 70mS (90% of signal) at 20 Hz -3 dB
Input Impedance: 50‰ for 4 to 20 mA and 0 to 20 mA ranges, 20‰ for 0 to 5 mA and 0 to 50 mA ranges, 5 M‰ for ranges †1V, 1 M ‰ for ranges ‡10 V
Over Range Protection: 3.5 Vdc for 4 to 20 mA and 0 to 20 mA ranges, 2.5 Vdc for 0 to 5 mA and 0 to 50 mA ranges, 15 V for ranges ‡1 V, 150 V for ranges ‡10V
Vexc Output for Transducers: +15 Vdc ±10% (22 mA max.)

Range Code Table

Range Code	Range
0/5MA	0 to 5 mA
0/50MA	0 to 50 mA
0/20MA	0 to 20 mA
4/20MA	4 to 20 mA
0/1VDC	0 to 1 Vdc
0/10VDC	0 to 10 Vdc

AVAILABLE FOR FAST DELIVERY!

To Order *(Specify Model Number)*

Model No.		Description
DRF-PR-(*)-(**)-(***)		Signal conditioner for DC process input
CS-3790		Reference Book: McGraw-Hill Dictionary of Electrical and Computer Engineering

** Specify Power, 24 Vdc for 24 Vdc power, 115 Vac for 115 Vac power or 230 Vac for 230 Vac power*
*** Specify range code from the Input Range Table*
**** Specify output, 4/20 for 4 to 20 mA output or 0/10 for 0 to 10 Vdc output*
***Ordering Example: DRF-PR-24VDC-0/10VDC-4/20,** signal conditioner for process input with a 0 to 10 Vdc input range, 4 to 20 mA output and 24 Vdc power.*

aquaazul

LAMP ARRAY

	WAVELENGTH	BF-BF LENGTH	POWER	CURRENT	UV OUTPUT AT 254 nm		RATED LIFE		
	nm	IN	W	mA	µW/cm²	W	H		
STANDARD LAMPS									
L-1-212-N	254	8.35	10	425	26	2.7	12,000		
L-1-212-VH	185	8.35	10	425	26	2.7	12,000		
L-1-805-N	254	11.3	14	425	40	4	12,000		
L-1-915-N	185	11.3	14	425	40	4	12,000		
L-1-806-N	254	14.06	17	425	57	5.7	12,000		
L-1-809-N	185	14.06	17	425	57	5.7	12,000		
L-1-803-N	254	33.19	41	425	130	15	12,000		
L-1-807-N	185	33.19	41	425	130	15	12,000		
L-1-804-N	254	61.18	75	425	220	31	12,000		
L-1-808-N	185	61.18	75	425	220	31	12,000		
HIGH OUTPUT									
L-1-803-HO	254	33.19	87	800	260	28	12,000		
L-1-807-HO	185	33.19	87	800	260	28	12,000		
L-1-941-HO	254	61.18	155	800	380	45	12,000		
AMALGAM				A					
L-1-804-A	254	61.18	190	1.2	500	68	12,000		

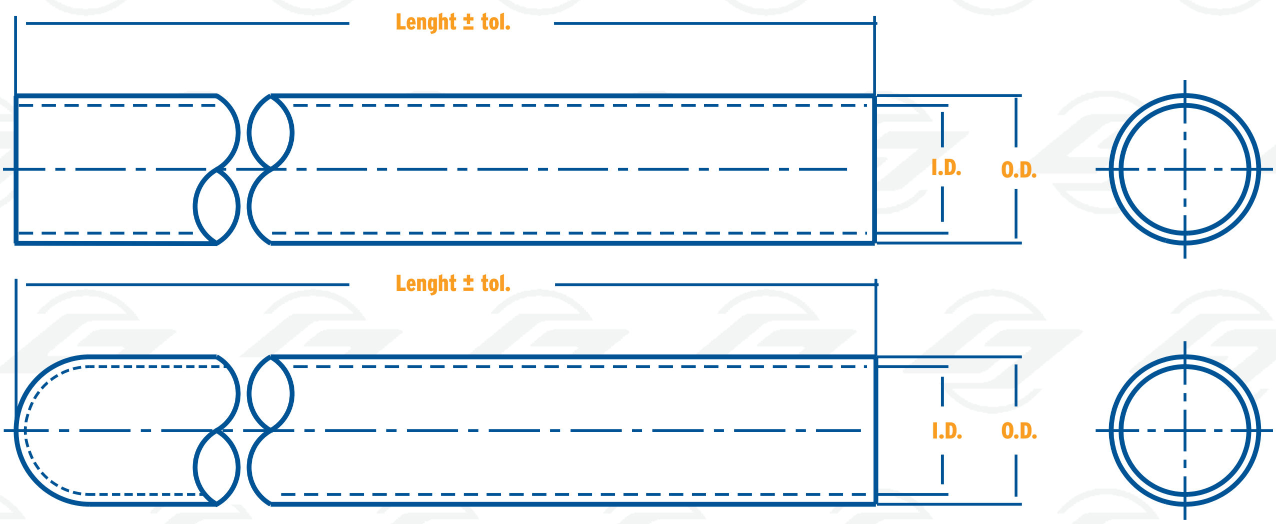
Sleeves

Quartz Sleeves

Light Sources and Lighttech make a variety of quartz sleeves, jackets, and wells in various diameters and lengths for use in water disinfection and air purifier units, photochemical reactors and other special equipment. These are available with closed or open ends, saw cut or fire polished ends, or in special shapes.

Most Commonly Used Quartz Sleeves

Inside Diameter mm	Outside Diameter mm	Wall Thickness mm	Suggested Applications
17.0	19.0	1.00	15mm O.D. Standard and High Output lamps without end caps
18.0	20.5	1.25	
19.6	22.0	1.20	
20.0	22.0	1.00	15mm O.D. Standard and High Output lamps
20.0	22.5	1.25	15mm O.D. Standard and High Output lamps
20.0	23.0	1.50	15mm O.D. Standard and High Output lamps
22.0	24.5	1.25	15mm O.D. Standard, High Output and Amalgam lamps
22.0	25.0	1.50	15mm O.D. Standard and High Output lamps
25.0	28.0	1.50	19mm O.D. Standard, High Output and Amalgam lamps
26.0	30.0	2.00	19mm O.D. Standard and High Output lamps
26.4	30.0	1.80	19mm O.D. Standard and High Output lamps
30.0	33.0	1.50	19mm O.D. Standard and High Output lamps
32.0	36.0	2.00	25mm O.D. Standard, High Output and Amalgam lamps
34.0	38.0	2.00	
35.0	38.0	1.50	
42.0	45.0	1.50	32mm O.D. Standard, High Output and Amalgam lamps
44.0	48.0	2.00	32mm O.D. Standard, High Output and Amalgam lamps
45.0	48.0	1.50	32mm O.D. Standard and High Output lamps



SPECIFICATION SHEET : WH7-120-H

This Is An Original Product From Fulham Co., Inc

Description : WorkHorse Series Versatile, Solid State Electronic Ballast. Small Case Size, High Power Factor, Light Weight, Available In 120/230/277V 50/60 Hz.

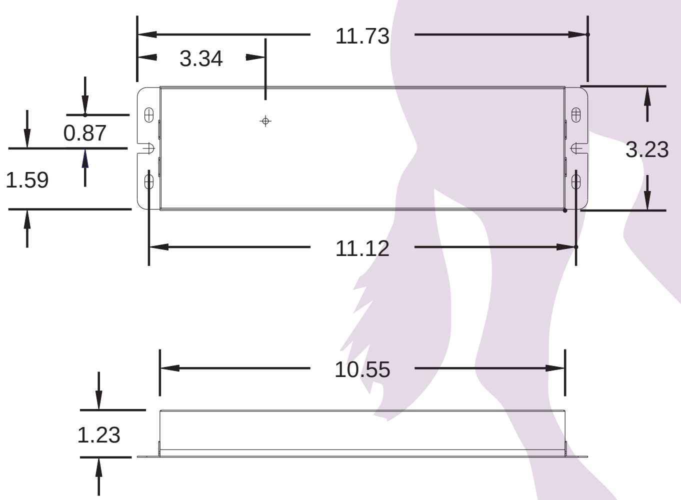
This Ballast Will Operate Following Lamps.

REFER TO LAMP LIST

ELECTRICAL DATA

INPUT VOLT: 120V ± 10%, 50/60Hz									
LAMP WATTS/TYPE	F71T12HO	F71T12HO	F71T12HO	-	-	-	-	-	-
WIRING DIAGRAM #	14	9	11						
LAMPS OPERATED	1	2	2						
INPUT WATTS	97	146	194						
LINE CURRENT:	0.88	1.32	1.75						
POWER FACTOR	0.92	0.92	0.92						
BALLAST FACTOR	0.66	0.71	0.97						
EFFICACY FACTOR	0.68	0.49	0.50						
THD	40%	38%	37%						
EMI/RFI COMPLIANCE	FCC PART 18-A (Non Consumer)								
SOUND RATING	" A "								
BALLAST TYPE	INSTANT START								
VOLTAGE TRANSIENTS	ANSI 62.41								
INPUT/PROTECTION	FUSE								
OUTPUT/PROTECTION	EOL								
MIN. OPERATING TEMP	See Lamps Spec								
MAX. CASE TEMP	70 ^{0}C (158 ^{0}F)								
ENERGY STAR 4.0									

MECHANICAL DATA



Where : L = Length, W = Width, H = Height

WIRING DIAGRAMS

WIRE	BLACK	WHITE	RED	BLUE	YELLOW	BROWN
LENGTH - INCHES	12 ± 1"	12 ± 1"	36 ± 1"	-	36 ± 1"	-

WIRING DIAGRAMS DEPENDS ON THE LAMP TYPE. PLEASE REFER TO FULHAM'S CATALOG.

NOTE : This Ballast Must Be Grounded

Fulham Co., Inc extends limited warranty only to the original purchaser or to the first user for the period of 5 years from the date of manufacture as indicated by the date code stamped on each product and when properly installed and under normal conditions of use. For additional warranty guide line, please refer to our Complete Product Catalog OR call Customer Service at 1-323-599-5000.

DUE TO A PROGRAM OF CONTINUOUS IMPROVEMENT, FULHAM Co., INC RESERVES THE RIGHT TO MAKE ANY VARIATION IN DESIGN OR CONSTRUCTION TO THE EQUIPMENT DESCRIBED.

Address : 12705 South Van Ness Ave., Hawthorne, CA 90250 Tel.: 1-323-599-5000, Fax.: 1-323-754-9060. Website: www.fulham.com

.563" Double Row Phenolic Barrier Terminal Strip

Description

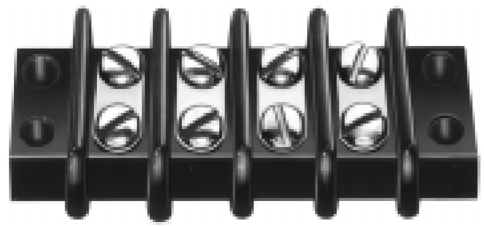
The series 21 phenolic double row terminal strip is a power product rated for 30 Amps @ 300 Volts and 150° C. The terminal block is offered in feed-thru and closed bottom designs and is available in a variety of terminal and screw styles.

The robust #8-32 screw is standard, making the product compatible with 10 AWG wire applications without the addition of wire clamps.

Made in the USA, all Beau terminal blocks embody the highest quality standards in the industry-using the finest materials and world class manufacturing processes. They meet or exceed all applicable industry standards.

Features

- **Robust and durable** #8-32 screw insures years of reliability and allows for 10 AWG wire without wire clamps.
- **Closed bottom and feed-thru** construction allows the product series to be PCB, bulkhead or panel mounted, satisfying any of your applications.
- **High temperature phenolic** insulator out performs thermoplastic compounds.
- **Wide variety of options.** Our broad range of screw, terminal, hardware and mounting options allows us to save you assembly costs and improve interconnect performance.



PRODUCT RATINGS

#8-32 BINDING HEAD SCREW

UL	Class B	30 Amps @ 300 V 10 AWG
	Class C	30 Amps @ 300 V 10 AWG
CSA	Class B	30 Amps @ 300 V 10 AWG
	Class C	30 Amps @ 300 V 10 AWG

#8-32 WIRE CLAMP SCREW

UL	Class B	30 Amps @ 300 V 10 AWG
	Class C	30 Amps @ 300 V 10 AWG
CSA	Class B	30 Amps @ 300 V 10 AWG
	Class C	30 Amps @ 300 V 10 AWG

AGENCY LISTINGS

UL	File No. E48521
	Guide No. XCFR2
CSA	File No. 025562

TECHNICAL SPECIFICATIONS

ELECTRICAL

DWV	10500 VDC
IR	>5000 Megohms

MECHANICAL

Tightening torque	16 in-lbs.
Maximum torque	18 in-lbs.
Wire strip length	5/16"
Wire range	10 to 18 AWG

ENVIRONMENTAL

Continuous Use Temp

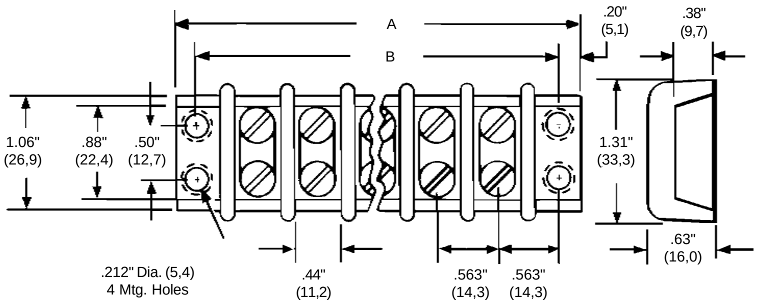
RTI electrical	150°C
RTI mechanical w/o impact	150°C

MATERIALS

Insulator	General purpose phenolic, UL94VO, black
Terminal	Brass, nickel plate
Screws	#8-32, phillips/slotted, steel, zinc chromate plate

OPTIONS

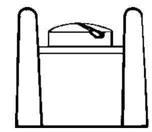
-45	Slotted screw
-45-56	Stainless steel screws, slotted
-49	Brass, phillips/slotted screw
-50	Clamp washer, phillips/slotted screw
-58	No screws, barrier only
-59	Screws supplied unassembled
-60	One row screws supplied un-assembled
-61	One row screws not supplied
-66	Bonded marker strip
-C	No mounting ends
-CB	Closed bottom



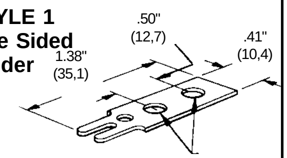
No. of Circuits	A		B	
	in.	mm	in.	mm
2	2.09	53,9	1.69	42,9
3	2.66	67,6	2.25	57,2
4	3.22	81,8	2.81	71,4
5	3.78	96,0	3.38	85,9
6	4.34	110	3.94	100
7	4.91	125	4.50	114
8	5.47	139	5.06	129
9	6.03	153	5.62	143
10	6.59	167	6.19	157
11	7.16	182	6.75	171
12	7.72	196	7.31	186
13	8.28	210	7.88	200
14	8.84	226	8.44	214
15	9.41	239	9.00	229
16	9.97	253	9.56	243
17	10.53	267	10.13	257
18	11.09	282	10.69	272
19	11.66	296	11.25	286
20	12.22	310	11.81	300
21	12.78	326	12.38	314
22	13.34	339	12.94	329
23	13.91	353	13.50	343
24	14.47	368	14.06	357
25	15.03	382	14.63	372
26	15.59	396	15.19	386

TERMINAL STYLES

STYLE 0
Screw
Terminal

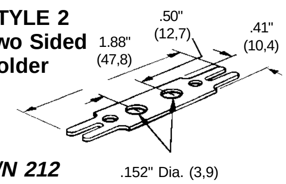


STYLE 1
One Sided
Solder



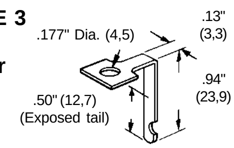
P/N 211

STYLE 2
Two Sided
Solder



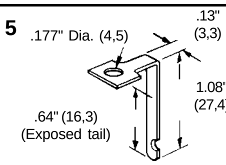
P/N 212

STYLE 3
Short
Solder



P/N 213

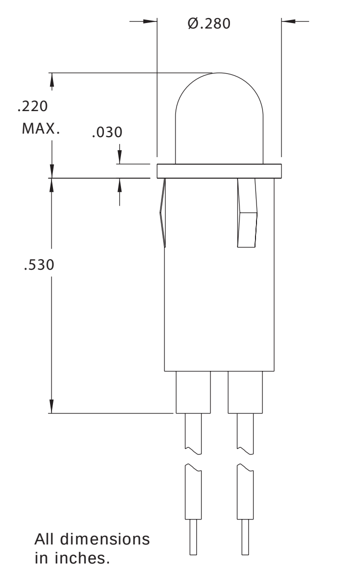
STYLE 5
Long
Solder



P/N 215

Panel Mounted LED Indicator Light with Wire Leads 1/4" Diameter Mounting Hole

DESCRIPTION AND FEATURES



Features

- •Super-Brite 30mcd
- •Low current
- •Built-in resistor chip operates directly off 5 volt or 12 volt supply without external resistor.

Mounting: Will snap-fit in Ø.249/.254 hole in panels .031/.062 thick.

Wire leads: No. 24 AWG, 6" insulated, bonded strands, stripped 1/2"

Anode(+): Red Lead

Housing: Black Nylon

Alternate LEDs are also available in this package as standard variations.

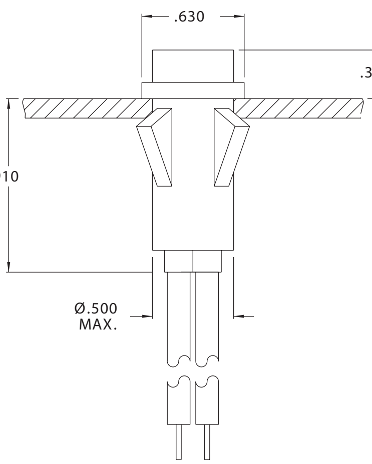
Part Number	Emitted Color	Typical Intensity (mcd)	Rated Current (mA)	Continuous Forward Current Max. (mA)	Forward Voltage Typ. (V)	Forward Voltage Max. (V)	Peak Forward Current @ 1ms-300 PPS (A)	Reverse Breakdown Voltage Min. (V)	Peak Wavelength (nm)	
5100H1	Red	30	20	35	2.0	3.0	1.0	5	635	
5100H3	Amber	20	20	35	2.0	3.0	1.0	5	608	
5100H5	Green	30	20	30	2.2	3.0	.09	5	562	
5100H6	Blue	3.0	45	50	3.4	3.9	-	5	470	
5100H7	Yellow	25	20	35	2.1	3.0	1.0	5	585	
5100H1LC	Red	2.0	2	7	1.8	2.2	.007	5	635	Low Current
5100H5LC	Green	2.5	2	7	1.8	2.2	.007	5	565	Low Current
5100H7LC	Yellow	2.0	2	7	1.9	2.7	.007	5	585	Low Current
5102H1-5V	Red	6.0	10	15	5	7.5	-	5	635	Built-In Resistor 5 Volts
5102H3-5V	Amber	7.0	10	15	5	7.5	-	5	583	Built-In Resistor 5 Volts
5102H5-5V	Green	10.0	12	15	5	7.5	-	5	565	Built-In Resistor 5 Volts
5102H1-12V	Red	4.0	13	15	12	20.0	-	5	635	Built-In Resistor 12 Volts
5102H3-12V	Amber	4.0	13	15	12	20.0	-	5	583	Built-In Resistor 12 Volts
5102H5-12V	Green	4.0	13	15	12	20.0	-	5	565	Built-In Resistor 12 Volts

Chicago Miniature Lamp reserves the right to make specification revisions that enhance the design and/or performance of the product

CHICAGO MINIATURE LAMP, INC.
WHERE INNOVATION COMES TO LIGHT

1050C, 1051C, 1052C, 1053C and 1090C Series Non-Relampable Neon-Incandescent Indicator Lights

DESCRIPTION AND FEATURES



Mounting: Will snap-fit into Ø.500/.505 hole in panels .020/.100 thick. Push-on speednut SN0461 also available.
Mounting hole pattern on page SP2.

Wire Leads: No.22 AWG (105°C) 4.40/4.80 long, stripped .430/.570

Lens: Nylon on model 1050C1, 1050C3, 1050C4, 1051C1, 1051C3, 1051C4, Polycarbonate on all other models.

Bezel: Polished stainless steel.
For black finish add "X" after the series letter(s).

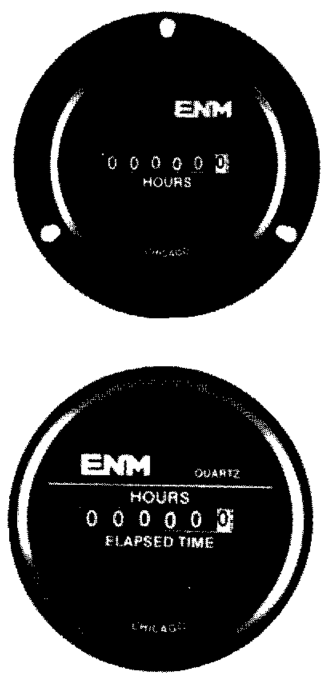
Housing: White Nylon

Lens Color	Neon		Incandescent	
	Model No. (105-125VAC)	Model No. (208-250V)	Model No. (12V)	Model No. (28V)
Red	1050C1	1051C1	1090C1-12V	1090C1-28V
Clear	1050C2	1051C2	-	-
Amber	1050C3	1051C3	1090C3-12V	1090C3-28V
White	1050C4	1051C4	1090C4-12V	1090C4-28V
Green	1052C5*	1053C5*	1090C5-12V	1090C5-28V
Lamp used	C2A+Resistor	C2A+Resistor	#2162	#2187
Lead Color	Black	One Black/One Red	Yellow	Purple

* Incorporates G2B lamp and resistor.
Underwriters Laboratories (UL) File No. E20325
Canadian Standards Association (CSA) File No. LR13346

Electronic Hour Meter — Technical Data

AC Hour Meter, Series T50 — 211



Series T50

ENM's Series T50 electronic AC hour meter is a low cost reliable hour meter incorporating the latest state-of-the-art in electonics. It's quartz-crystal time base insures accurate long term time-keeping.

A reliable electromechanical wheel-type indicator is used to store accumulated hours.

This compact tamperproof meter is sealed against the environment to provide years of service.

The T50 elapsed time indicator was designed for use on test and recording equipment, for providing maintenance control, for establishing warranty programs, for measuring machine utilization and production time, or for any application where time-in-use is to be determined.

FEATURES:

- Solid State Electronic Circuit
- Quartz-Crystal for Accurate Timing
- Absolutely Will Not Lose Count
- High Impact, Tamperproof Plastic Case
- Sealed Against Moisture and Dirt
- UL and CSA Recognized
- Indicates Operating Time in Hours and Tenths
- Frequency Insensitive Design
- With Optional Gasket,complies to NEMA 4Xand 12
- **MADE IN THE USA**

SPECIFICATIONS:

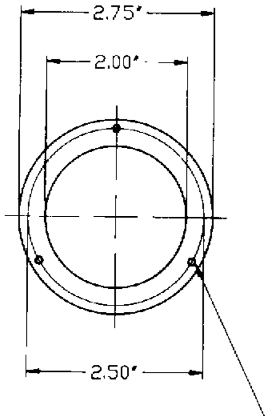
Time Scale:	6-digits 99,999.9 Hours Automatic recycle to zero
Figures:	Hours — White on black Tenths — Red on White Height — 0.140"
Operating Voltage:	230,115,24V AC+10% Other Voltage available
Frequency:	50 or 60 Hz
Power Consumption:	Less than 0.4 Watts
Accuracy:	Better than ±0.02% over entire range
Temperature:	From -30° C to 65°
Vibration Resistance:	Withstands 10 to 75 hz at 1 to 8 g's
Termination:	1/4" male blade terminals
Configuration:	Round 3-hole Bezel Round SAE Bezel with new push-on retaining ring

Series T50 AC

Dimensional Data

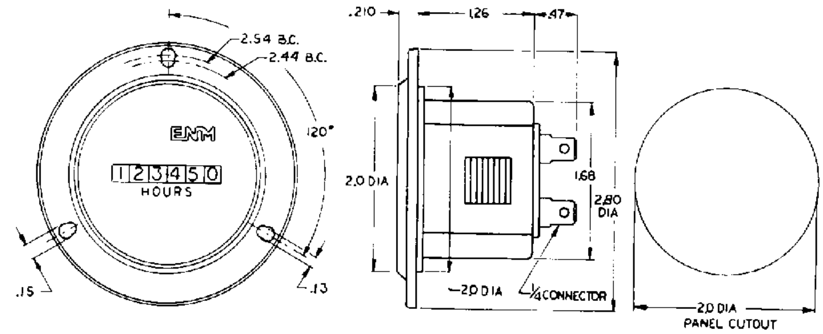
Panel Gasket
UL/NEMA 4X,12

Description	Part No.
NEMA Gasket	A40047-S
NEMA Gasket w/ Mounting Hardware	B20017

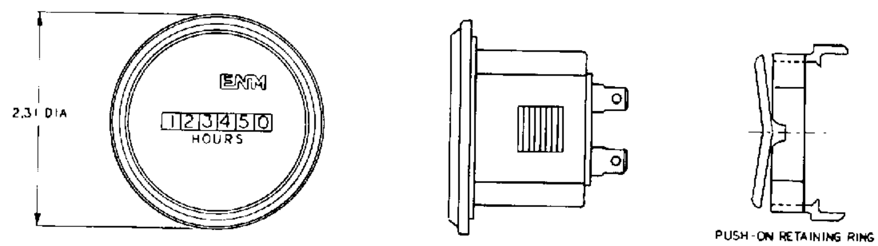


.100" Dia. undersize for #6 screw
3 Holes Equally Spaced

Round 3-Hole Bezel

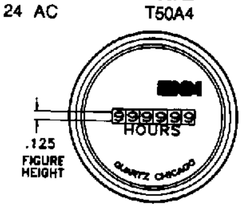


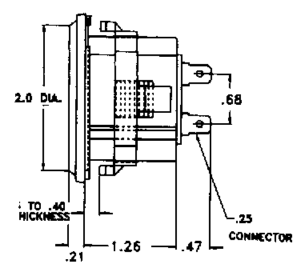
Round SAE Bezel

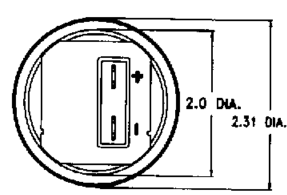


Power: Less than 0.4 Watts

Voltage	Part No.
230 AC	T50A1
115 AC	T50A2
24 AC	T50A4



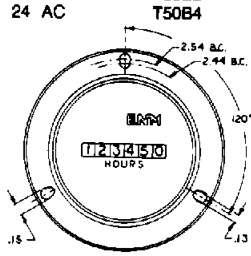


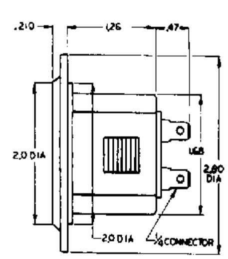


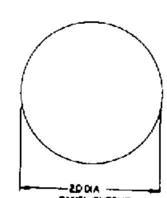
Technical Data Sheet #211

Power: Less than 0.4 Watts

Voltage	Part No.
230 AC	T50B1
115 AC	T50B2
24 AC	T50B4







Technical Data Sheet #211

Limited Warranty/Hour Meters

ENM Company hour meters are warranted to the consumer to be free from defects in material and workmanship for a period of 10,000 operating hours or for a period of 3 years, whichever first occurs.

All ENM products which fall within the warranty period due to defects in material or workmanship will be repaired or replaced, at ENM's option, without charge to the consumer when returned with proof of purchase to any authorized ENM dealer in the United States, transportation charges prepaid, provided there is no evidence of improper installation, tampering, or other abuse.

All implied warranties, including any implied warrantly of merchantability or fitness for a particular purpose, shall be limited in duration to the express warranty period specified above.

ENM disclaims any liability for consequential damages due to breach of any written or implied warranty on its hour meters.

1.5 INCH 350 SERIES EDGEWISE METER

Accuracy: 5%

Technology: DC Models, polarized-vane solenoid or moving magnet AC Models, double-vane repulsion, jeweled bearing

Description: 1.5 inch edgewise, Polystyrene cases with metal scales, white field, printed black, age and moisture resistant, install in front or behind panels, special scales, ranges and dampening available

DC Milliammeters

RANGE	PART #	RANGE	PART #
0-1 Milli Amps	3300	0-100 Milli Amps	3307
0-3 Milli Amps	3301	0-150 Milli Amps	3308
0-5 Milli Amps	3302	0-200 Milli Amps	3309
0-10 Milli Amps	3303	0-300 Milli Amps	3310
0-25 Milli Amps	3305	0-500 Milli Amps	3312
0-50 Milli Amps	3306		

DC Ammeters

RANGE	PART #	RANGE	PART #
0-1 Amps	3201	0-15 Amps	3206
0-3 Amps	3202	10-0-10 Amps	3213
0-5 Amps	3203		
0-10 Amps	3205		

DC Voltmeters

RANGE	PART #	RANGE	PART #
0-3 Volts	3102z	0-50 Volts	3122
0-5 Volts	3104z	0-100 Volts	3113z
0-10 Volts	3107z	0-150 Volts	3115z
0-15 Volts	3108z	0-300 Volts	3117z**
0-25 Volts	3109z	0-500 Volts	3118z**

AC Voltmeters

RANGE	PART #	RANGE	PART #
0-10 Volts	3403	0-300 Volts	3407**
0-15 Volts	3404	0-25 Volts	3412
0-50 Volts	3405	0-500 Volts	3414**
0-150 Volts	3406		

VU Meters

RANGE	PART #
-20 to +3 VU	3801

OTHER SPECIALTY METERS AVAILABLE:

- ***550 Series***

3.5 INCH 750 SERIES ROUND BARREL METER

Accuracy: 5%

Technology: DC Models, polarized-vane solenoid or moving magnet AC Models, double-vane repulsion, jeweled bearing

Description: 3.5 inch, Polystyrene cases with metal scales, white field, printed black, age and moisture resistant, install in front or behind panels, special scales, ranges and dampening available

DC Milliammeters

RANGE	PART #	RANGE	PART #
0-1 Milli Amps	7336z	0-100 Milli Amps	7307z
0-3 Milli Amps	7301z	0-150 Milli Amps	7308z
0-5 Milli Amps	7302z	0-200 Milli Amps	7309z
0-10 Milli Amps	7303z	0-300 Milli Amps	7310z
0-25 Milli Amps	7305z	0-500 Milli Amps	7312z
0-50 Milli Amps	7306z		

DC Ammeters

RANGE	PART #	RANGE	PART #
0-1 Amps	7201z	0-25 Amps	7207z
0-3 Amps	7202z	0-50 Amps	7208z
0-5 Amps	7203z	0-30 Amps	7209z
0-10 Amps	7205z	20-0-20 Amps	7214z
0-15 Amps	7206z	50-0-50 Amps	7216z

DC Voltmeters

RANGE	PART #	RANGE	PART #
0-3 Volts	7102z	0-50 Volts	7122z
0-5 Volts	7104z	0-100 Volts	7113z
0-10 Volts	7107z	0-150 Volts	7115z
0-15 Volts	7108z	0-300 Volts	7117z**
0-25 Volts	7109z	0-500 Volts	7118z**

AC Milliammeters

RANGE	PART #	RANGE	PART #
0-10 Milliamps	7607z	0-100 Milliamps	7603z
0-25 Milliamps	7601z	0-250 Milliamps	7604z
0-50 Milliamps	7602z	0-500 Milliamps	7605z

AC Ammeters

RANGE	PART #	RANGE	PART #
0-1 Amps	7501z	0-10 Amps	7504z
0-5 Amps	7503z	0-30 Amps	7505z
0-5/0-50 Amps•	7503z-50	0-50 Amps	7506z
0-5/0-100 Amps•	7503z-100	0-80 Amps	7507z
0-5/0-150 Amps•	7503z-150	0-15 Amps	7508z
0-5/0-200 Amps•	7503z-200		
0-5/0-250 Amps•	7503z-250		
0-5/0-300 Amps•	7503z-300		
0-5/0-400 Amps•	7503z-400		
0-5/0-600 Amps•	7503z-600		

AC Voltmeters

RANGE	PART #	RANGE	PART #
0-10 Volts	7403z	0-300 Volts	7407z**
0-15 Volts	7404z	0-500 Volts	7414z**
0-25 Volts	7412z		
0-50 Volts	7405z		
0-150 Volts	7406z		

VU Meters

RANGE	PART #
-20 to +3 VU	7801z

2.5 INCH 850 SERIES ROUND BARREL METER

Accuracy: 5%

Technology: DC Models, polarized-vane solenoid or moving magnet AC Models, double-vane repulsion, jeweled bearing

Description: 2.5 inch, Polystyrene cases with metal scales, white field, printed black, age and moisture resistant, install in front or behind panels, special scales, ranges and dampening available

DC Milliammeters

RANGE	PART #	RANGE	PART #
0-1 Milli Amps	8336z	0-50 Milli Amps	8306z
0-3 Milli Amps	8301z	0-100 Milli Amps	8307z
0-5 Milli Amps	8302z	0-150 Milli Amps	8308z
0-10 Milli Amps	8303z	0-200 Milli Amps	8309z
0-15 Milli Amps	8304z	0-300 Milli Amps	8310z
0-25 Milli Amps	8305z	0-500 Milli Amps	8312z

DC Ammeters

RANGE	PART #	RANGE	PART #
0-1 Amps	8201z	0-25 Amps	8207z
0-3 Amps	8202z	0-50 Amps	8208z
0-5 Amps	8203z	10-0-10 Amps	8213z
0-10 Amps	8205z	20-0-20 Amps	8214z
0-15 Amps	8206z	30-0-30 Amps	8215z
0-20 Amps	8204z	50-0-50 Amps	8216z

DC Voltmeters

RANGE	PART #	RANGE	PART #
0-3 Volts	8102z	0-50 Volts	8122z
0-5 Volts	8104z	0-100 Volts	8113z
0-10 Volts	8107z	0-150 Volts	8115z
0-15 Volts	8108z	0-300 Volts	8117z
0-25 Volts	8109z	0-500 Volts	8118z**
0-30 Volts	8120z		

AC Milliammeters

RANGE	PART #	RANGE	PART #
0-10 Milliamps	8607z	0-100 Milliamps	8603z
0-25 Milliamps	8601z	0-250 Milliamps	8604z
0-50 Milliamps	8602z	0-500 Milliamps	8605z

AC Ammeters

RANGE	PART #	RANGE	PART #
0-1 Amps	8501z	0-5/0-150 Amps•	8503z-150
0-3 Amps	8502z	0-5/0-200 Amps•	8503z-200
0-5 Amps	8503z	0-10 Amps	8504z
0-15 Amps	8508z	0-30 Amps	8505z
0-5/0-30 Amps•	8503z-30	0-50 Amps	8506z
0-5/0-50 Amps•	8503z-50	0-80 Amps	8507z
0-5/0-100 Amps•	8503z-100		

AC Voltmeters

RANGE	PART #	RANGE	PART #
0-10 Volts	8403z	0-150 Volts	8406z
0-15 Volts	8404z	0-300 Volts	8407z**
0-25 Volts	8412z	0-500 Volts	8414z**
0-50 Volts	8405z		

VU Meters

RANGE	PART #
-20 to +3 VU	8801z

* *REMOVE "Z" SUFFIX FROM PART NUMBER TO ORDER WITHOUT ZERO ADJUST.*
** *SUPPLIED WITH EXTERNAL RESISTOR*

Littelfuse®

Axial Lead and Cartridge Fuses

Class CC* Fast-Acting & Slo-Blo® Type Fuses CCMR Series

Fast-acting KLKR fuses provide fast-acting protection to equipment containing surge sensitive components. Use KLKR fuses for non-inductive loads not requiring time delay. CCMR fuses (formerly KLMR) are specifically designed to withstand sustained starting currents of small motors. The CCMR fuses provide short-circuit protection for motor branch-circuits. KLDR fuses are specifically designed to withstand the momentary high magnetizing currents of control transformers, solenoids, and similar inductive loads.

ELECTRICAL CHARACTERISTICS:

% of Ampere Rating	Ampere Rating	Opening Time
110%	1/10–30	15 minutes, **Min**imum
135%	1/10–30	1 hour, **Max**imum

AGENCY APPROVALS: DC ratings are self-certified. KLKR Series: UL listed Fast-Acting Class CC per UL 248 and CSA Certified. KLDR, **CCMR Series:** UL listed Time-Delay Class CC per UL 248 and CSA Certified.
*CCMR 35-60A UL Listed Time-Delay Class CD.

INTERRUPTING RATING:
AC: 200,000 ampere
DC: 20,000 amperes

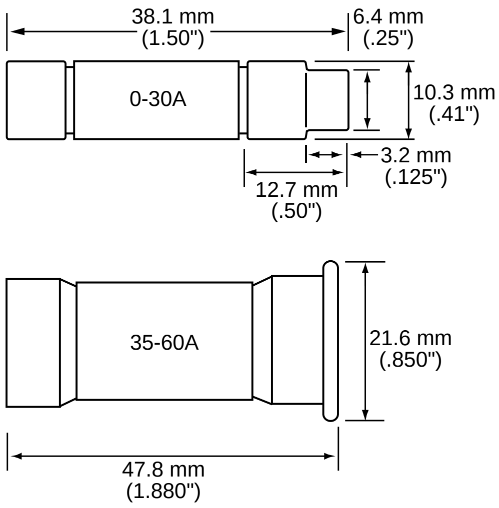
AGENCY FILE NUMBERS: UL E81895, CSA LR 29862.

VOLTAGE RATINGS:
AC: 600 Volts
DC: 250 Volts (CCMR 2/10 – 2A)
(CCMR 4 1/2 – 10A)
(CCMR 35 – 60A)
300 Volts (CCMR 2 1/4 – 4A)
300 Volts (KLDR)
300 Volts (KLKR)

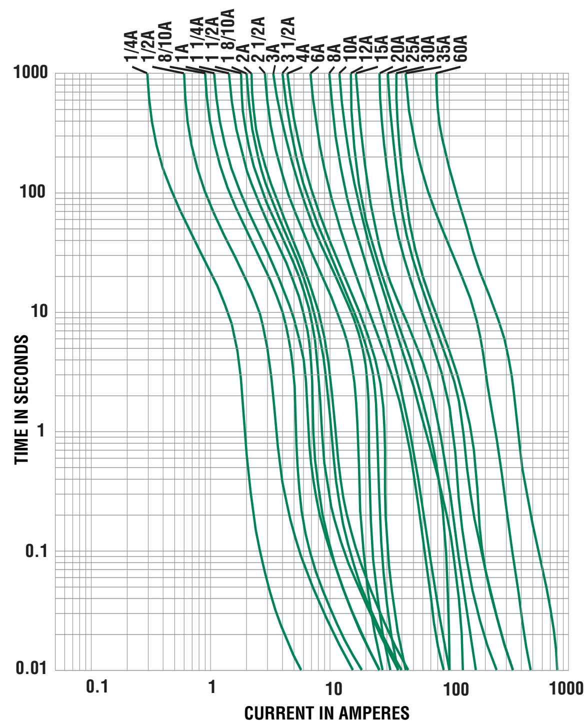
ORDERING INFORMATION:

Ampere Rating	Catalog Number	Nominal Resistance Cold Ohms	Catalog Number	Nominal Resistance Cold Ohms	Catalog Number	Nominal Resistance Cold Ohms
1/10	–	–	**KLDR**.100	246	**KLKR**.100	79.33
1/8	–	–	**KLDR**.125	134.9	**KLKR**.125	56.52
15/100	–	–	**KLDR**.150	96	–	–
3/16	–	–	**KLDR**.187	66.4	–	–
2/10	**CCMR**.200	68.4	**KLDR**.200	57.8	**KLKR**.200	28.21
1/4	**CCMR**.250	43.3	**KLDR**.250	31.61	**KLKR**.250	19.22
3/10	**CCMR**.300	28.6	**KLDR**.300	25.5	**KLKR**.300	15.10
4/10	–	–	**KLDR**.400	13.6	–	–
1/2	**CCMR**.500	7.62	**KLDR**.500	15.9	**KLKR**.500	6.95
6/10	**CCMR**.600	8.2	**KLDR**.600	9.99	–	–
3/4	–	–	**KLDR**.750	6.08	**KLKR**.750	3.581
8/10	**CCMR**.800	4.013	**KLDR**.800	6.2	–	–
1	**CCMR** 001.	2.59	**KLDR** 001.	4.0	**KLKR** 001.	.2342
1 1/8	–	–	**KLDR** 1.12	2.94	–	–
1 1/4	**CCMR** 1.25	1.687	**KLDR** 1.25	2.33	–	–
1 4/10	**CCMR** 01.4	1.33	**KLDR** 01.4	1.5	–	–
1 1/2	**CCMR** 01.5	1.24	**KLDR** 01.5	.898	**KLKR** 01.5	.225
1 6/10	**CCMR** 01.6	.9894	**KLDR** 01.6	.625	–	–
1 8/10	**CCMR** 01.8	.7783	**KLDR** 01.8	.486	–	–
2	**CCMR** 002.	.485	**KLDR** 002.	.55	**KLKR** 002.	.135
2 1/4	**CCMR** 2.25	.4166	**KLDR** 2.25	.52	–	–
2 1/2	**CCMR** 02.5	.3375	**KLDR** 02.5	.333	**KLKR** 02.5	.0906
2 8/10	**CCMR** 02.8	.2400	**KLDR** 02.8	.26	–	–
3	**CCMR** 003.	.2188	**KLDR** 003.	.21	**KLKR** 003.	.0776
3 2/10	**CCMR** 03.2	.1855	**KLDR** 03.2	.171	–	–
3 1/2	**CCMR** 03.5	.1346	**KLDR** 03.5	.239	**KLKR** 03.5	.0562
4	**CCMR** 004.	.1231	**KLDR** 004.	.118	**KLKR** 004.	.0468
4 1/2	**CCMR** 04.5	.093	**KLDR** 04.5	.082	–	–
5	**CCMR** 005.	.0704	**KLDR** 005.	.0399	**KLKR** 005.	.0332
5 6/10	**CCMR** 05.6	.0535	**KLDR** 05.6	.0334	–	–
6	**CCMR** 006.	.0517	**KLDR** 006.	.0315	**KLKR** 006.	.0238
6 1/4	**CCMR** 6.25	.0464	**KLDR** 6.25	.03	–	–
7	**CCMR** 007.	.0369	**KLDR** 007.	.0253	**KLKR** 007.	.0208
7 1/2	**CCMR** 07.5	.027	**KLDR** 07.5	.0205	–	–
8	**CCMR** 008.	.023	**KLDR** 008.	.0193	**KLKR** 008.	.0177
9	**CCMR** 009.	.0193	**KLDR** 009.	.0155	**KLKR** 009.	.0151
10	**CCMR** 010.	.0133	**KLDR** 010.	.0122	**KLKR** 010.	.01325
12	**CCMR** 012.	.0114	**KLDR** 012.	.0114	**KLKR** 012.	.00852
15	**CCMR** 015.	.00708	**KLDR** 015.	.00708	**KLKR** 015.	.0074
17 1/2	**CCMR** 17.5	.00495	**KLDR** 17.5	.00495	–	–
20	**CCMR** 020.	.00360	**KLDR** 020.	.0036	**KLKR** 020.	.00511
25	**CCMR** 025.	.00250	**KLDR** 025.	.0025	**KLKR** 025.	.003775
30	**CCMR** 030.	.00240	**KLDR** 030.	.0024	**KLKR** 030.	.002954
35	**CCMR** 035.	.00426	–	–	–	–
40	**CCMR** 040.	.00286	–	–	–	–
45	**CCMR** 045.	.00246	–	–	–	–
50	**CCMR** 050.	.00182	–	–	–	–
60	**CCMR** 060.	.00118	–	–	–	–

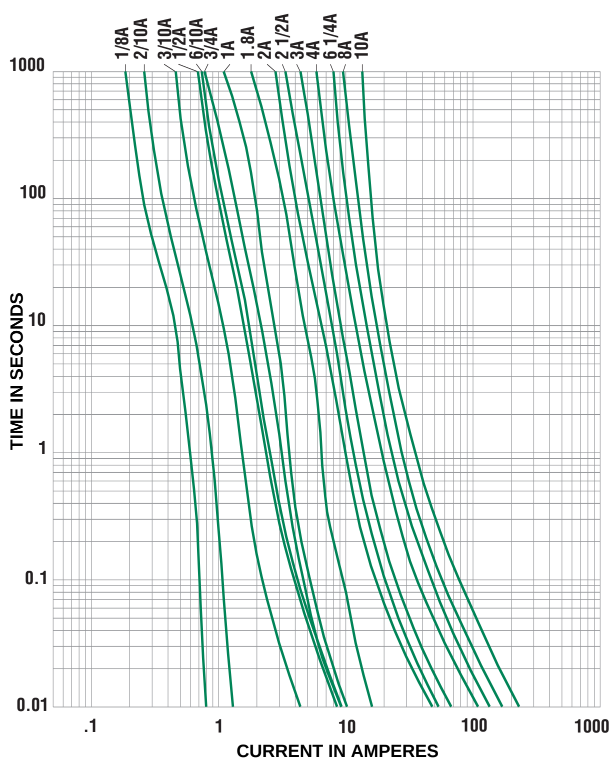
Class CC Fast-Acting & Slo-Blo® Type Fuses



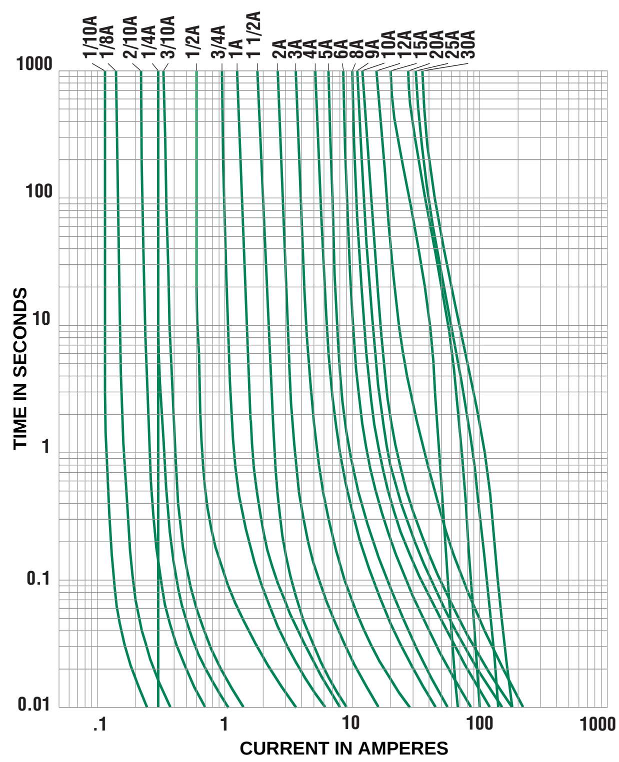
Average Time Current Curve (CCMR)



Average Time Current Curve (KLDR)



Average Time Current Curve (KLKR)



Class CC Fuseblocks

600 Volt, 30 Amps

BC Series

Catalog Symbol: BC Series

Class CC Fuseblocks

For use with Class CC Fuses (Bussmann LP-CC, KTK-R, and FRQ-R)

Ampere Rating: 1⁄10 to 30A

Voltage Rating: 600V

Withstand Rating: 200,000A RMS Sym.

Agency Information:

UL Listed, UL 512, Guide IZLT, File E14853

CSA Certified, C22.2 No. 39, Class 6225-01, File 47235

UL Flammability: 94VO

Materials: Base - Thermoplastic

Clips - Bright tin-plated bronze

DIN-RAIL Adapters: DRA-1 and DRA-2

Catalog Data

		Terminal Type				
Amps	Poles	Screw	Screw with Quick Connect*	Pressure Plate	Pressure Plate w/ Quick Connect*	Box Lug
1⁄10	1	BC6031S	BC6031SQ	BC6031P	BC6031PQ	BC6031B
to	2	BC6032S	BC6032SQ	BC6032P	BC6032PQ	BC6032B
30	3	BC6033S	BC6033SQ	BC6033P	BC6033PQ	BC6033B

Wire Range CU Only

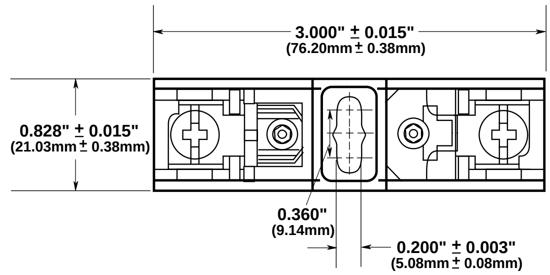
#10-#14 | #10-#14 | #10-#14 | #10-#14 | #6-#14

* QUICK CONNECT RATED FOR 20A MAXIMUM.

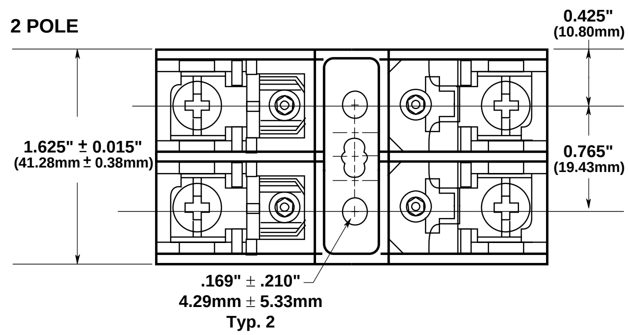
CE logo denotes compliance with European Union Low Voltage Directive (50-1000 Vac, 75-1500 Vdc). Refer to Data Sheet: 8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

Dimensional Data

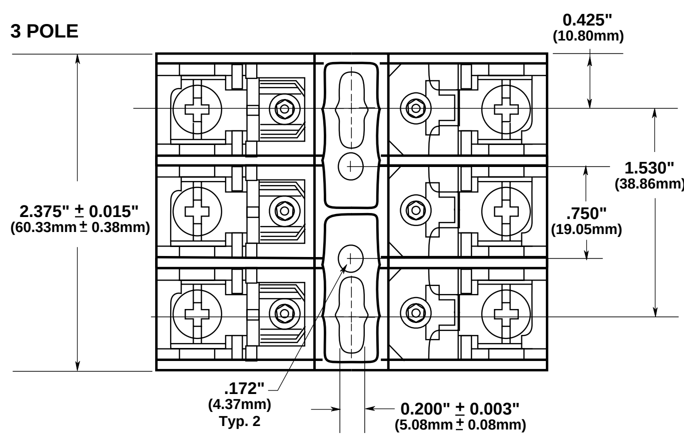
1 POLE



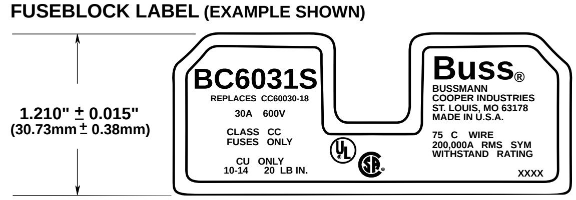
2 POLE



3 POLE

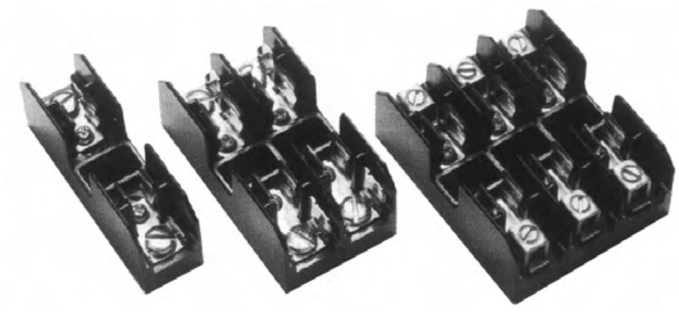


FUSEBLOCK LABEL (EXAMPLE SHOWN)



Supplementary Fuseblocks
Type M, For 13⁄32″ × 1½″ Fuses
600 Volt, 30 Amps

BM Series



Catalog Symbol: BM Series

Type M Supplementary Fuseblocks

For use with any 13⁄32″ × 1½″ Fuses

(Bussmann KTK, FNQ, FNM, BAF, BAN and AGU)

Ampere Rating: 1⁄10 to 30A

Voltage Rating: 600V

Withstand Rating: 10,000A RMS Sym. or interrupting rating of the fuse used, whichever is lower.

Agency Information:

UL Recognized, UL 512, Guide IZLT2, File E14853

CSA Certified, C22.2 No. 39, Class 6225-01, File 47235

UL Flammability: 94VO

Material: Thermoplastic

DIN-RAIL Adapters: DRA-1 and DRA-2

Catalog Data

		Terminal Type			
Amps	Poles	Screw with Quick Connect*	Pressure Plate w/ Quick Connect*	Box Lug	Fig. No.
1⁄10	1	BM6031SQ	BM6031PQ	BM6031B	1
to	2	BM6032SQ	BM6032PQ	BM6032B	2
30	3	BM6033SQ	BM6033PQ	BM6033B	3

Wire Range CU Only

#10-#14

#10-#14

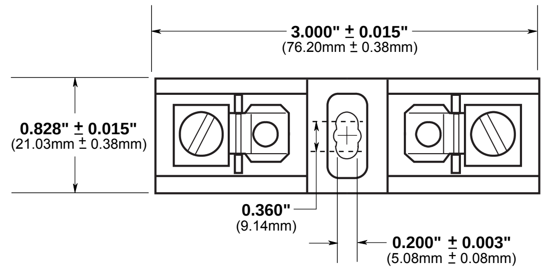
#6-#14

* QUICK CONNECT RATED FOR 20A MAXIMUM.

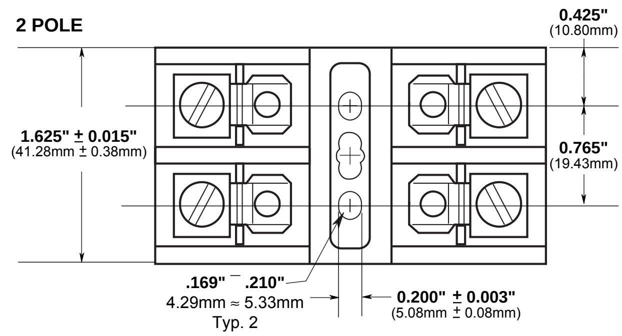
CE logo denotes compliance with European Union Low Voltage Directive (50-1000 Vac, 75-1500 Vdc). Refer to Data Sheet: 8002 or contact Bussmann Application Engineering at 636-527-1270 for more information.

Dimensional Data All dimensions (±0.015)

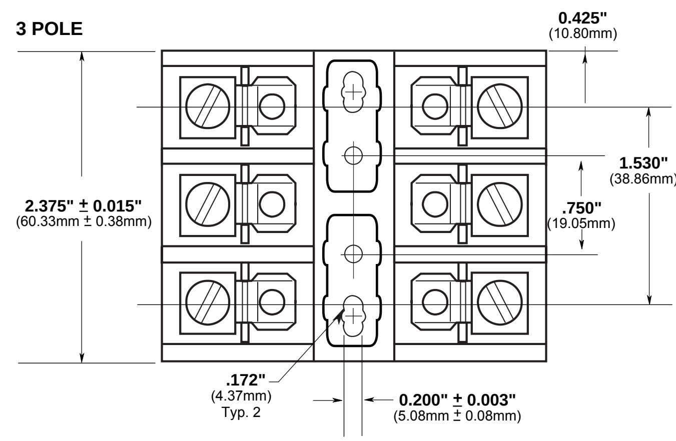
1 POLE



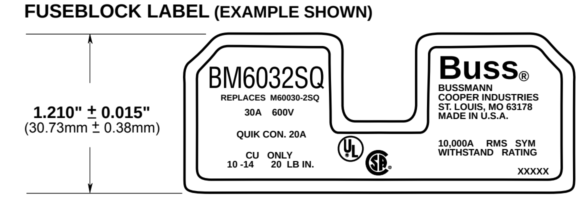
2 POLE



3 POLE



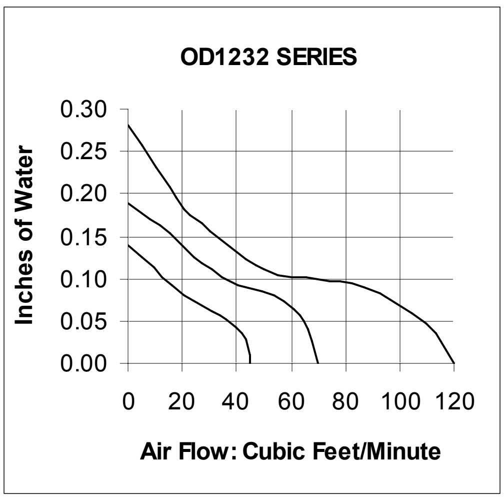
FUSEBLOCK LABEL (EXAMPLE SHOWN)

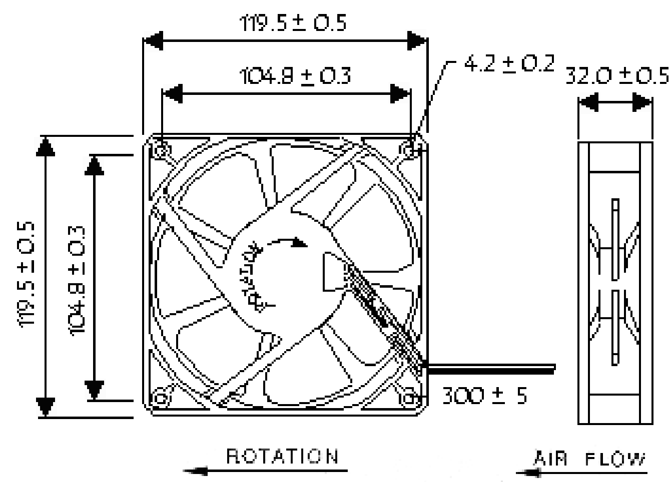


RIGEL SERIES

4.72 x 1.25
(120 x 32mm)
Ball Bearing
(Use Fan Guard G109-15A)

Motor	Brushless DC, auto restart impedance & polarity protected
Impeller & Frame	Glass reinforced thermoplastic, PBT, UL94V-0 or Diecast Aluminum
Bearing System	Two Ball or Sleeve
Insulation Resistance	Min. 10 M at DC 500V
Dielectric Strength	500VAC/1 sec. max. leakage 500 micro amp.
Operating Temperature	Ball bearing -20 C~+80 C Sleeve Bearing -10 C~50 C
Life Expectancy	Ball bearing 70,000 hours at 60 C Sleeve bearing 30,000 hours at 45 C
Safety Approvals	UL, CUL, T V





Model Number	Speed (RPM)	Max CFM	Noise (dB)	Volts (VDC)	Voltage Range	Current (Amp)	Max. Static Pressure Inches
OD1232-12H ( )	3550	120	43	12	7 ~ 17	.80	.28
OD1232-12M ( )	2600	70	35	12	7 ~ 17	.40	.19
OD1232-12L ( )	1800	45	25	12	7 ~ 17	.20	.14
OD1232-24H ( )	3550	120	43	24	10 ~ 29	.40	.30
OD1232-24M ( )	2600	70	35	24	10 ~ 29	.19	.19
OD1232-24L ( )	1800	45	25	24	10 ~ 29	.15	.15
OD1232-48H ( )	3550	120	48	48	18 ~ 53	.23	.42
OD1232-48M ( )	2600	70	35	48	18 ~ 53	.08	.19
OD1232-48L ( )	1800	45	25	48	18 ~ 53	.07	.15

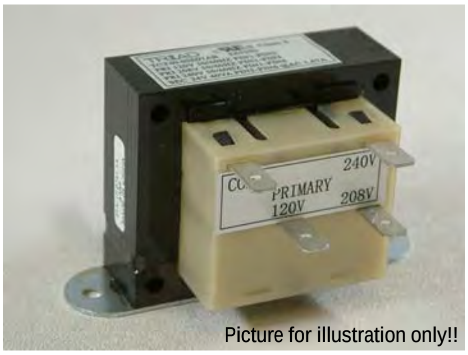
( ) Indicate (B) Ball or (S) Sleeve

The OD1232 Series is available with Tach or alarm output, thermal control and / or PWM input by special order. Minimums may apply.

Control Transformer
Class 2

TCT40-06E07AB

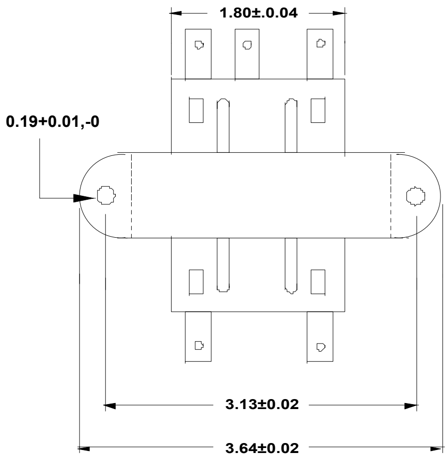
Description:
Triad control transformers come with tamper resistant shrouds for safety and a steel bracket welded to the bottom of the transformer for ease of mounting. These transformers are design and have the safety agency recognition for application where a Class 2 transformer is necessary. Some of the applications would include, but not limited to HVAC, Control boards, Lighting, etc.



Picture for illustration only!!

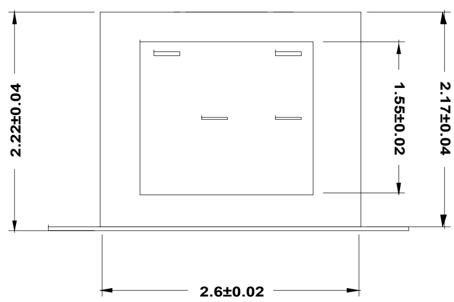
Electrical Specifications (@25C):
1. Maximum Power: 40VA
2. *Input: 120V, 50/60 Hz
   240V, 50/60Hz
3. Output: 24V @ 1.67Amps
4. Voltage Regulation: 15% TYP @ full load to no load
5. Temperature Rise: <40°C TYP
6. Hipot: 1500VAC – Input to Output, Input & Output to Core
7. Inherently Limited. No fusing required.

* Only one input voltage to be applied to primary at any time.



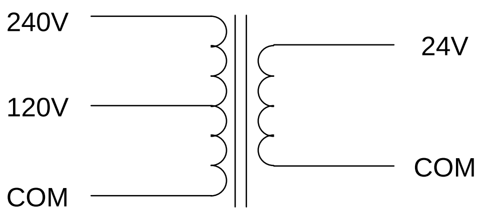
Construction:
Three flange bobbin construction with primaries and secondaries wound side by side for low capacitive coupling. Unit weight is 1.5lbs.

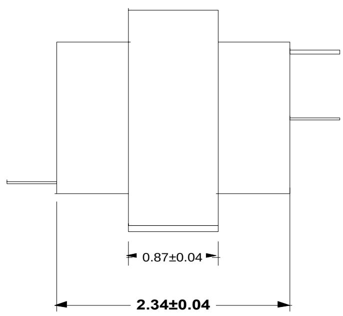
Agency File:
UL: File E65390, UL 5085-3 (1585), Class 2 Transformer
cUL: File E65390, UL 5085-3 (1585) For Canadian Use (CSA 22.2, No.66.3-06)



Connections:
Input: Quick Disconnect tabs, 0.5 x 0.25 x 0.032
Output: Quick Disconnect tabs, 0.5 x 0.25 x 0.032

Schematic:





RoHS Compliance:
As of manufacturing date February 2005, all standard products meet the requirements of 2002/95/EC, known as the RoHS initiative.

As of April 7, 2008, UL standards 506 and 1585 will be migrated to UL 5085-2 and 5085-3, respectively.

* Upon printing, this document is considered "uncontrolled". Please contact Triad Magnetics' website for the most current version.

Publish Date: July 21, 2008

OWNERS MANUAL

ULTRAVIOLET DISINFECTION SYSTEM
MODEL IVM-15-HO-WM

2013

aquaazul

MANUFACTURERS OF ULTRAVIOLET STERILIZERS

13701 6TH STREET STE C1 • ARMONA, CA. 93202
P.O. BOX 337 • ARMONA, CA. 93202
Phone: 559-589-1430 • Fax: 559-589-1185
www.aquaazul.com

aquaazul

Installation, Operation, and Maintenance for aquaazul Ultraviolet Disinfection Systems

It is important that those responsible for installation of this equipment, as well as the owner/operator, read this manual and carefully follow the instructions and guidelines.

TABLE OF CONTENTS

PLEASE RECORD THE INFORMATION PRINTED ON YOUR PURIFIER'S LABEL IN THE SPACE PROVIDED BELOW:

MODEL NUMBER: IVM-15-HO-WM

SERIAL NUMBER: A-

QUARTZ SLEEVE NO: Q-8-245

ULTRAVIOLET LAMP NO: L-1-803-HO-N

BALLAST NO: B-1-431-WH7-120

POWER IN: 120

HERTZ: 50-60Hz

DATE:

DEALERSHIP PURCHASED AT:

1. BEFORE INSTALLATION

Your Aqua Azul purifier has been thoroughly hydrostatically and electrically tested at the factory. It will give you years of trouble-free service provided these simple instructions are followed.

Check purifier and components --Each lamp and quartz jacket is wrapped and packaged separately to avoid breakage. Handle only with clean gloves.

Incoming water quality --Check the physical and chemical quality of the water to be sure transmission is acceptable for ultraviolet penetration. Each model is rated for several flow rates based on the water transmissions. A pre-filter is recommended on all water supplies.

Location of unit --The purifier should normally be installed horizontally, using the brackets provided. Clearance on the head end should be a few inches more than the overall length of the chamber. This allows room for re-lamping and removal of quartz jackets. The purifier should be located as close as possible to the point of use, or prior to all branches that need disinfecting. It should be protected from dust, heat and freezing. If an electrical plug connection is supplied, do not remove the ground prong. In wet areas, run a separate ground wire from the chamber or power supply to earth ground.

2.GENERAL INSTRUCTIONS

Read the instructions carefully --If you have any questions, consult your nearest service center or the factory. Never look at a lighted ultraviolet lamp; it can be harmful to the eyes.

Check Purifier and Components -- The inlet is normally closest to the chamber head nearest the electrical junction box. A pressure compensated flow control regulator is recommended. The flow control is installed on the outlet. If a normally closed solenoid shutoff valve is used, it is installed on the inlet of the purifier. Both the flow regulator and solenoid valve are directional; therefore, they must be positioned according to the "in" and "out" marked on the body.

Inlet and outlet manual shutoff valves should be installed, and Teflon tape should be used on all threaded connections for a good seal. Bypass around the unit is not recommended. A typical installation should be through the inlet valve, through the solenoid valve to the purifier chamber, and out through the flow control valve and outlet valve into the service line.

After the purifier has been secured and the piping connected, install the quartz jackets which are normally packed separately. Remove the quartz from the packing, using care not to get it dirty or marked with fingerprints. Unscrew the quartz nipple in the purifier head and remove the stainless steel washer and O-ring over the end of the quartz jacket approx 1/2". For purifiers with 3 ft. and 5 ft. chambers, a 3/4" diameter wooden dowel 6" to 12" longer than the quartz jacket can be a handy tool to assist as a guide in installing the quartz. (See **Figure A**). If the quartz jacket is closed at one end, wet that end first. Then slowly and carefully push the quartz straight through the head and wiper assembly (if supplied) until it sticks out approx. 5/8". Then slide on the stainless steel washer over the protruding end of the quartz jacket until it stops on the O-ring seal. (See **Figures B** & **C** below.)

QUARTZ FITTING ILLUSTRATION FOR JACKETS WITH ONE END OPEN AND OTHER CLOSED:

Figure A

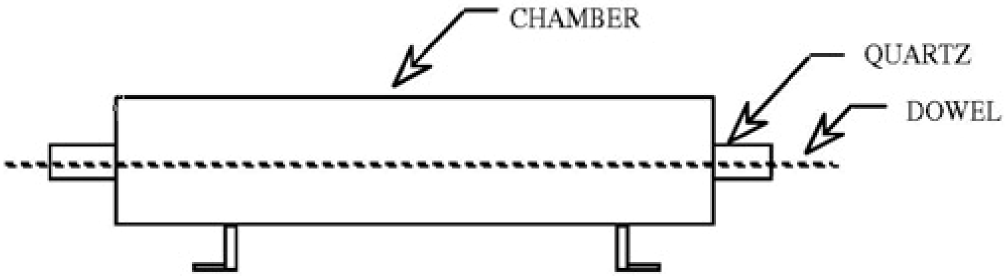
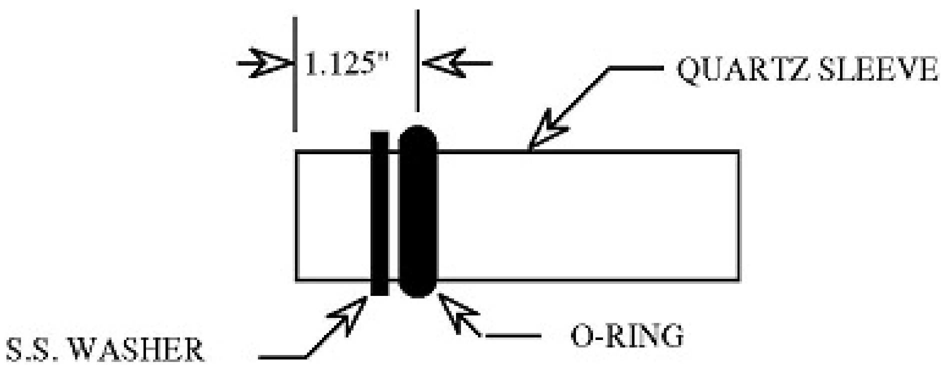
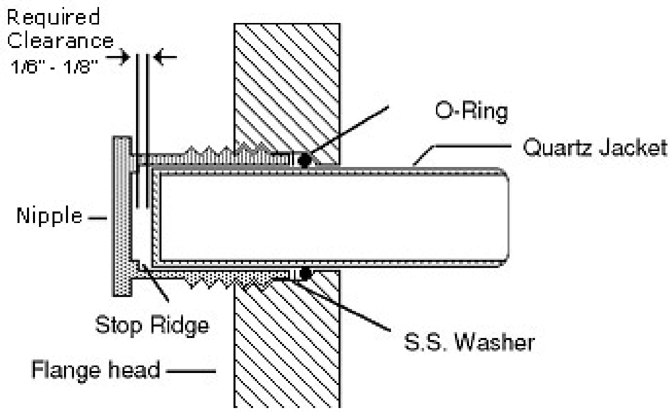


Figure B



INSTALLING QUARTZ NIPPLE OVER QUARTZ JACKET:

Figure C



Quartz jackets with both ends open disregard the 0.125 dimensions required in the illustration above. Space quartz jackets evenly between both quartz nipples at each end of the purifier head before final tightening

---

Be very careful when installing the quartz nipple over the quartz jacket. The quartz nipple should be assembled with care. Make sure that the end of the quartz jacket will clear the stop ridge machined into the inside of the quartz nipple. (See Quartz Fitting Illustration above.) Tighten the quartz nipple by hand. **NEVER USE PLIERS OR CHANNEL LOCKS.** The use of a tool may cause possible damage to the quartz jacket. The quartz nipple seal is designed to be tightened by hand only. Some quartz jackets have been hydrostatically tested to over 600 PSI without leaking.

To pressurize the purifier, open the outlet valve on the purifier and on spigot. Slowly open the inlet valve and flush all the air, then close the spigot. On remote power models, the inlet solenoid valve will have to be hot wired to allow solenoid to remain open.

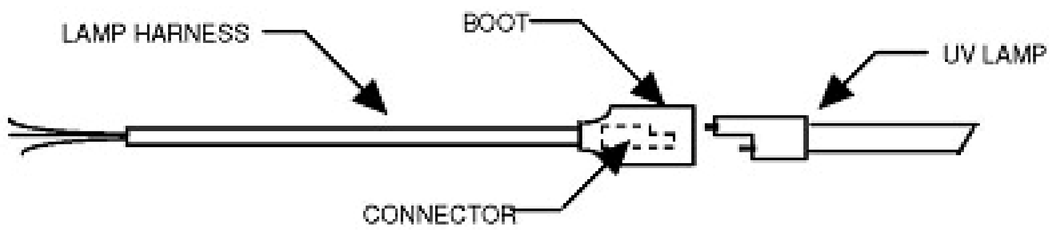
For models with UV monitor, install the monitor sensor in the sight port located on the chamber. On remote power box models plug the monitor into the power outlet or the junction box.

Slowly pressurize the purifier, and check the quartz nipples for leaks. If there is a small leak, do not tighten the quartz nipple if the edge of the quartz jacket is against the quartz nipple stop ridge. (See quartz fitting illustration). Depressurize the purifier and unscrew the leaking nipple. Inspect the end of the quartz jacket and the O-ring for possible damage. Then carefully reinstall the O-ring, stainless steel washer and quartz nipple, and tighten. If your purifier is supplied with quartz jackets with only one open end, then gently push the quartz jacket 1/8" to 1/4" farther into the purifier chamber. This will allow proper clearance for the quartz nipple stop ridge when reassembled into the purifier head. By hand, tighten the quartz nipple, re-pressurize the purifier and check again for leaks.

Straighten the UV lamp Wiring Harness. (See **Figure D**.) Install each UV lamp in the quartz jacket. Slide in carefully. Push on the lamp all the way in. Be sure there are no marks or fingerprints on the UV lamp. Clean with denatured alcohol and cotton, if necessary.

ULTRAVIOLET LAMP WIRING HARNESS:

<u>Figure D</u>



After the purifier has been pressurized and any leaks corrected, shut off the inlet valve, then outlet valve, and drain the chamber. Remove the monitor sensor and reinstall the drain plug. Fill the chamber with chlorine or other disinfectant. Reinstall the monitor in the port. Open the spigots downstream and open the outlet manual valve and then slowly open the inlet manual valve. This forces the disinfectant into the service lines. Shut off the water inlet and the spigots. Wait 30 seconds, then open and flush.

Restore the system to normal by plugging the solenoid valve cord into solenoid outlet, if provided. (On remote power boxes, rewire according to print.) Your purifier is now complete and ready for operation.

Reconnect power to the UV monitor and turn on the system.

If the UV energy dosage, as measured by the monitor, falls below the U.S. Department of Health Standard, the solenoid valve will close, and UV monitors with audible alarm will sound. No impure water can enter the service line when the monitor is in the failure mode, See Table II, Troubleshooting Guide.

Complete the Warranty Registration Card and mail to the factory.

Keep the quartz jacket(s) clean --If the quartz jacket becomes coated, the bacteria-killing strength of the ultraviolet lamps are reduced and the purifier will have to be disassembled and the quartz jacket(s) cleaned by hand.

GENERAL MAINTENANCE

If your purifier is equipped with a Manual Wiper System, the wiper should be operated regularly to keep the Quartz Sleeve clean and the ultraviolet intensity at its peak. The quality of the water flowing through the purifier will determine the frequency at which the Manual Wiper System should be operated. Weekly cleaning may be sufficient for most potable water, but color turbidity and iron are factors in some water supplies. In this situation, daily cleaning may be necessary.

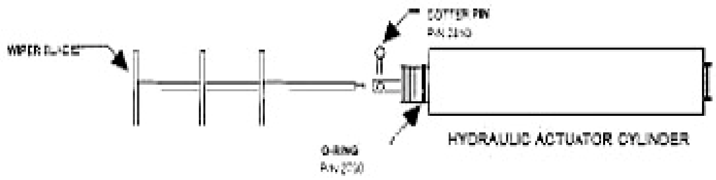
MANUAL WIPER ASSEMBLY:

Figure E

Models with Fully Automatic Wiper Systems have a pressure-driven hydraulic cylinder installed, which drives the Quartz Sleeve Wiper Assembly (50 PSI to 100 PSI air pressure). The timer is pre-set at the factory, normally for the 12-hour cycle; however, it can also be factory-set for either the 6-hour or the 3-hour cycle for water or other liquids with low transmission. (Consult the factory for further details.)

A hose should be run to a floor drain for cylinder exhaust if water is used to pressure the hydraulic cylinder. Connect the four-way solenoid valve, with ¼" copper tubing, to a pressure source of 75 PSI minimum. Connect the wiper feed line upstream from purifier inlet. (**Note:** If water is used, a pre-filter should be installed on the cylinder feed water line.)

Figure F



U.V. LAMP REPLACEMENT

The U.V. lamps are rated for 13,000 to 15,000 hours of continuous use. After this period of time, the U.V. lamp's glass envelope has undergone a photo-chemical change, and, while the lamp may not have burned out, the envelope will no longer pass the amount of U.V. energy required to destroy bacteria. **Failure to replace U.V. lamps every 15,000 hours could cause the equipment to go into performance failure!**

UNDER NO CIRCUMSTANCES SHOULD A U.V. LAMP BE USED OR STORED FOR MORE THAN 24 MONTHS. (Normal shelf life is 24 months).

The use of clean cotton gloves is recommended when handling Quartz and Lamps. Be very careful when handling the Quartz Sleeve and Lamps as they are extremely fragile.

Replace ultraviolet lamps after 10 to 12 months of continuous use, or when the monitor reads 70% of new lamp output. You should not wait for the monitor to cut off. Always stock spare Ultraviolet Lamps and Quartz Sleeves.

Disinfect the entire system after shutdown or service.

If equipped, operate the Quartz Sleeve Wiper Systems regularly on manual modes (push /pull stroke). You cannot over-clean the Quartz Sleeve.

Keep a record of ultraviolet intensity readings, ultraviolet lamp replacement dates and service dates.

Test the water quality periodically Collect samples in sterile bottles, listing the time and date the sample was drawn on the bottle's label. Send to the nearest testing laboratory of your local health department. In most areas the local department will collect and test your water for purity at no charge.

During Ultraviolet Lamp replacement, clean the inside and outside of the Quartz Sleeves with denatured alcohol. Clean and polish the lens on the Fail-safe Monitor Sensor. If purifier is supplied with a Wiper Cleaning System, replace the Wiper Rings (Part No. W-8-119), and Quartz O-Rings (Part No.

8-109A). When ordering parts always give the Part Number, Serial Number, and Voltage / Cycle Input (120/60).

INSTALLATION

Installation for swimming pools and hot tubs
Install the purifier in series with return line after the filter, but before the heater, if one is used.

Note: Flow control is used as each purifier is sized for your pump flow. Do not install a purifier with a smaller opening than the pump discharge, as the flow will be restricted.

The water should be re-circulated through the purifier 24 hours per day. A small residual of 0.25 parts per million (ppm) of chlorine may be required. The 1ppm or 2ppm chlorine residual normally required can be reduced up to 75%, depending on the weather, the size of the pump, and the filter.
For optimum swimming conditions, the recommended turnover time is every six (6) hours. Longer turnover time may require higher chlorine residuals for algae control.

The entire pool and hot tub area,-water walk area, pump filter, lines-should be purged with a 12 ppm residual of chlorine at start-up to eliminate algae spores and other Microorganisms.

Purifier Maintenance in pools and Hot tubs
The Maintenance is the same as that of standard purifier. In the wintertime, when temperature is at the freezing point, the purifier should be drained and the lamps and Quartz Sleeves should be removed from the purifier and stored in a clean, dry area.

On start-up follow the standard installation procedure.

WARRANTIES

GENERAL LIMITED WARRANTY

Aqua Azul warranties products manufactured against defects in materials and workmanship when used in accordance with applicable instructions for a period of one year from the date of product shipment where applicable or from an Aqual Azul approved period of time. Aqua Azul makes no other warranty, expressed or implied. There is no warranty or merchantability or fitness for a particular purpose. The warranty provided herein, and the data, specifications, and descriptions of Aqua Azul’s published catalogues and product literature may not be altered except by express written agreement signed by an officer of Aqua Azul. Representations, oral or written, which are inconsistent with said warranties or such publications are not authorized, and, if given is not the responsibility of Aqua Azul.

In the event of a breach of the foregoing warranty, Aqua Azul’s sole obligation shall be to repair or replace, at its discretion, any product or part thereof that proves defective in materials or workmanship within the warranty period, provided that the customer notifies Aqua Azul promptly of any defect. Aqua Azul shall not be liable for consequential damages resulting from economic loss or property damages sustained by a customer from the use of its products.

LAMP WARRANTY

Aqua Azul warrants the Ultraviolet lamps on a pro-rated formula. Mercury vapor UV lamps supplied by Aqua Azul --either with the original equipment or as replacement lamps – found to be faulty, shall be replaced as follows:

Units installed for continuous operation:

Less than 1500 hours of operation..Lamp replaced at no charge
More than 1500 and less than 4000 hours of operation ....Lamp replaced at 50% of charge
More than 4000 and less than 6000 hours of operation ....Lamp replaced at 75% of charge
More than 6000 and less than 8000 hours of operation ....Lamp replaced at 80% of charge
More than 8000 hours of operation ....Lamp replaced at full charge

Units installed for intermittent operation:

In any installation where more than 6 strikes are experienced in any 24 hour period, faulty or failed lamps will be replaced by Aqua Azul at no charge where failure occurs within the first 100 hours of operation.

TROUBLESHOOTING GUIDE

PROBLEM	CAUSE	CORRECTION
UV LAMPS WON'T LIGHT	INCORRECT VOLTAGE	INSTALL A VOLTAGE REGULATOR
	DISCONNECTED OR DEFECTIVE OUTLET	CHECK AND REPLACE
	DEFECTIVE UV LAMP	REPLACE LAMP
	DEFECTIVE LAMP BALLAST * Check output. Must be 480V - 580V across lamp connections	REPLACE BALLAST
	BLOWN FUSE	REPLACE FUSE
	LOOSE OPEN-CIRCUIT WIRE	TRACE OUT AND REPAIR
LEAK AT QUARTZ NIPPLE	DEFECTIVE OR CRACKED O-RING	REPLACE
	O-RING NOT SEATED PROPERLY	REPLACE
	QUARTZ SLEEVE CRACKED	REPLACE
LOW UV READING OR WATER SHUTOFF	POOR TRANSMISSION * Check output of lamps by emptying liquid from chamber. Clean quartz, monitor, sensor, and lens. Turn on lamps in empty purifier and check reading. EXAMPLE: READING IN WATER = 12 READING IN AIR = 42 TRANSMISSION = 12/42 X 100 @ 28%	ENSURE LAMPS DO NOT NEED REPLACEMENT. (See 4: UV Lamp Replacement) INSTALL PREFILTER AND TEST * Less than 60% considered poor transmission.
	INPUT VOLTAGE LOW	INSTALL VOLTAGE REGULATOR
	OLD OR DEFECTIVE LAMP	REPLACE
	DIRTY LAMP OR QUARTZ	REMOVE AND CLEAN CAREFULLY
	DIRTY SENSOR LENS	REMOVE AND CLEAN
	WIPER RINGS WORN OUT OR NOT OPERATED OFTEN ENOUGH	REPLACE AND INCREASE FREQUENCY OF OPERATION

POOR QUALITY WATER UNDER 0.2 ABSORPTION COEFFICIENT (60%), WILL RESULT IN A LOWER PERCENTAGE OF TRANSMISSION OF ULTRAVIOLET AND MUST BE CORRECTED BY PROPER PRETREATMENTS. INTERFERING FACTORS SUCH AS COLOR, TURBIDITY, IRON, ORGANICS, CHLORINE, OR NITRATES IN HIGH LEVELS WILL CAUSE LOW UV MONITOR READINGS. IF THE PERCENTAGE OF TRANSMISSION IS NOT INCREASED BY PROPER PRETREATMENT, THE FLOW THROUGH THE PURIFIER MUST BE REDUCED FOR LONGER UV TIME.

FINAL NOTE: WHEN THE PURIFIER IS ON, ENSURE THAT WATER IS ALWAYS FLOWING THROUGH IT. OPERATING THE PURIFIER FOR EXTENDED PERIODS OF TIME WITHOUT WATER FLOW WILL OVERHEAT THE PURIFIER AND DECREASE THE GERMICIDAL RADIATION EFFICIENCY OF THE LAMPS. IT MAY ALSO DAMAGE OTHER ELECTRICAL COMPONENTS.

SPECIFICATIONS

Model Number: IVO-15-WM

Flow rate capacity: 25 GPM

Number of Lamps: 2

Inlet/Outlet Size:
Material: 304 SS

Voltage/Cycle Input: 120V / 50-60Hz

kW:
Amps: 2.3 amp

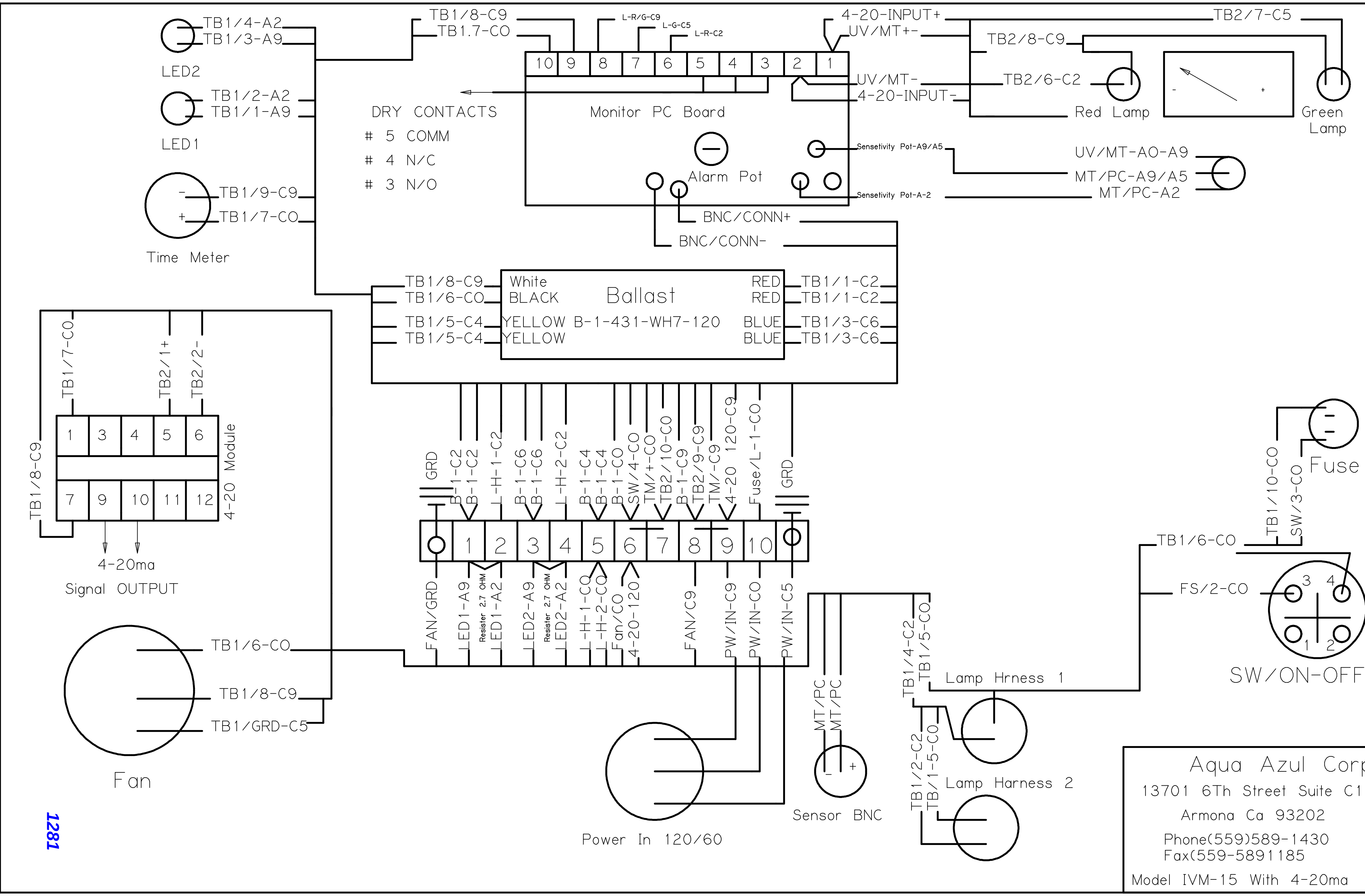
Dimensions:

Length: 37”
Width: 7”
Height: 37”

Shipping Weight:
Accessories: Manual Wiper
Auto Wiper
Remote Alarm
Inlet Solenoid
UV.MONITOR

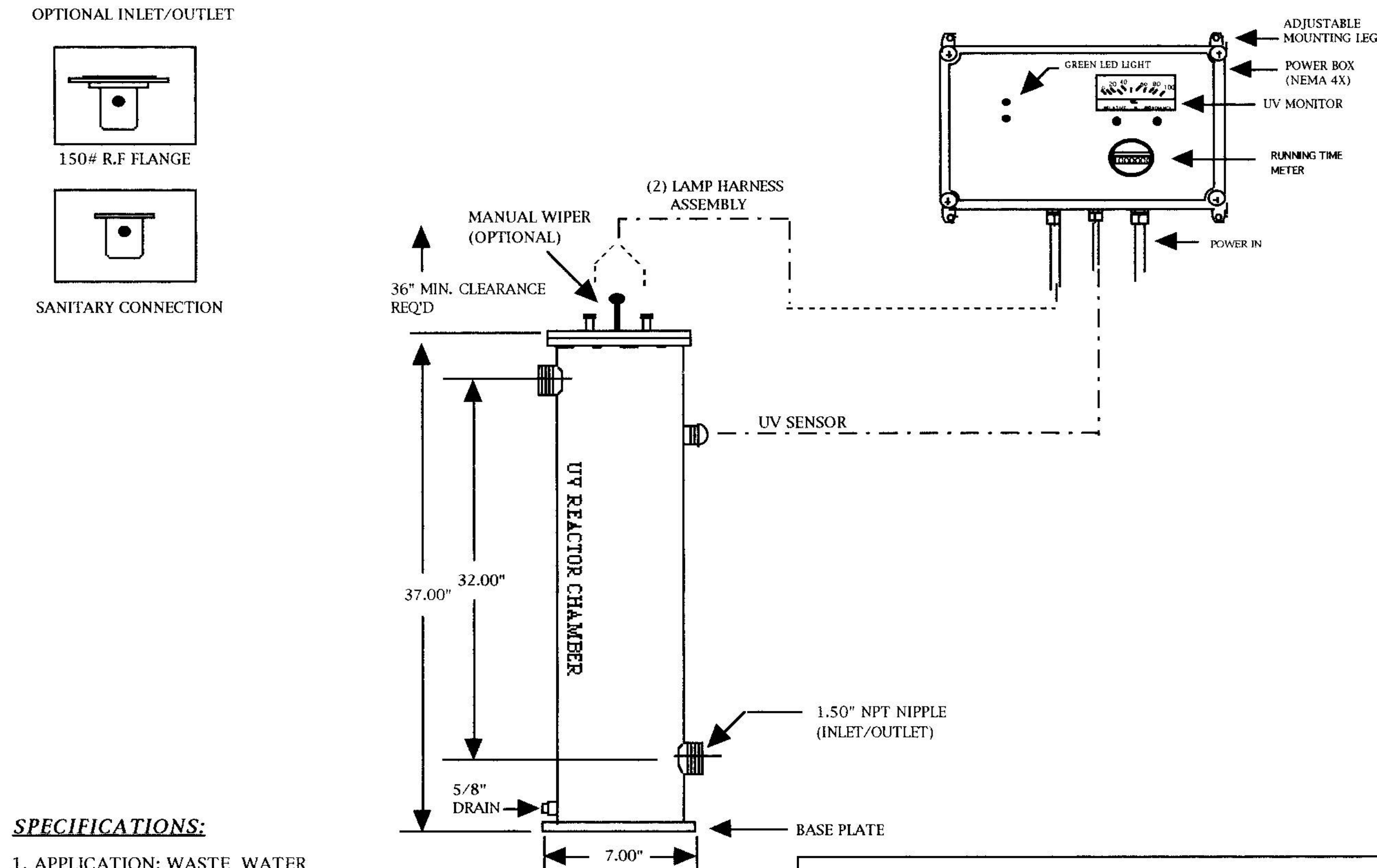
MAINTENANCE SCHEDULE

DATE	CHEMICAL CLEAN	LAMP REPLACEMENT	O-RINGS	QUARTZ	LAMP HOURS



TB1/4-A2
TB1/3-A9
LED2
TB1/2-A2
TB1/1-A9
LED1
TB1/9-C9
TB1/7-CO
Time Meter
TB1/8-C9
TB1.7-CO
DRY CONTACTS
5 COMM
4 N/C
3 N/O
L-R/G-C9
L-G-C5
L-R-C2
10 9 8 7 6 5 4 3 2 1
Monitor PC Board
Alarm Pot
Sensetivity Pot-A9/A5
Sensetivity Pot-A-2
BNC/CONN+
BNC/CONN-
4-20-INPUT+
UV/MT+-
UV/MT-
4-20-INPUT-
TB2/7-C5
TB2/8-C9
TB2/6-C2
Red Lamp
Green Lamp
UV/MT-AO-A9
MT/PC-A9/A5
MT/PC-A2
TB1/8-C9
TB1/6-CO
TB1/5-C4
TB1/5-C4
White
BLACK
YELLOW
YELLOW
Ballast
B-1-431-WH7-120
RED
RED
BLUE
BLUE
TB1/1-C2
TB1/1-C2
TB1/3-C6
TB1/3-C6
TB1/7-CO
TB2/1+
TB2/2-
TB1/8-C9
1 3 4 5 6
7 9 10 11 12
4-20 Module
4-20ma
Signal OUTPUT
GRD
B-1-C2
B-1-C2
L-H-1-C2
B-1-C6
B-1-C6
L-H-2-C2
B-1-C4
B-1-C4
B-1-CO
SW/4-CO
TM/+-CO
TB2/10-CO
B-1-C9
TB2/9-C9
TM/-C9
4-20 120-C9
Fuse/L-1-CO
GRD
1 2 3 4 5 6 7 8 9 10
FAN/GRD
LED1-A9
Resister 2.7 OHM
LED1-A2
LED2-A9
Resister 2.7 OHM
LED2-A2
L-H-1-CO
L-H-2-CO
Fan/CO
4-20-120
FAN/C9
PW/IN-C9
PW/IN-CO
PW/IN-C5
TB1/6-CO
TB1/8-C9
TB1/GRD-C5
Fan
Power In 120/60
MT/PC
MT/PC
Sensor BNC
TB1/4-C2
TB1/5-CO
Lamp Hrness 1
TB1/2-C2
TB1/-5-CO
Lamp Harness 2
TB1/10-CO
SW/3-CO
Fuse
TB1/6-CO
FS/2-CO
3 4 1 2
SW/ON-OFF
Aqua Azul Corp
13701 6Th Street Suite C1
Armona Ca 93202
Phone(559)589-1430
Fax(559-5891185
Model IVM-15 With 4-20ma

1281



SPECIFICATIONS:

1. APPLICATION: WASTE WATER
2. FLOW RATE: 25 GPM
3. UV DOSAGE: 30,000 PLUS MW SEC. / CM2
4. OPERATING PRESSURE: 150 PSIG MAX.
5. ELECTRICAL BOX: REMOTE
6. ELECTRICAL: 120 VAC / 60 HZ
7. LAMP: 254 NM

1282

AQUA AZUL CORPORATION
13701 6TH STREET, ARMONA, CALIFORNIA 93202
(PH) 559-589-1185 (FAX) 559-589-1185

MODEL: IVM-15 HO		MATERIAL: 304L SS
DATE: 10/13	DRAWN: DA	PROJECT:

SECTION 18: PERMEATE TANK

P&ID: Item #: P-0841

Unit Details:	***2000 Gallon Vertical Tank*** **ICT 2000, polyethylene tank with associated fittings custom welded**
Manufacturer:	**Assmann Corporation of America** **300 North Taylor Road** **Garrett, IN 46738** **Phone: (260) 357-3181** **Fax: (260) 357-3738** **www.assmann-usa.com**

Local Distributor/Contact:

Eastern Reliability
P.O. Box 68
Fairhaven, MA 02719
Phone: (508) 992-9189

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Vertical Storage Tanks

Assmann vertical tanks (ICT, ACT, IFT) are rotationally molded from your choice of virgin high density crosslink or FDA-compliant linear polyethylene. They are semi-translucent with gallon markers and access openings molded-in. Either is more corrosion and chemical resistant than fiberglass, stainless or mild steel. Tanks are one-piece seamless molded units, designed with wall thicknesses conforming to ASTM D-1998 standards for liquid storage and have narrow diameters for space-saving in-plant use. They possess excellent low temperature impact resistance and are U.V. stabilized. They are available in natural color or optional blue, green, yellow or black. They can be equipped with accessories to fit your specifications.

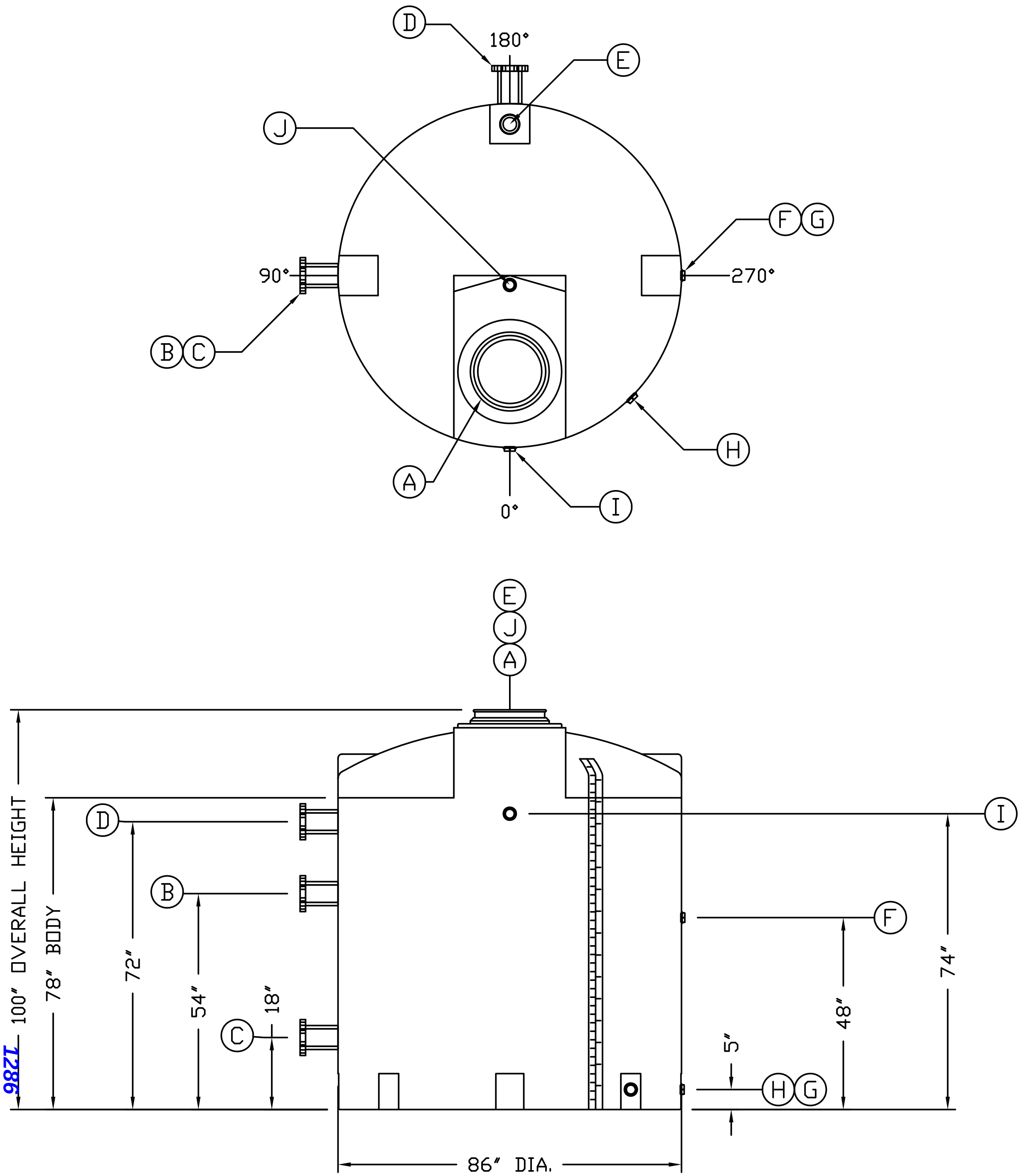
Model Number	Capacity (US Gallons)	Dimensions (inches)		Weight (lbs) Linear and Crosslink Polyethylene				Access Opening (inches)
		Diameter	Height	1.35 Sp. Gravity	1.5 Sp. Gravity	1.9 Sp. Gravity	2.2 Sp. Gravity	
ICT 40	40	20	38	N/A	N/A	20	N/A	16
ICT 60	60	23	42	N/A	N/A	28	N/A	16
ICT 65	65	23	44	N/A	N/A	28	N/A	7
ICT 80	80	24	49	N/A	N/A	30	N/A	16
ICT 120	120	29	52	N/A	N/A	50	N/A	7
ICT 140	140	29	58	N/A	N/A	50	N/A	16
ICT 175	175	35	51	N/A	N/A	56	N/A	16
ICT 200 (35″)	200	35	57	N/A	N/A	64	N/A	16
ICT 200 (36″)	200	36	53	N/A	N/A	60	N/A	16
ICT 250	250	35	69	N/A	N/A	75	N/A	16
ICT 300	300	35	82	N/A	N/A	85	115	16
ACT 550	550	69	43	N/A	N/A	120	160	16
ICT 550	550	48	82	N/A	130	130	160	16
IFT 550	550	48	83	N/A	130	130	160	11
ICT 700	700	69	58	N/A	130	150	175	16
ICT 850	850	48	120	166	180	230	267	16
IFT 950	950	64	83	171	190	205	240	11
ICT 1000	1000	64	84	171	190	205	240	16
ICT 1100	1100	86	55	171	190	220	260	16
ICT 1200	1200	64	100	203	260	330	350	16
ACT 1500	1500	86	74	227	250	320	420	16
ICT 1500	1500	64	121	295	320	415	480	16
ICT 1850	1850	96	78	335	350	400	605	16
ICT 2000	2000	86	100	335	375	445	665	16
ICT 2050	2050	64	165	450	500	620	800	16
ICT 2400	2400	96	95	412	450	620	800	16
ICT 2500	2500	86	119	441	450	620	808	16
ICT 2900	2900	96	111	568	620	800	990	16
ICT 3000	3000	90	122	568	620	800	1035	16
ICT 4000	4000	90	162	782	850	1100	1620	16
ICT 4100	4100	119	108	782	850	1100	1400	24*
ICT 4200	4200	96	152	782	850	1100	1620	16
ICT 5200	5200	105	160	1101	1200	1550	1895	24*
ICT 5500	5500	119	141	1215	1350	1600	2200	24*
ICT 5600	5600	96	196	1350	1500	1750	2600	24*
ICT 6500	6500	105	193	1776	1900	2500	2850	24*
ICT 6510	6510	119	163	1575	1750	2000	2450	24*
ICT 7300	7300	119	177	2028	2244	2866	3299	24*
ICT 8000	8000	143	142	1989	2200	2800	3250	24*
ICT 8410	8400	119	201	2758	3065	3882	4495	24*
ICT 10000	10000	143	173	2700	3000	3400	4770	24*
ICT 12000	12000	143	196	3400	3800	4400	5340	24*

*All 24″ manway access covers are hinged. Model number availability and individual specifications subject to change without notice. Gallonage and weights are approximate. All wall thicknesses conform to ASTM D-1998.

Assmann®
Assmann Corporation of America

NSF Certified to NSF/ANSI 61

Phone: 888-357-3181 • Fax: 888-Tank Fax (826-5329)
Phone: 260-357-3181 • Fax: 260-357-3738
E-mail: info@assmann-usa.com • www.assmann-usa.com



ACCESSORIES					
MK	SIZE	DESCRIPTION	DEG	ELEV	DOME
A	16	STRAP LOCK LID (MANWAY)	0	-	X
B	4	WELDED AND GUSSETED FLANGE (DISCHARGE)	90	54	-
C	4	WELDED AND GUSSETED FLANGE (SUCTION)	90	18	-
D	4	WELDED AND GUSSETED FLANGE (EFFLUENT)	180	72	-
E	3	PE WELDED COUPLER (VENT)	180	-	X
F	1.5	PE WELDED COUPLER (DISCHARGE)	270	48	-
G	1.5	PE WELDED COUPLER (SUCTION)	270	5	-
H	2	PE WELDED COUPLER (DRAIN)	315	5	-
I	2	PE WELDED COUPLER (FROM PERMEATE PUMPS)	0	74	-
J	2	PE WELDED COUPLER (ULTRASONICS)	CL	-	X

NOTES:
1 LOCATE FITTINGS FROM PLAN VIEW.
2 TANK(S) MUST BE INSTALLED PER ASSMANN CORPORATION USAGE & GUIDELINES.
3 FLEXIBLE EXPANSION JOINTS MUST BE USED ON ALL SIDEWALL CONNECTIONS.
4 TANKS ARE BUILT PER ASTM D 1998.

REV	REVISION DESCRIPTION	REV DATE

Assmann CORPORATION OF AMERICA

300 N TAYLOR ROAD
GARRETT, IN 46738
PHONE: (260) 357-3181
FAX: (260) 357-3738

RESIN USED: LINEAR POLYETHYLENE
TANK DESIGNED SPECIFIC GRAVITY 1.9 SP.G. MAX
TANK WEIGHT 445 LBS.
TANK COLOR NATURAL

TITLE ICT 2000 GALLON VERTICAL STORAGE TANK

DRAWN BY: B HALL | DRAWN DATE: 9/19/11 | SALES ORDER# 60308-A

DWG NUMBER: #3101 | REV -

BIOPROCESS H2O, LLC

ALL DIMENSIONS ARE IN INCHES AND ARE ±3%

SECTION 7: CONTROL PANEL

Unit Details: Teknikor Custom Engineered Control System

Manufacturer:

Teknikor Automation & Controls, Inc.
595 Airport Road
Fall River, MA 02720
Phone: (508) 679-9474
Fax: (508) 679-9125
www.teknikor.com

Local Distributor/Contact:

Teknikor Automation & Controls, Inc.
595 Airport Road
Fall River, MA 02720
Phone: (508) 679-9474
Fax: (508) 679-9125
www.teknikor.com

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PREPARED FOR:

BioProcess H20, LLC

45 Highpoint Avenue
Portsmouth, RI 02871

JOB # 270613, North Reading Waste Water Control System

PREPARED BY:

TEKNIKOR

TEKNIKOR AUTOMATION & CONTROLS INC.
595 AIRPORT ROAD
FALL RIVER, MA 02720 USA
(508) 679-9474 www.teknikor.com

CONTENTS:

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23651A
SHEET 0 OF 40

CUSTOMER: BioProcess H20, LLC
TITLE: COVER SHEET
FILE NAME: 23651A00.DWG DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	
B	
A	Approved for Prod, JAS, 11/19/13

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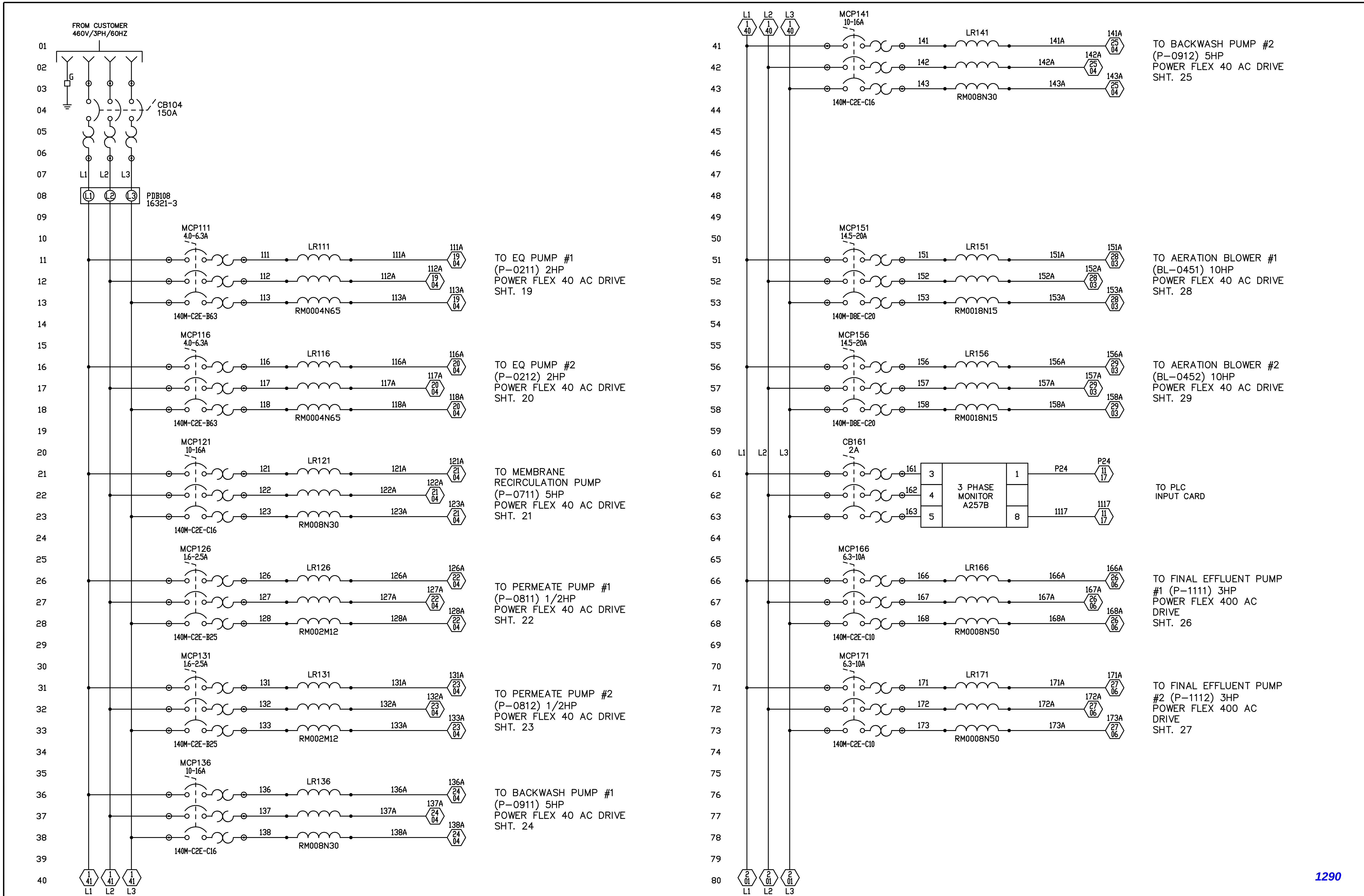
FALL RIVER, MA 02720 USA



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TITLE: POWER DISTRIBUTION
FILE NAME: 23651A01.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	AS STARTED, JAS, 5/5/14
B	AS SHIPPED, JAS, 2/12/14
A	

23651A D
SHEET 1 OF 40

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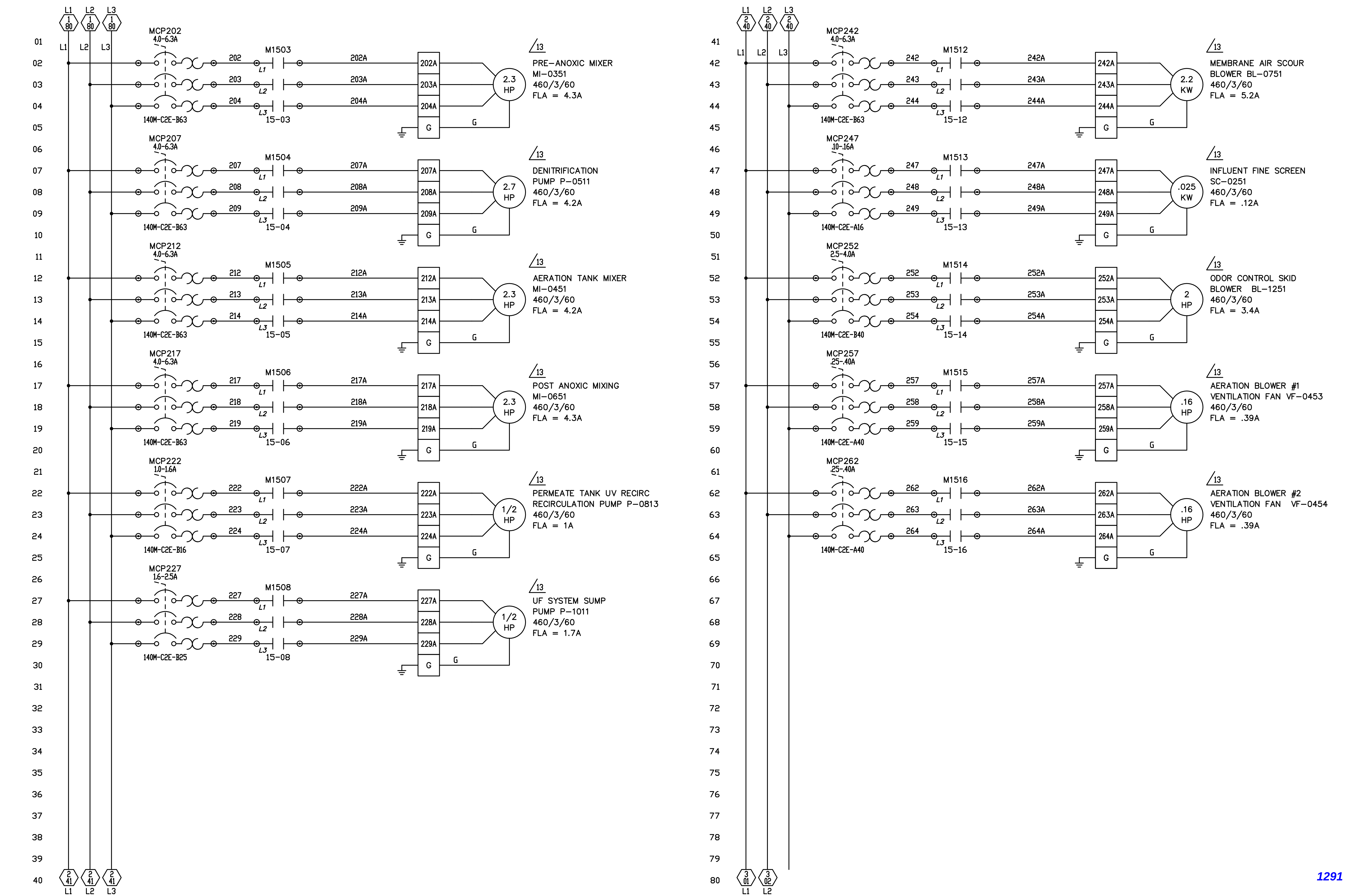

23651A D
SHEET 2 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: POWER DISTRIBUTION
FILE NAME: 23651A02.DWG DATE: 10/4/13
DRN JAS/LV CKD APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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FALL RIVER, MA 02720 USA
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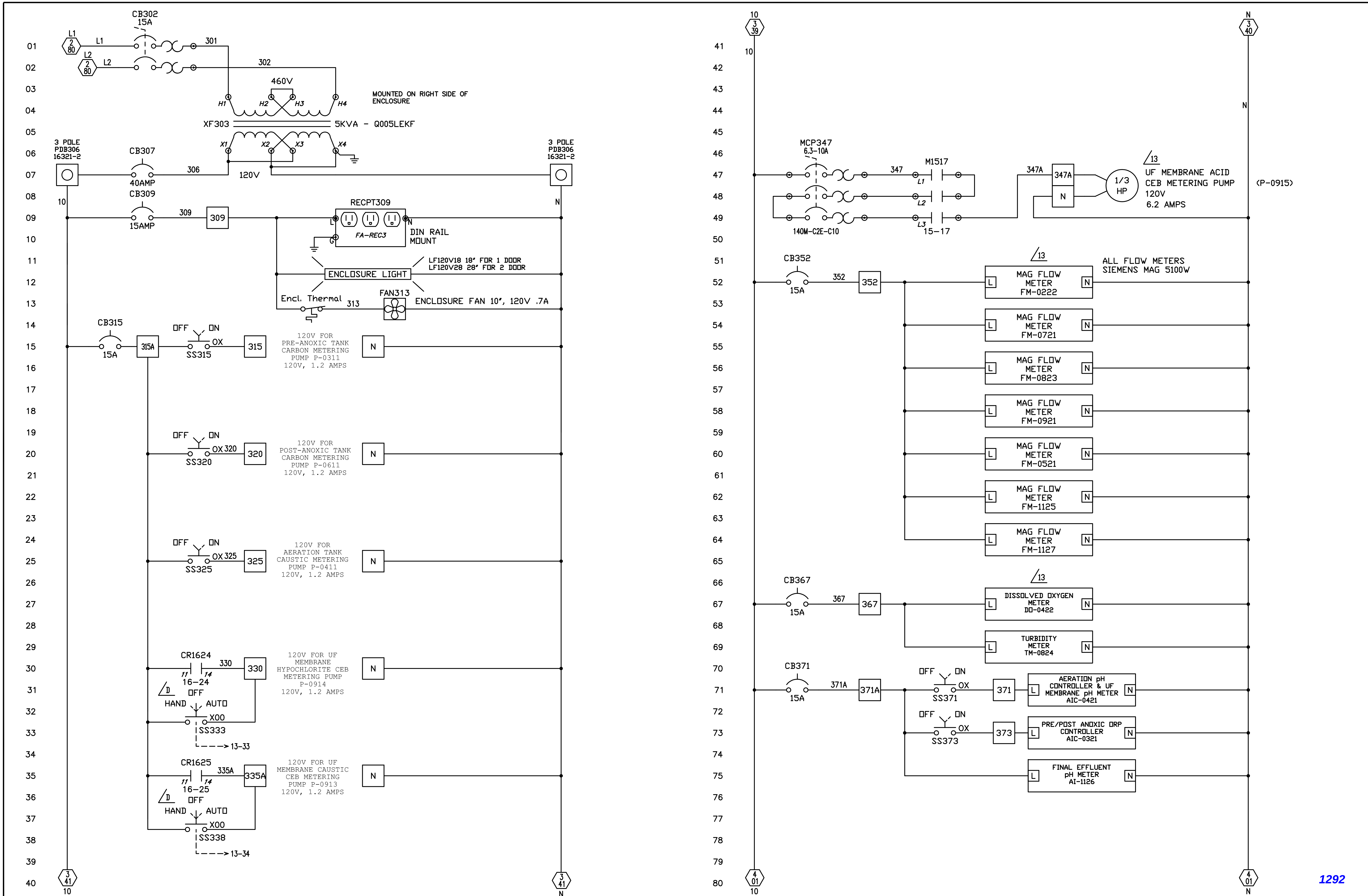

23651A
SHEET 3 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: AC CONTROL
FILE NAME: 23651A03.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14

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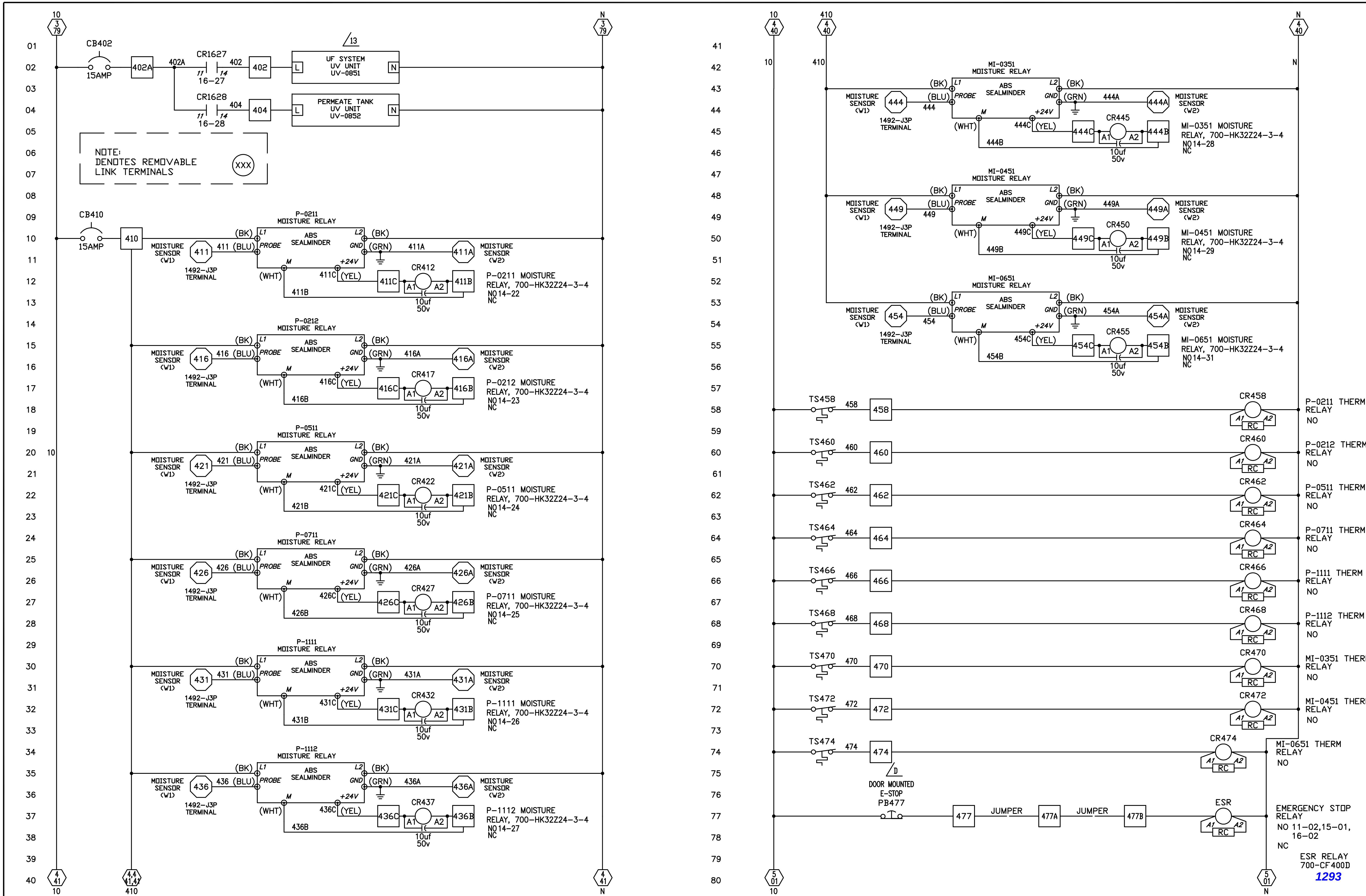

23651A
D
SHEET 4 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: AC CONTROL
FILE NAME: 23651A04.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

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B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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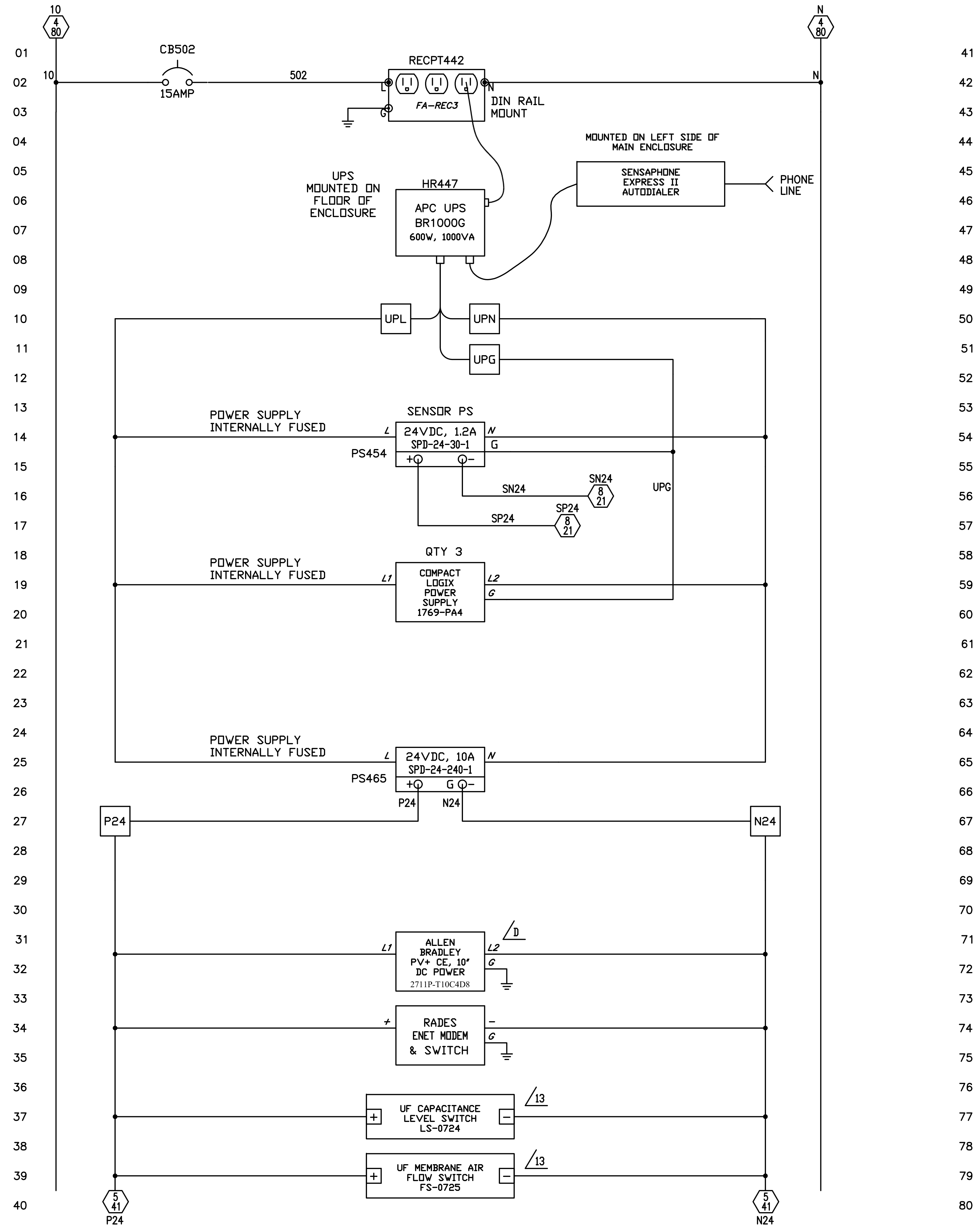

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23651A

SHEET 5 OF 40

CUSTOMER: BioProcess H2O, LLC

TITLE: AC CONTROL

FILE NAME: 23651A05.DWG

DATE: 10/4/13

DRN JAS/LV

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B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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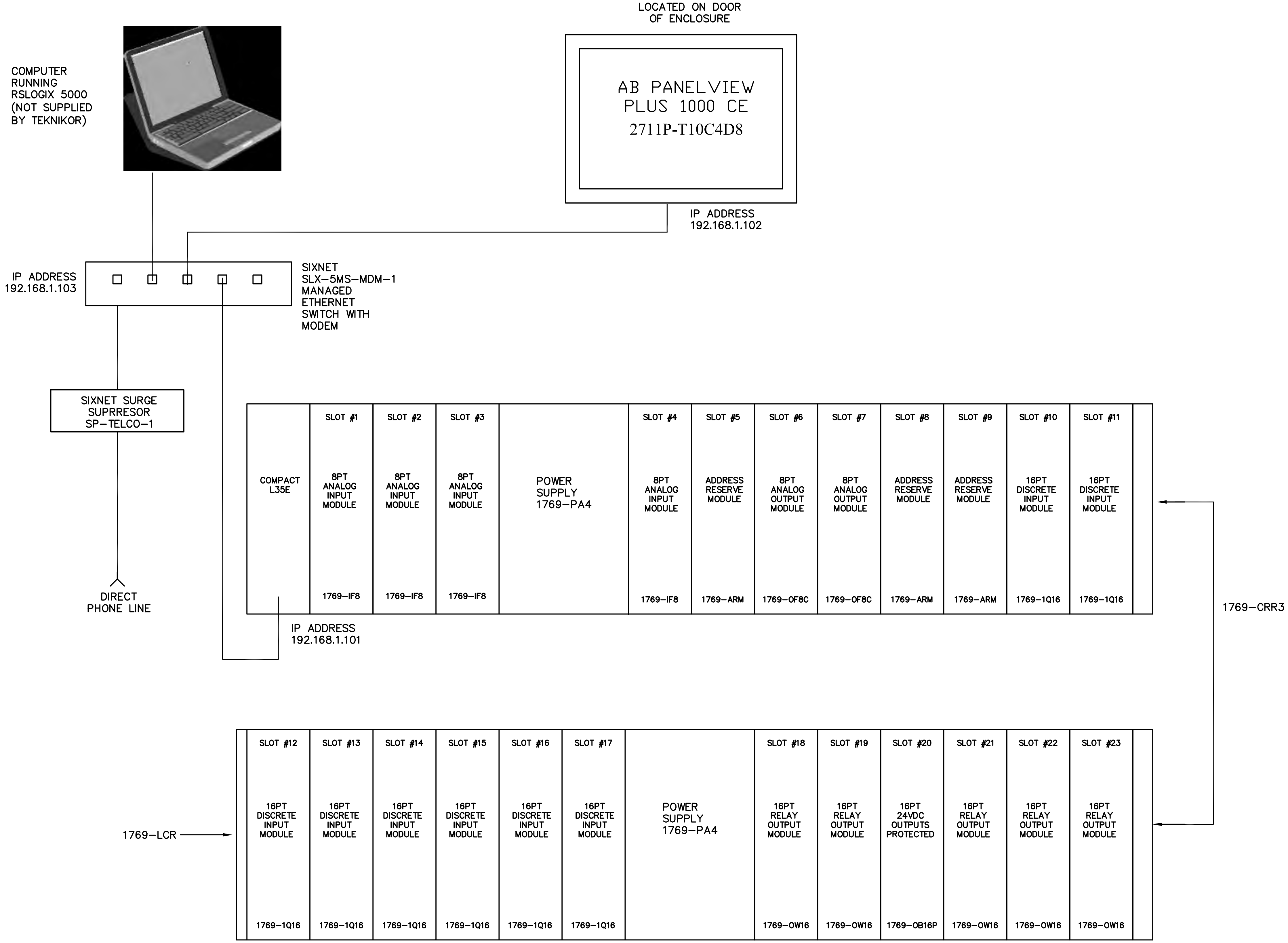

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CUSTOMER: BioProcess H2O, LLC
TITLE: NETWORK TOPOLOGY
FILE NAME: 23651A06.DWG
DATE: 10/4/13
DRN JAS/LV
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APP'D
REV
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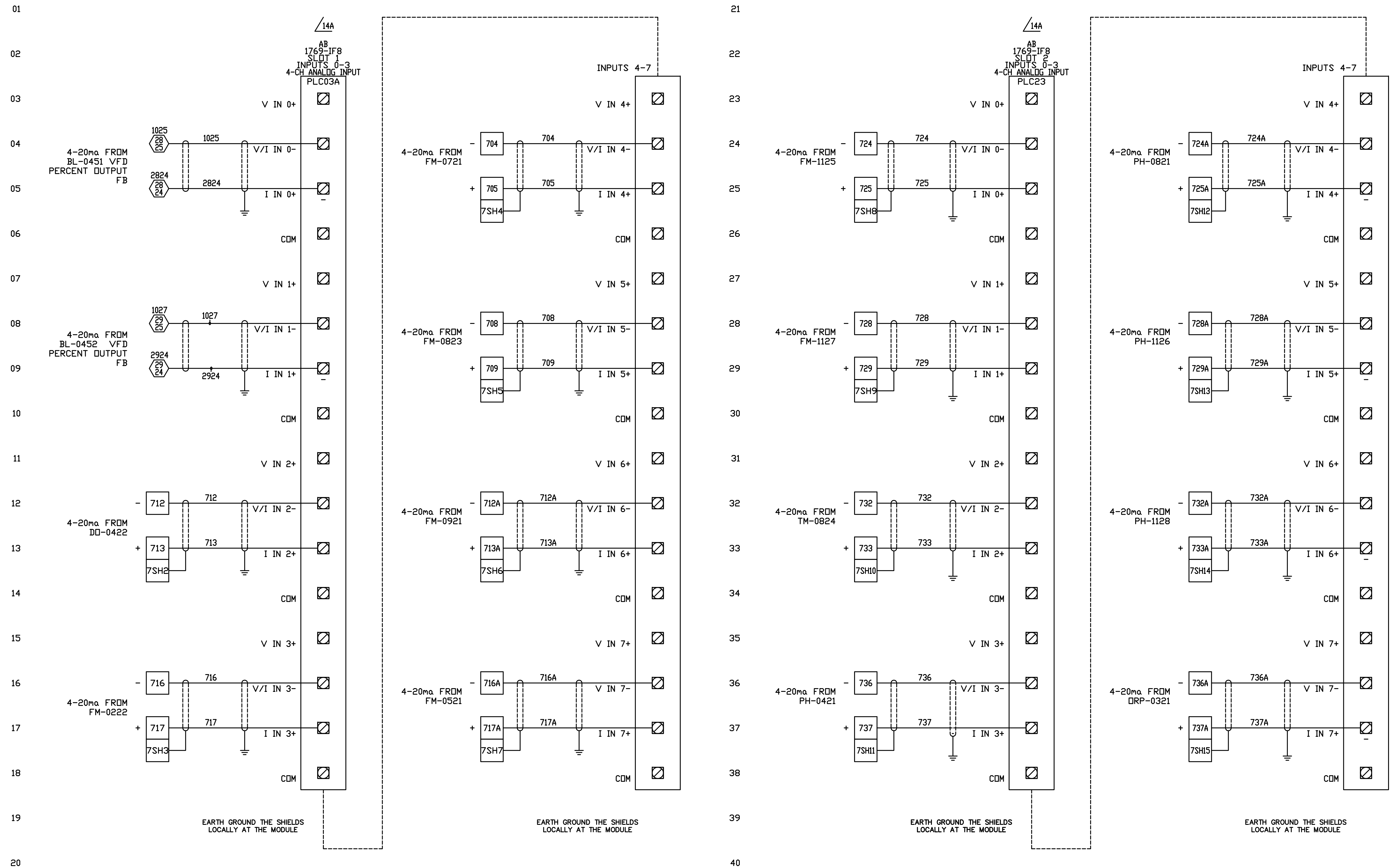

23651A
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D

CUSTOMER: BioProcess H2O, LLC
TITLE: PLC ANALOG INPUTS
FILE NAME: 23651A07.DWG
DATE: 10/4/13

DRN JAS/LV
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B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14

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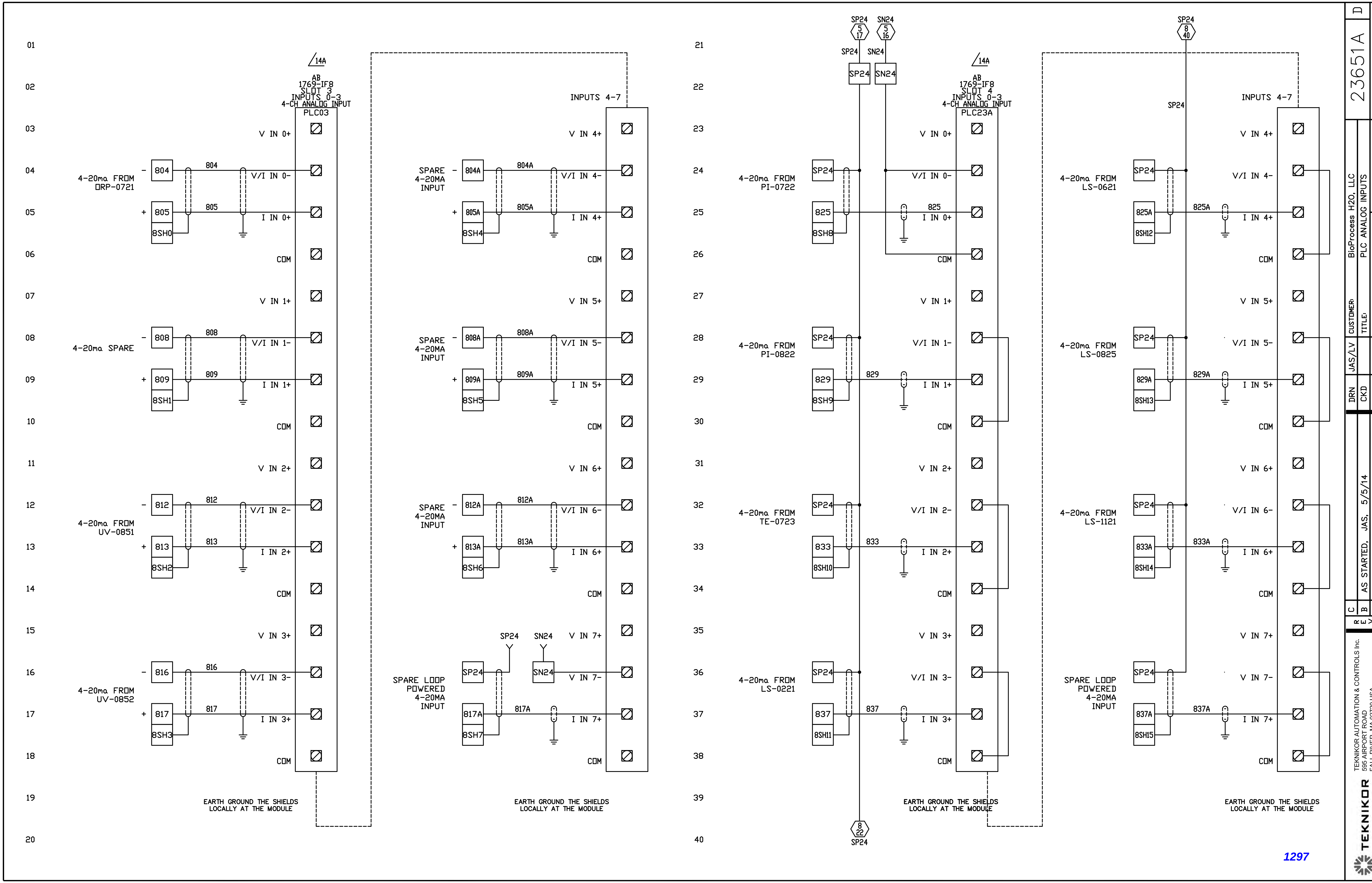

AB
1769-IF8
SLOT 3
INPUTS 0-3
4-CH ANALOG INPUT
PLC03
INPUTS 4-7
V IN 0+
V/I IN 0-
I IN 0+
COM
V IN 1+
V/I IN 1-
I IN 1+
V IN 2+
V/I IN 2-
I IN 2+
V IN 3+
V/I IN 3-
I IN 3+
V IN 4+
V/I IN 4-
I IN 4+
V IN 5+
V/I IN 5-
I IN 5+
V IN 6+
V/I IN 6-
I IN 6+
V IN 7+
V/I IN 7-
V IN 7-
I IN 7+
4-20ma FROM ORP-0721
4-20ma SPARE
4-20ma FROM UV-0851
4-20ma FROM UV-0852
SPARE 4-20MA INPUT
SPARE LOOP POWERED 4-20MA INPUT
804
805
8SH0
808
809
8SH1
812
813
8SH2
816
817
8SH3
804A
805A
8SH4
808A
809A
8SH5
812A
813A
8SH6
817A
8SH7
SP24
SN24
EARTH GROUND THE SHIELDS LOCALLY AT THE MODULE
AB
1769-IF8
SLOT 4
INPUTS 0-3
4-CH ANALOG INPUT
PLC23A
4-20ma FROM PI-0722
4-20ma FROM PI-0822
4-20ma FROM TE-0723
4-20ma FROM LS-0221
4-20ma FROM LS-0621
4-20ma FROM LS-0825
4-20ma FROM LS-1121
825
8SH8
829
8SH9
833
8SH10
837
8SH11
825A
8SH12
829A
8SH13
833A
8SH14
837A
8SH15
5 17
5 16
8 40
8 22
BioProcess H2O, LLC
PLC ANALOG INPUTS
23651A08.DWG
10/4/13
CUSTOMER:
TITLE:
FILE NAME:
DATE:
DRN
CKD
APP'D
JAS/LV
23651A
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REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14
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EXPANSION

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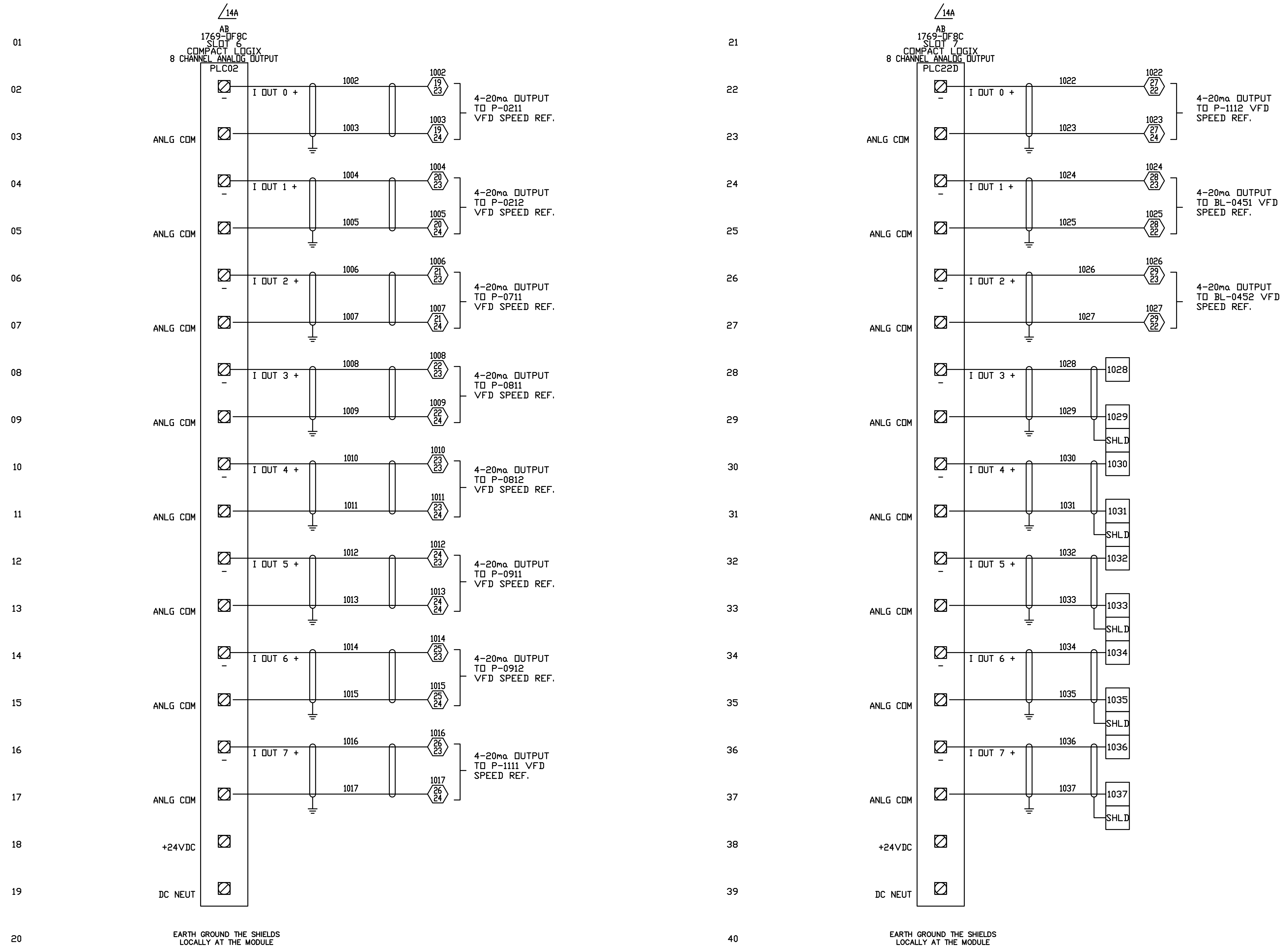
REV		
C		
B	AS STARTED, JAS, 5/5/14	
A	AS SHIPPED, JAS, 2/12/14	

DRN	JAS/LV	CUSTOMER:	BioProcess H2O, LLC
CKD		TITLE:	SPARE DRAWING
APP'D		FILE NAME:	23651A09.DWG
		DATE:	10/4/13

23651A D

SHEET 9 OF 40



23651A D
SHEET 10 OF 40
CUSTOMER: BioProcess H2O, LLC
TITLE: PLC ANALOG OUTPUTS
FILE NAME: 23651A10.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14

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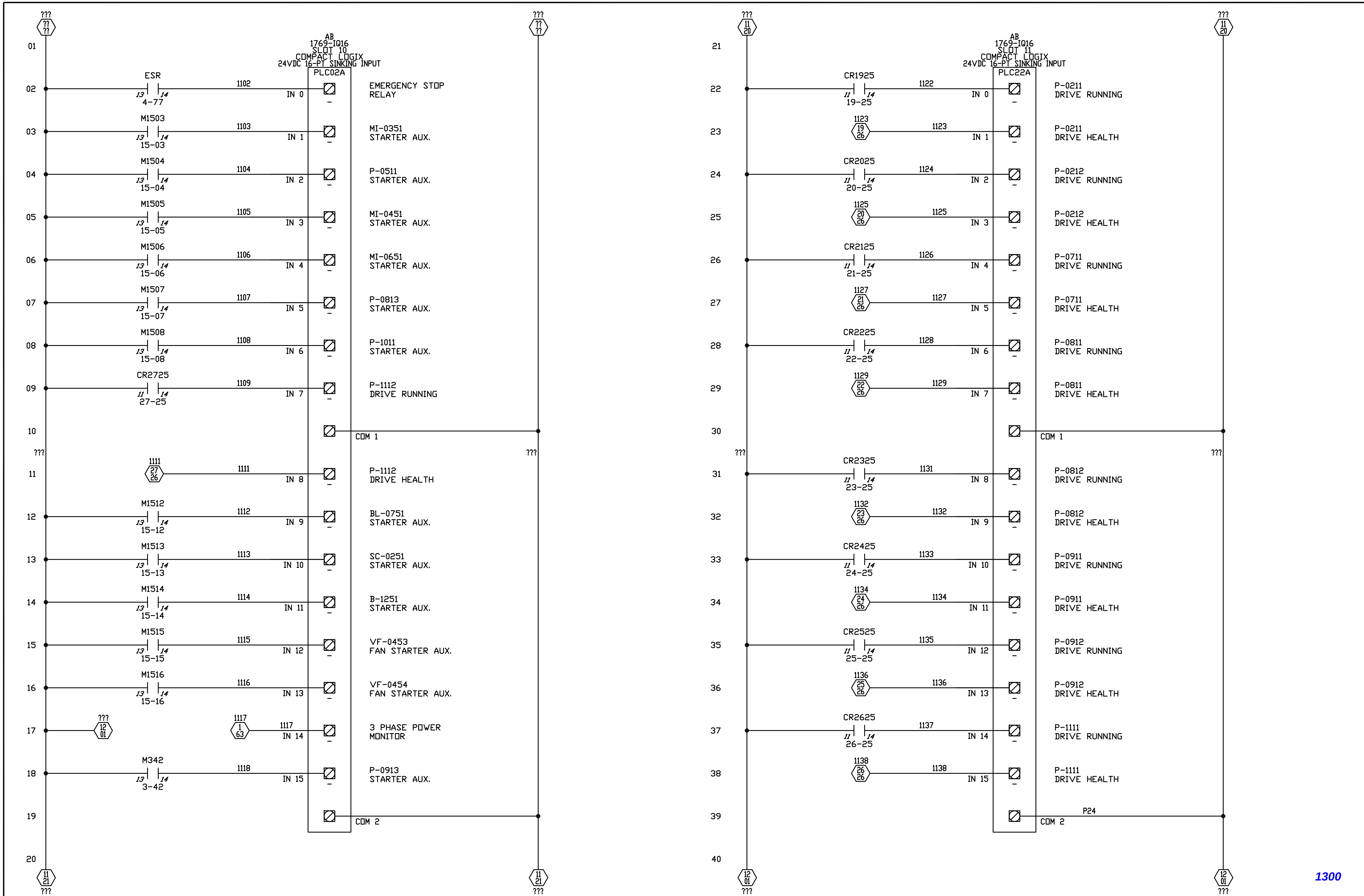
1299



1300

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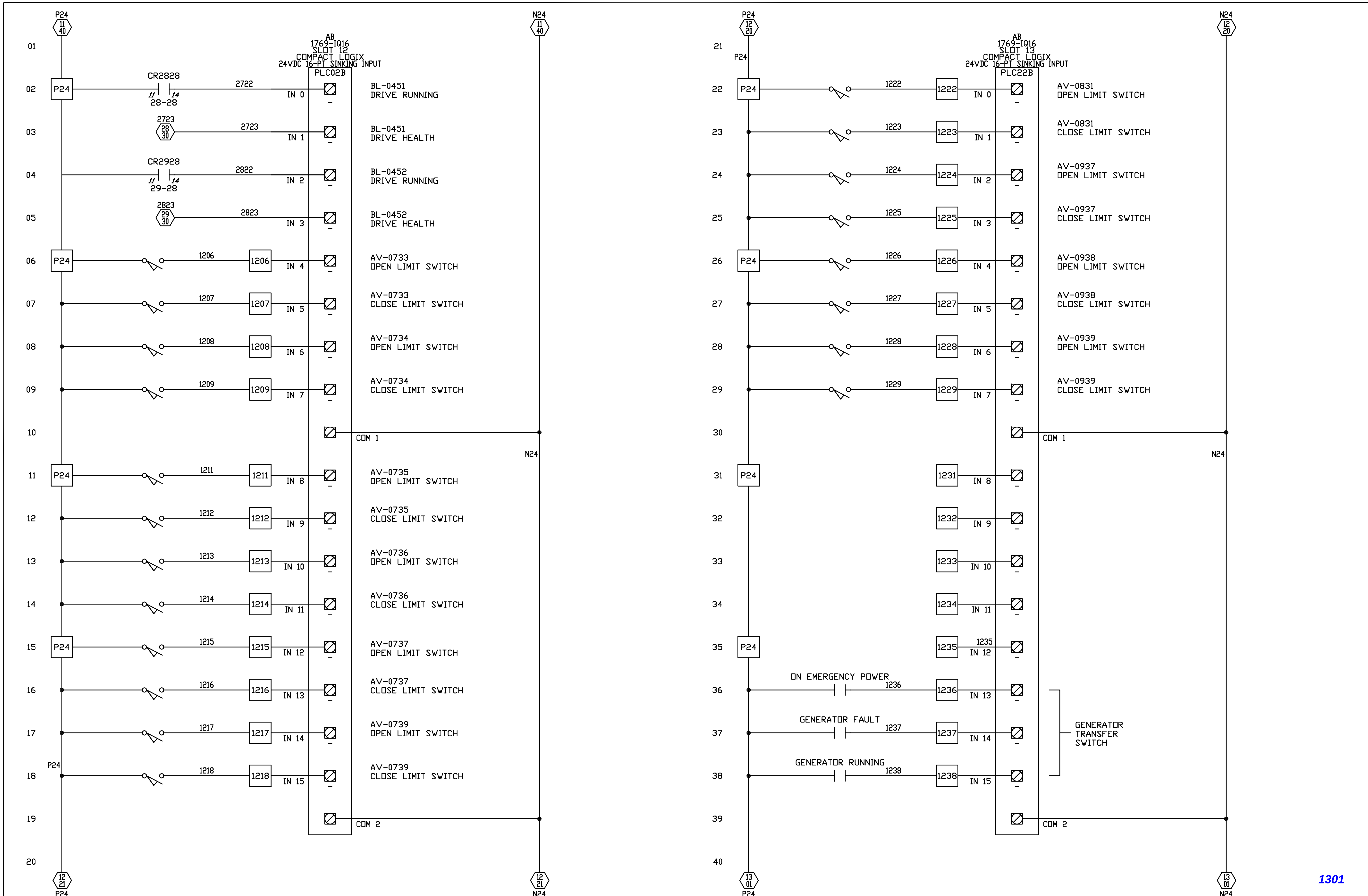
REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

DRN JAS/LV
CKD
APP'D

CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE INPUTS
FILE NAME: 23651A11.DWG
DATE: 10/4/13

23651A D
SHEET 11 OF 40



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23651A

SHEET 12 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE INPUTS
FILE NAME: 23651A12.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
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A AS SHIPPED, JAS, 2/12/14

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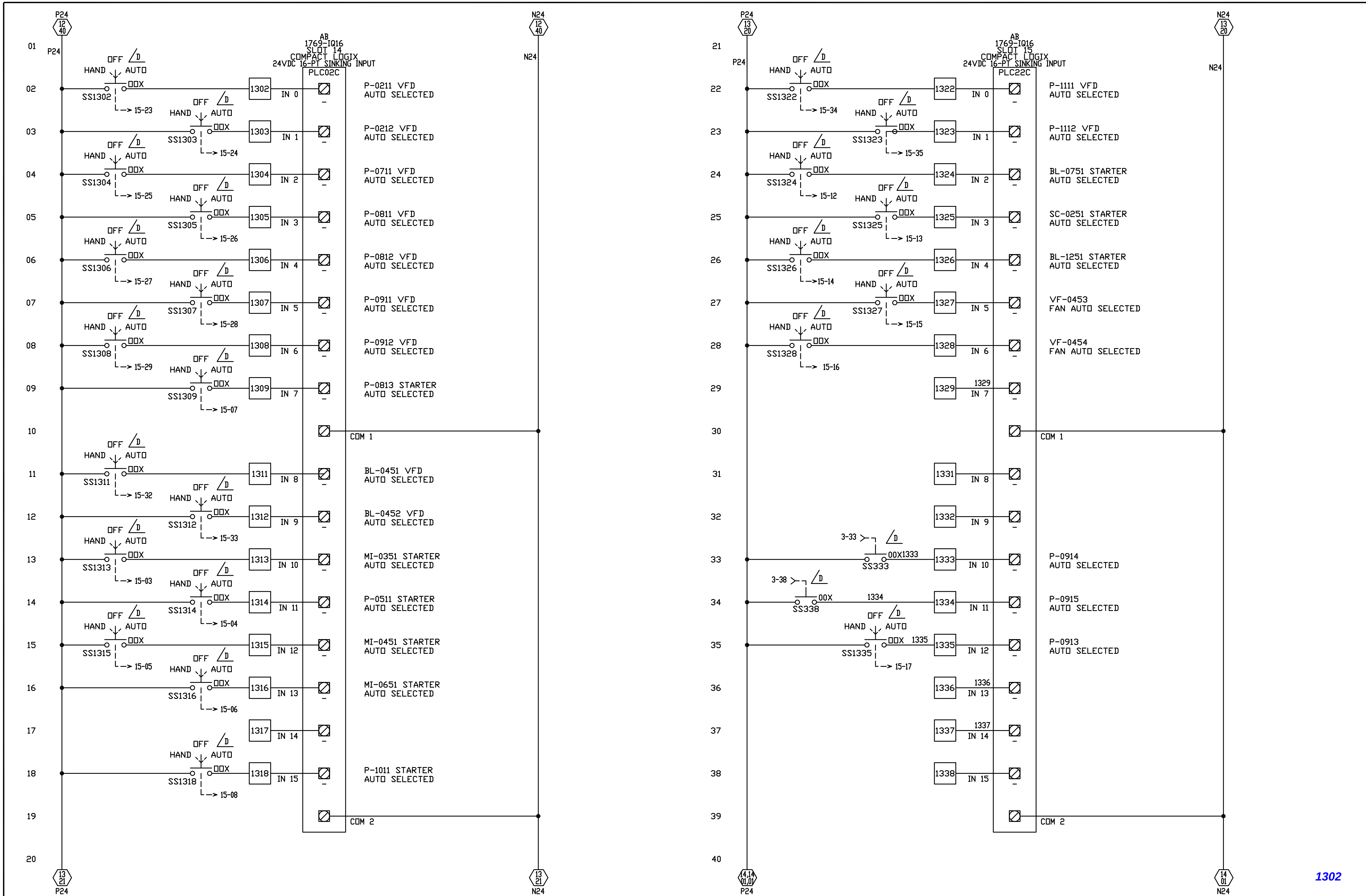

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23651A
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SHEET 13 OF 40
CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE INPUTS
FILE NAME: 23651A13.DWG
DATE: 10/4/13
DRN JAS/LV
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A AS SHIPPED, JAS, 2/12/14
REV

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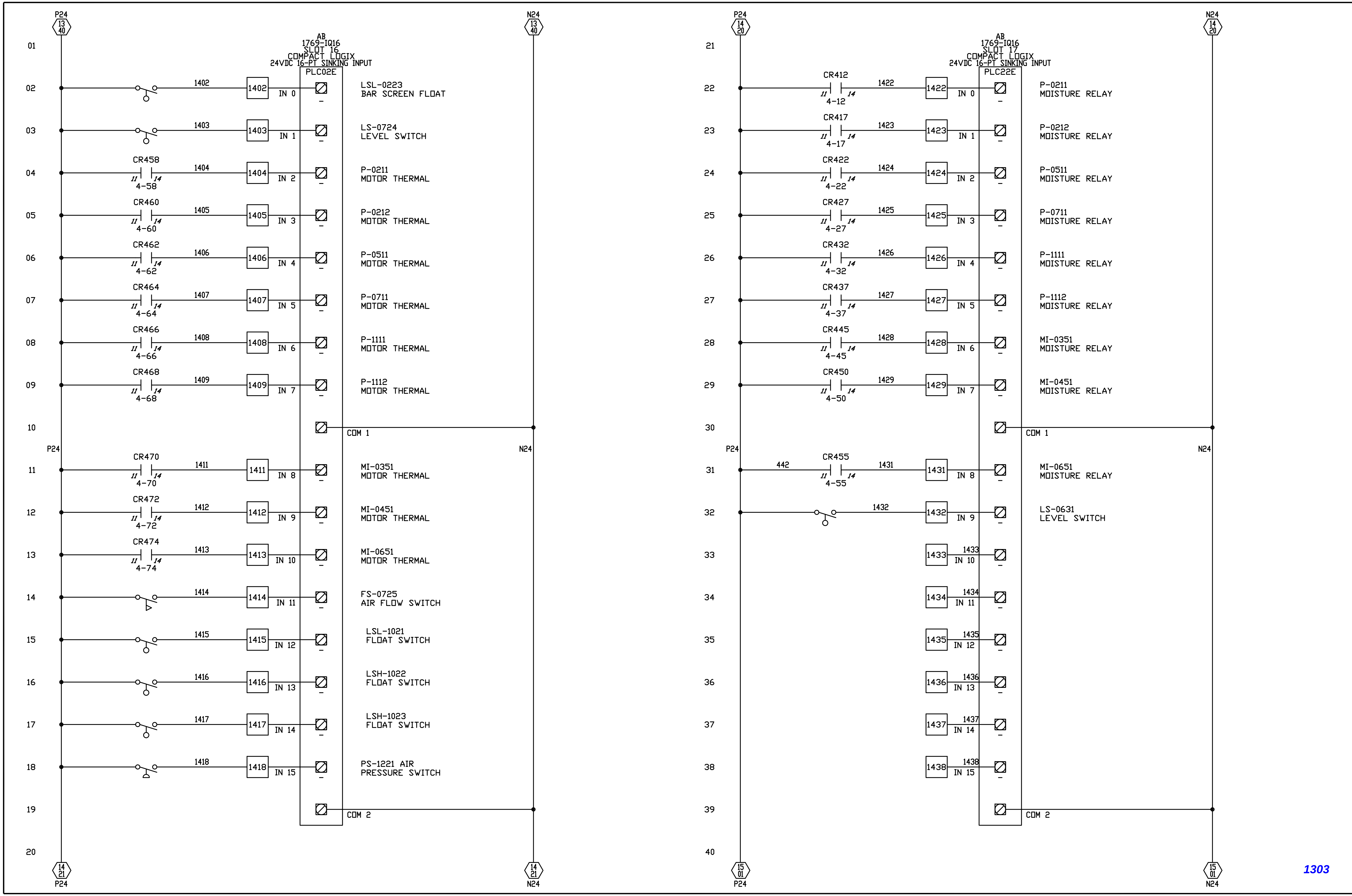

1303

D
23651A
SHEET 14 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE INPUTS
FILE NAME: 23651A14.DWG DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

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C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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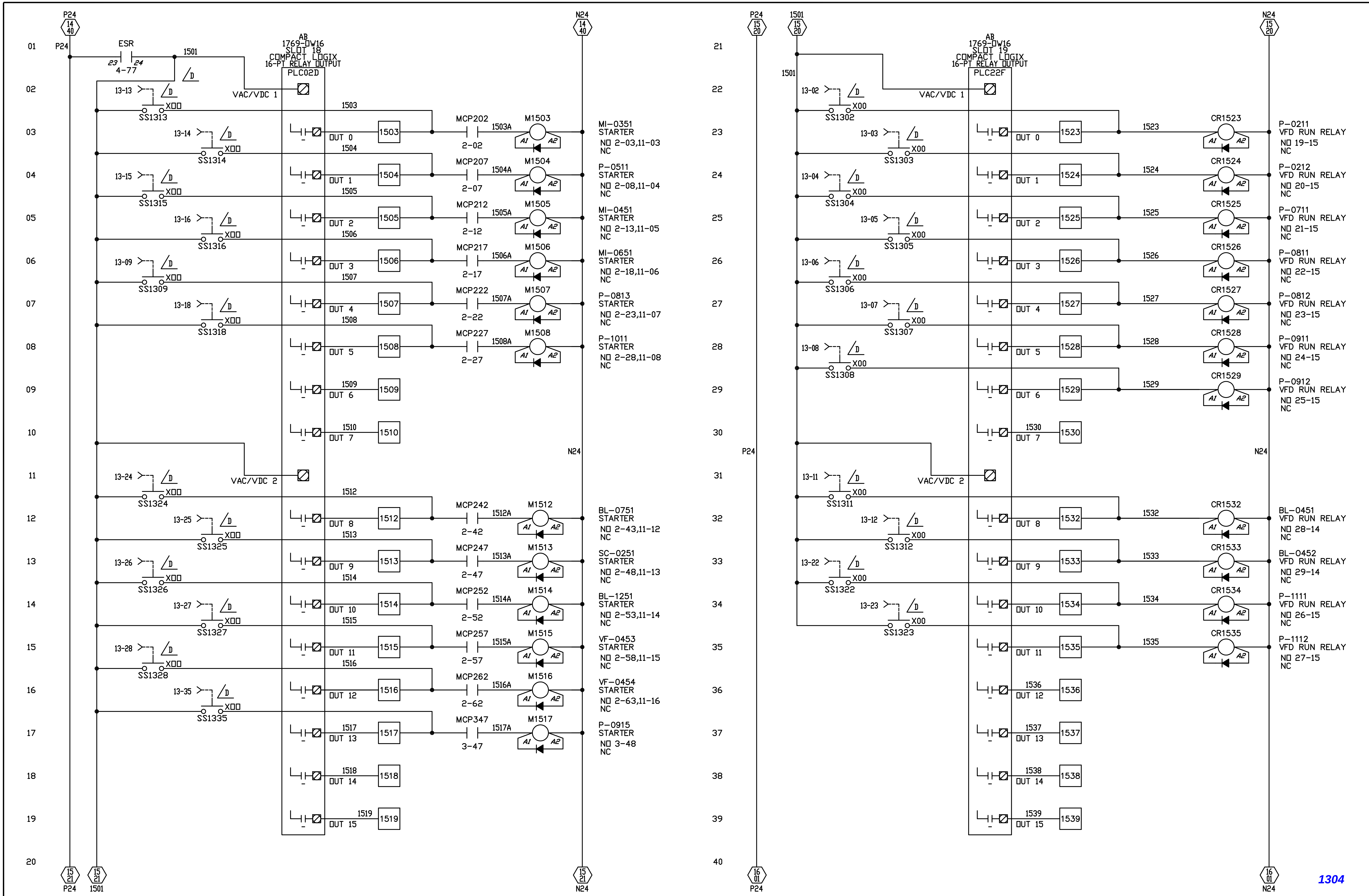

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23651A
SHEET 15 OF 40
D

CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE OUTPUTS
FILE NAME: 23651A15.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
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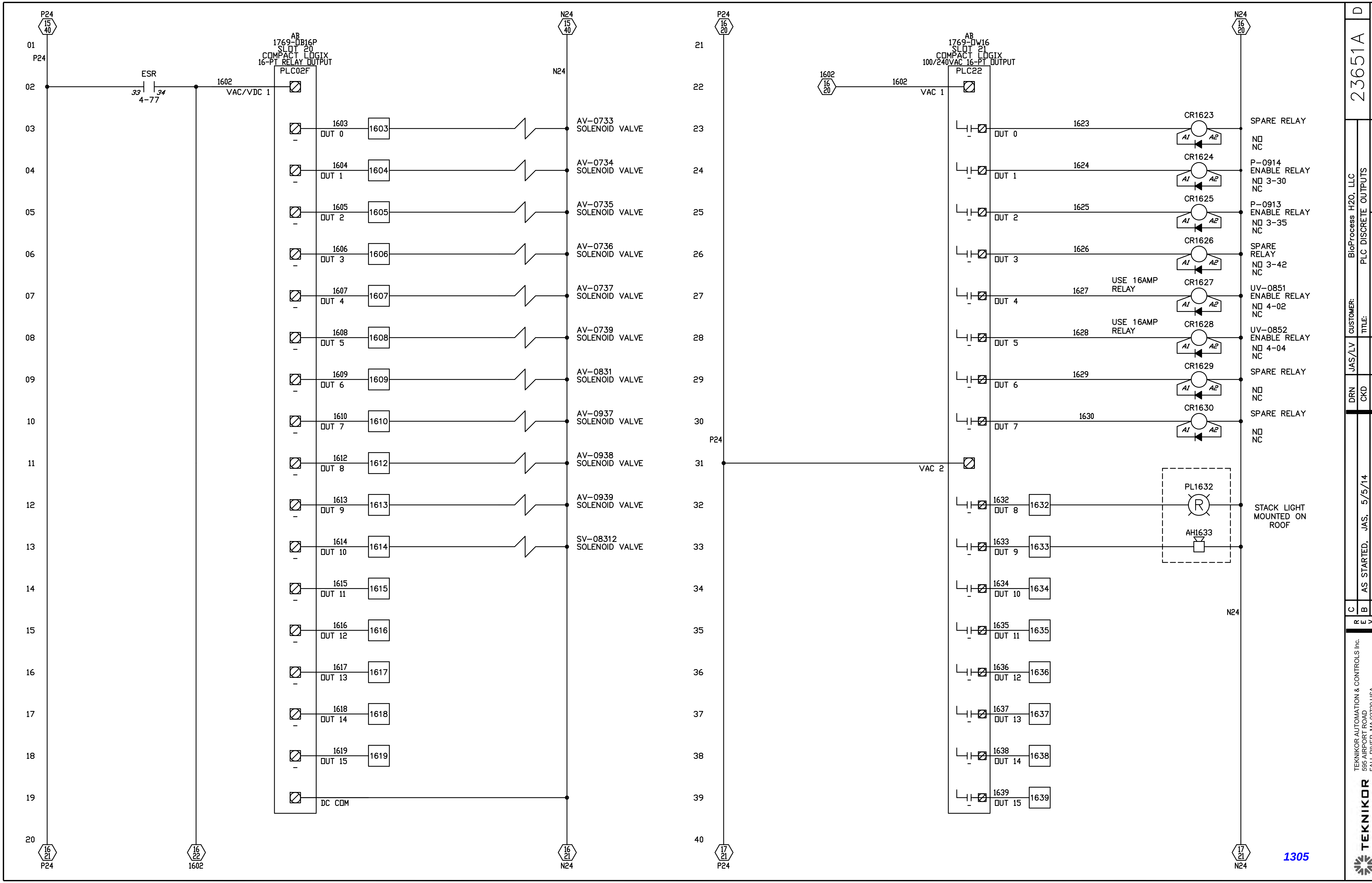

AB
1769-OB16P
SLOT 20
COMPACT LOGIX
16-PT RELAY OUTPUT
PLC02F
ESR
33 34
4-77
1602
VAC/VDC 1
P24
N24
1603 OUT 0 1603 AV-0733 SOLENOID VALVE
1604 OUT 1 1604 AV-0734 SOLENOID VALVE
1605 OUT 2 1605 AV-0735 SOLENOID VALVE
1606 OUT 3 1606 AV-0736 SOLENOID VALVE
1607 OUT 4 1607 AV-0737 SOLENOID VALVE
1608 OUT 5 1608 AV-0739 SOLENOID VALVE
1609 OUT 6 1609 AV-0831 SOLENOID VALVE
1610 OUT 7 1610 AV-0937 SOLENOID VALVE
1612 OUT 8 1612 AV-0938 SOLENOID VALVE
1613 OUT 9 1613 AV-0939 SOLENOID VALVE
1614 OUT 10 1614 SV-08312 SOLENOID VALVE
1615 OUT 11 1615
1616 OUT 12 1616
1617 OUT 13 1617
1618 OUT 14 1618
1619 OUT 15 1619
DC COM
AB
1769-OW16
SLOT 21
COMPACT LOGIX
100/240VAC 16-PT OUTPUT
PLC22
1602
VAC 1
1623 OUT 0 CR1623 SPARE RELAY NO NC
1624 OUT 1 CR1624 P-0914 ENABLE RELAY NO 3-30 NC
1625 OUT 2 CR1625 P-0913 ENABLE RELAY NO 3-35 NC
1626 OUT 3 CR1626 SPARE RELAY NO 3-42 NC
1627 OUT 4 USE 16AMP RELAY CR1627 UV-0851 ENABLE RELAY NO 4-02 NC
1628 OUT 5 USE 16AMP RELAY CR1628 UV-0852 ENABLE RELAY NO 4-04 NC
1629 OUT 6 CR1629 SPARE RELAY NO NC
1630 OUT 7 CR1630 SPARE RELAY NO NC
A1 A2
VAC 2
1632 OUT 8 1632 PL1632 R
1633 OUT 9 1633 AH1633
STACK LIGHT MOUNTED ON ROOF
1634 OUT 10 1634
1635 OUT 11 1635
1636 OUT 12 1636
1637 OUT 13 1637
1638 OUT 14 1638
1639 OUT 15 1639
16 21 P24
16 22 1602
16 21 N24
17 21 P24
17 21 N24
1305
23651A D
SHEET 16 OF 40
CUSTOMER: BioProcess H2O, LLC
TITLE: PLC DISCRETE OUTPUTS
FILE NAME: 23651A16.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14
REV
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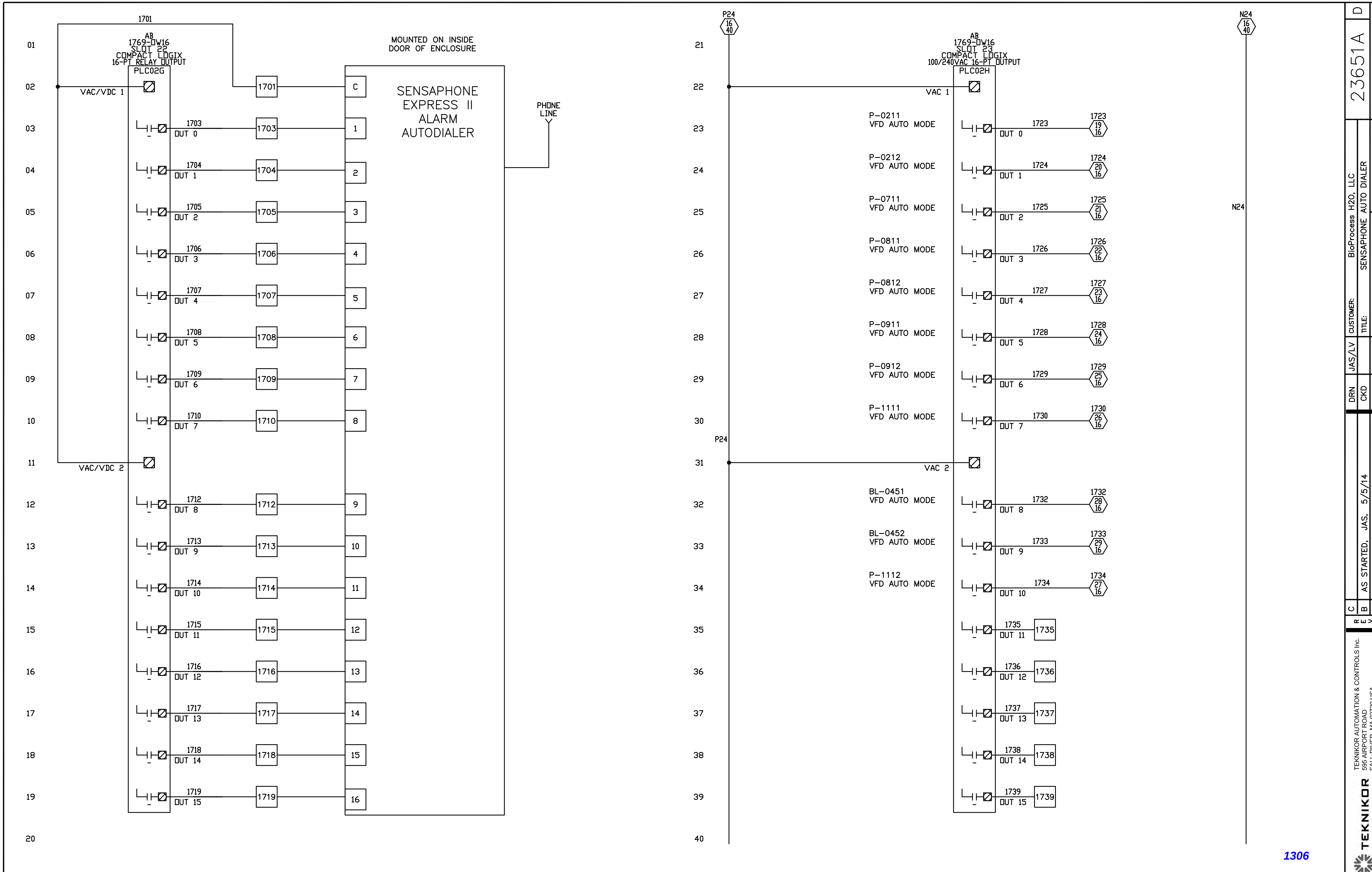

AB
1769-OW16
SLOT 22
COMPACT LOGIX
16-PT RELAY OUTPUT
PLC02G
VAC/VDC 1
VAC/VDC 2
1701
1703 OUT 0
1704 OUT 1
1705 OUT 2
1706 OUT 3
1707 OUT 4
1708 OUT 5
1709 OUT 6
1710 OUT 7
1712 OUT 8
1713 OUT 9
1714 OUT 10
1715 OUT 11
1716 OUT 12
1717 OUT 13
1718 OUT 14
1719 OUT 15
MOUNTED ON INSIDE
DOOR OF ENCLOSURE
SENSAPHONE
EXPRESS II
ALARM
AUTODIALER
C 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
PHONE
LINE
P24
N24
AB
1769-OW16
SLOT 23
COMPACT LOGIX
100/240VAC 16-PT OUTPUT
PLC02H
VAC 1
VAC 2
P-0211 VFD AUTO MODE
P-0212 VFD AUTO MODE
P-0711 VFD AUTO MODE
P-0811 VFD AUTO MODE
P-0812 VFD AUTO MODE
P-0911 VFD AUTO MODE
P-0912 VFD AUTO MODE
P-1111 VFD AUTO MODE
BL-0451 VFD AUTO MODE
BL-0452 VFD AUTO MODE
P-1112 VFD AUTO MODE
1723 OUT 0
1724 OUT 1
1725 OUT 2
1726 OUT 3
1727 OUT 4
1728 OUT 5
1729 OUT 6
1730 OUT 7
1732 OUT 8
1733 OUT 9
1734 OUT 10
1735 OUT 11
1736 OUT 12
1737 OUT 13
1738 OUT 14
1739 OUT 15
23651A
SHEET 17 OF 40
D
CUSTOMER: BioProcess H2O, LLC
TITLE: SENSAPHONE AUTO DIALER
FILE NAME: 23651A17.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14
REV
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REV		
C		
B	AS STARTED, JAS, 5/5/14	
A	AS SHIPPED, JAS, 2/12/14	

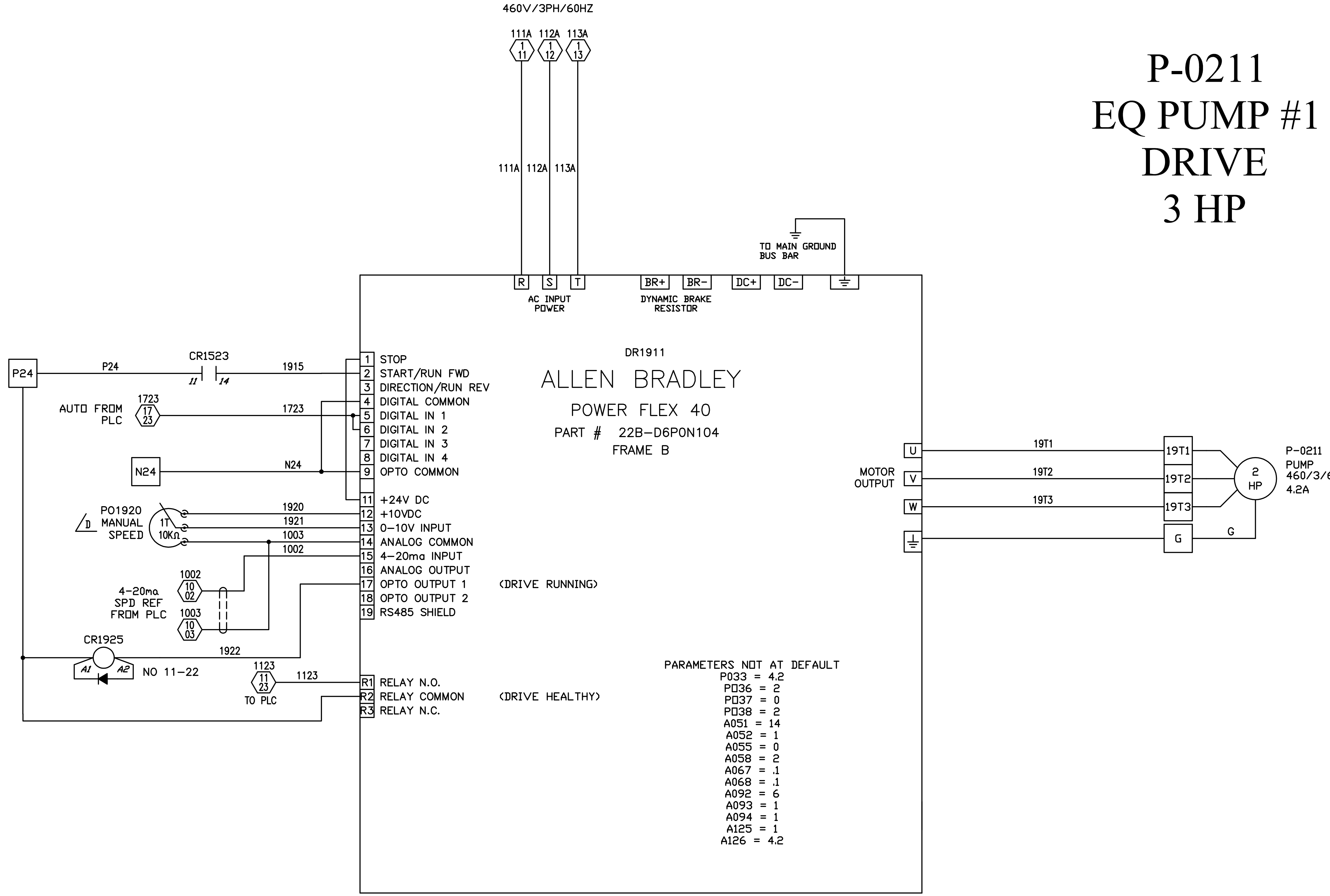
DRN JAS/LV
CKD
APP'D

CUSTOMER: BioProcess H2O, LLC
TITLE: SPARE DRAWING
FILE NAME: 23651A18.DWG
DATE: 10/4/13

D
23651A
SHEET 18 OF 40

1307

P-0211
EQ PUMP #1
DRIVE
3 HP



CUSTOMER: BioProcess H2O, LLC
TITLE: P-0211 DRIVE SCHEMATIC
FILE NAME: 23651A19.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
23651A D
SHEET 19 OF 40

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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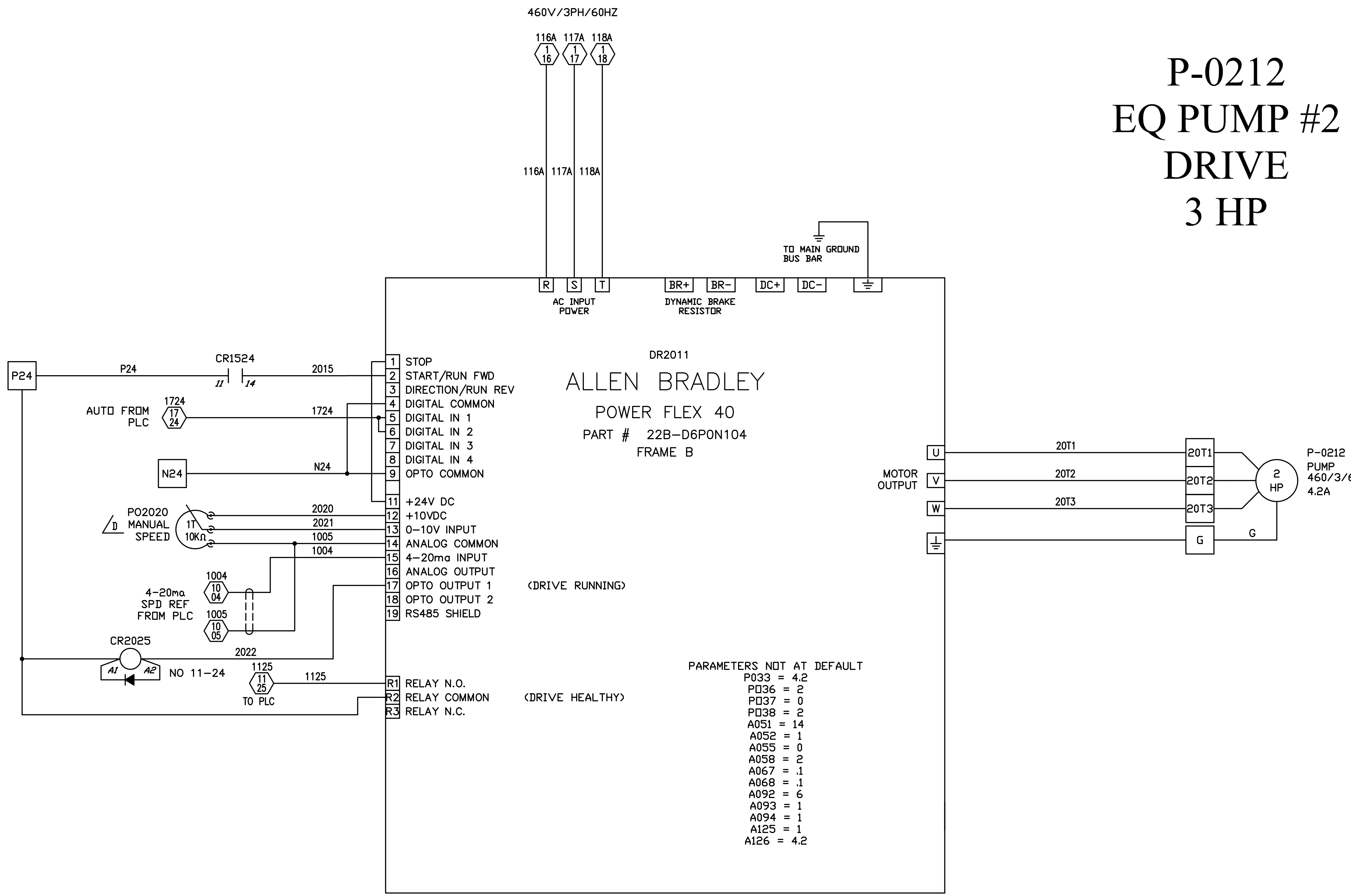
P-0212
EQ PUMP #2
DRIVE
3 HP



23651A D
SHEET 20 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: P-0212 DRIVE SCHEMATIC
FILE NAME: 23651A20.DWG DATE: 10/4/13

DRN JAS/LV CKD APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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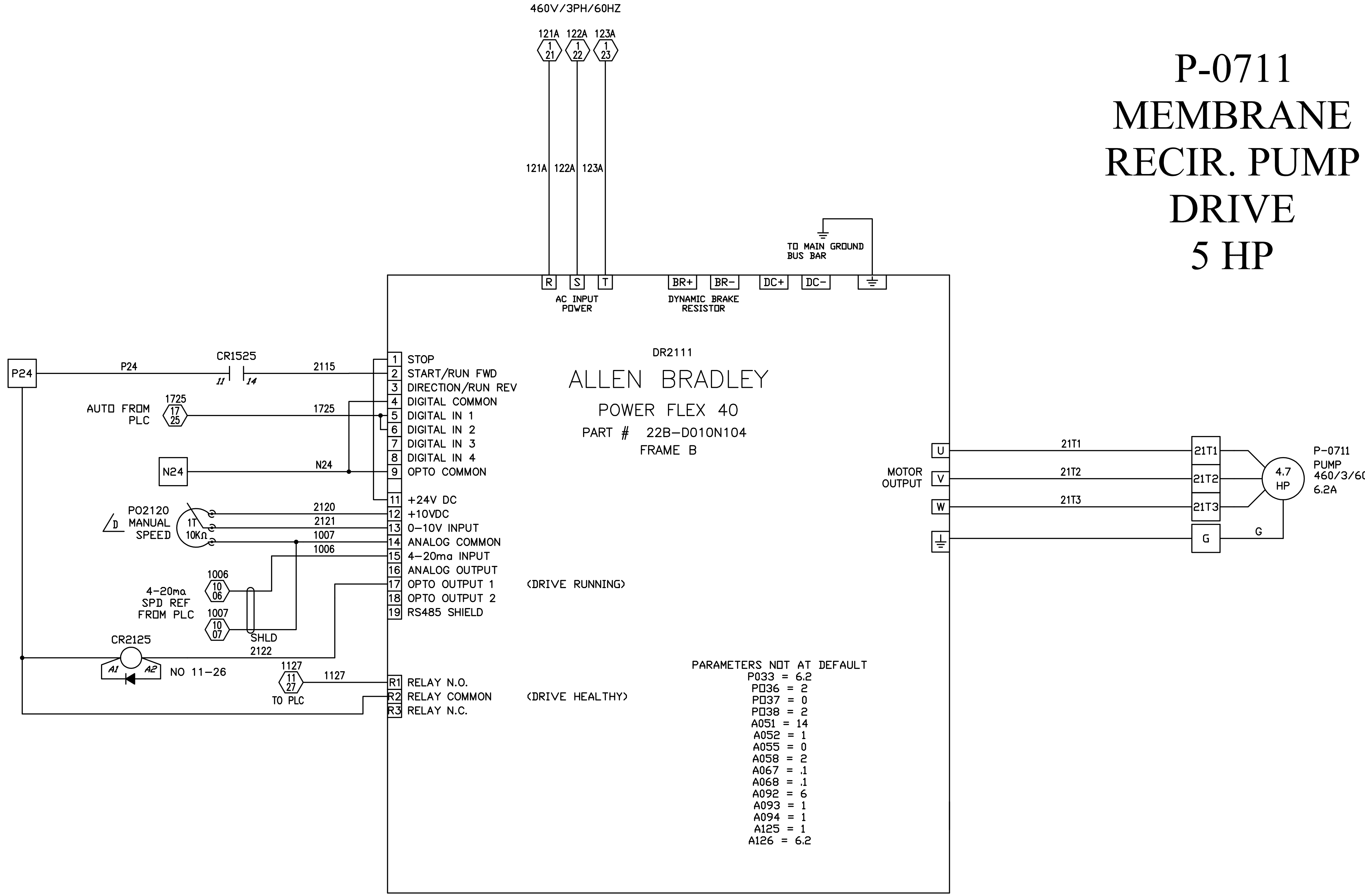
P-0711
MEMBRANE RECIR. PUMP DRIVE
5 HP



CUSTOMER:	BioProcess H2O, LLC
TITLE:	P-0711 DRIVE SCHEMATIC
FILE NAME:	23651A21.DWG
DATE:	10/4/13
DRN	JAS/LV
CKD	
APP'D	

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

23651A D
SHEET 21 OF 40

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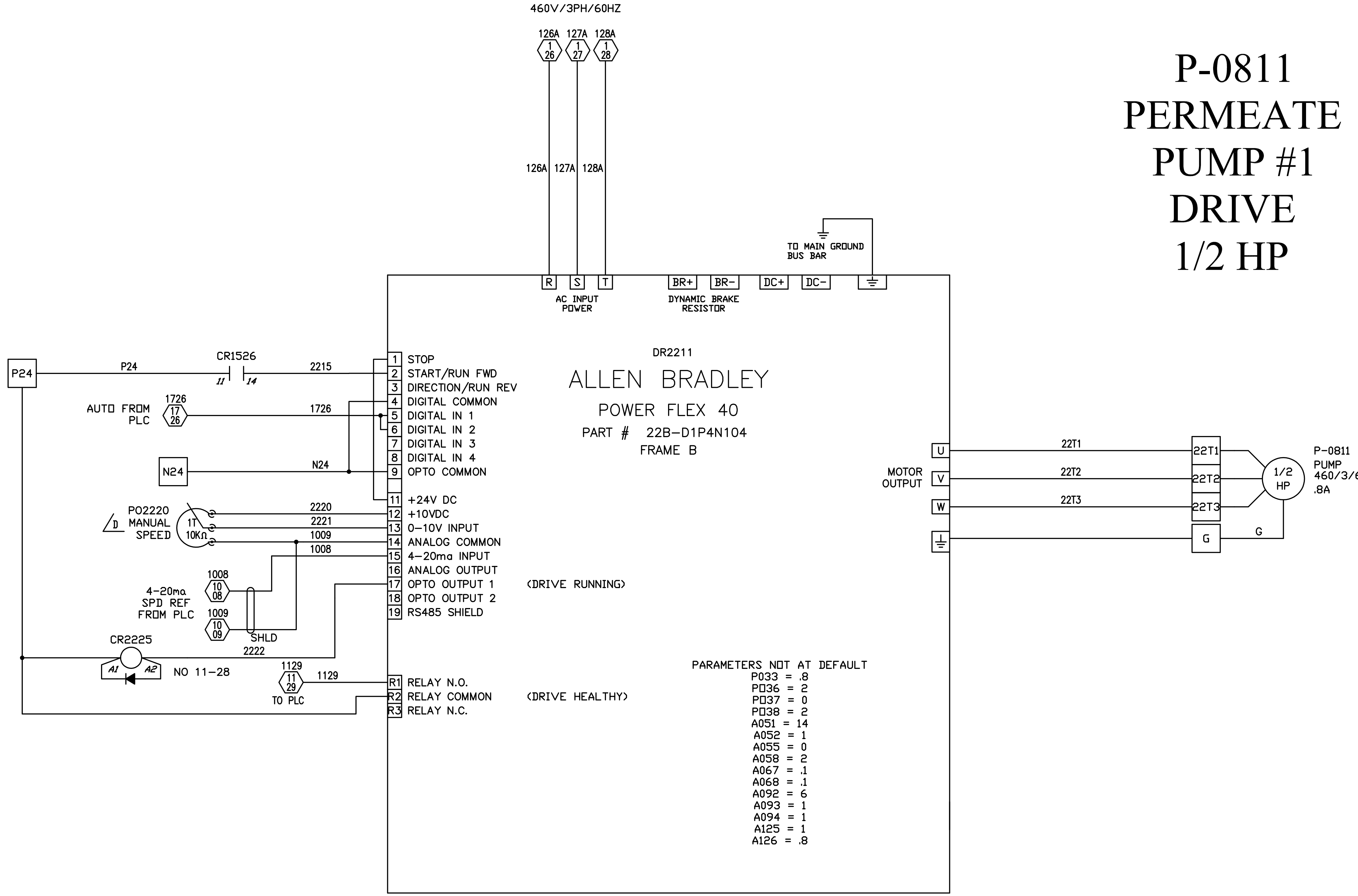
1310



P-0811 PERMEATE PUMP #1 DRIVE 1/2 HP

23651A D
SHEET 22 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: P-0811 DRIVE SCHEMATIC
FILE NAME: 23651A22.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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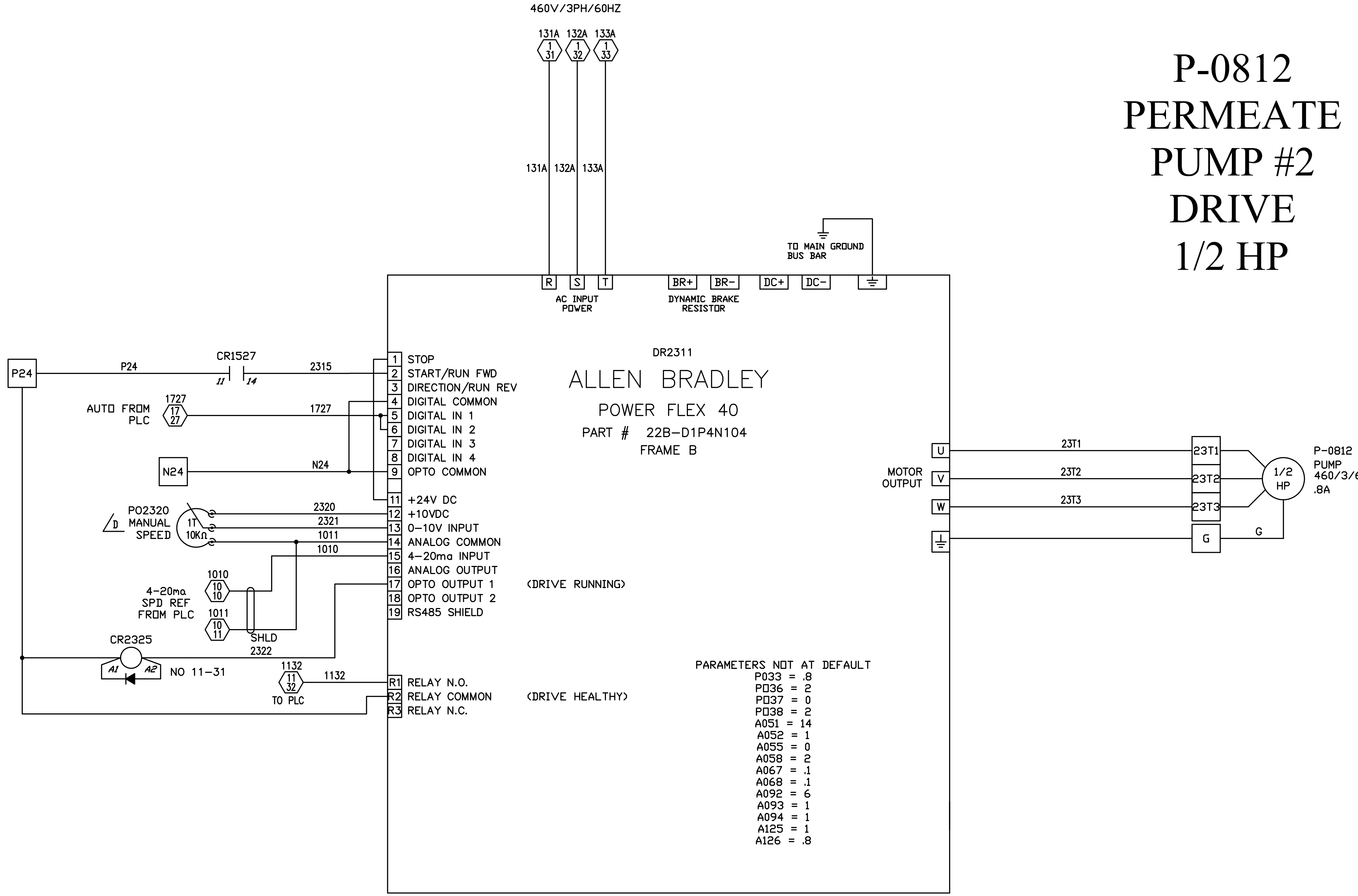
P-0812 PERMEATE PUMP #2 DRIVE 1/2 HP



23651A D
SHEET 23 OF 40
CUSTOMER: BioProcess H2O, LLC
TITLE: P-0812 DRIVE SCHEMATIC
FILE NAME: 23651A23.DWG DATE: 10/4/13
DRN JAS/LV CKD APP'D
REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14

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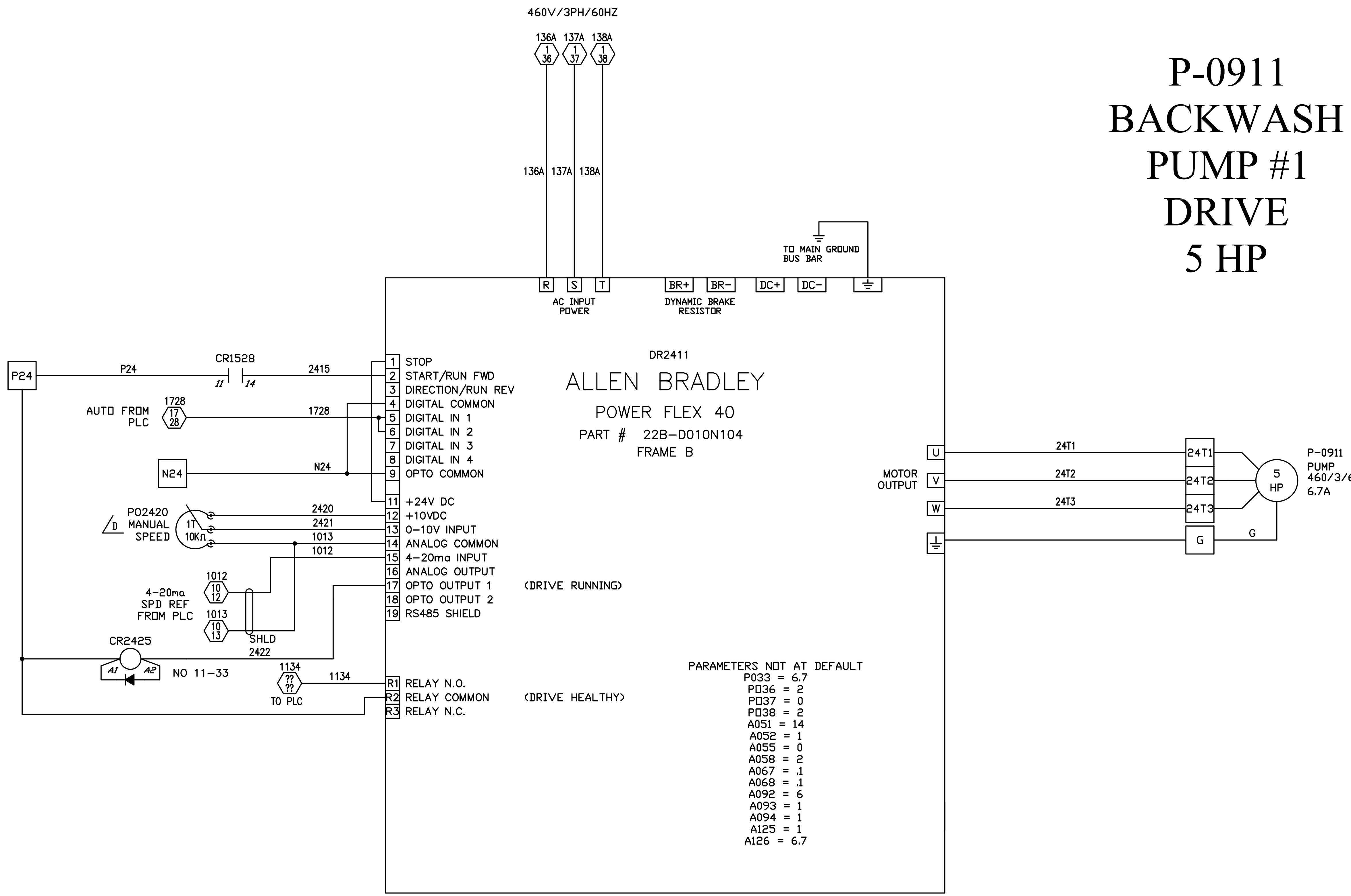
P-0911 BACKWASH PUMP #1 DRIVE 5 HP



23651A D
SHEET 24 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: P-0911 DRIVE SCHEMATIC
FILE NAME: 23651A24.DWG DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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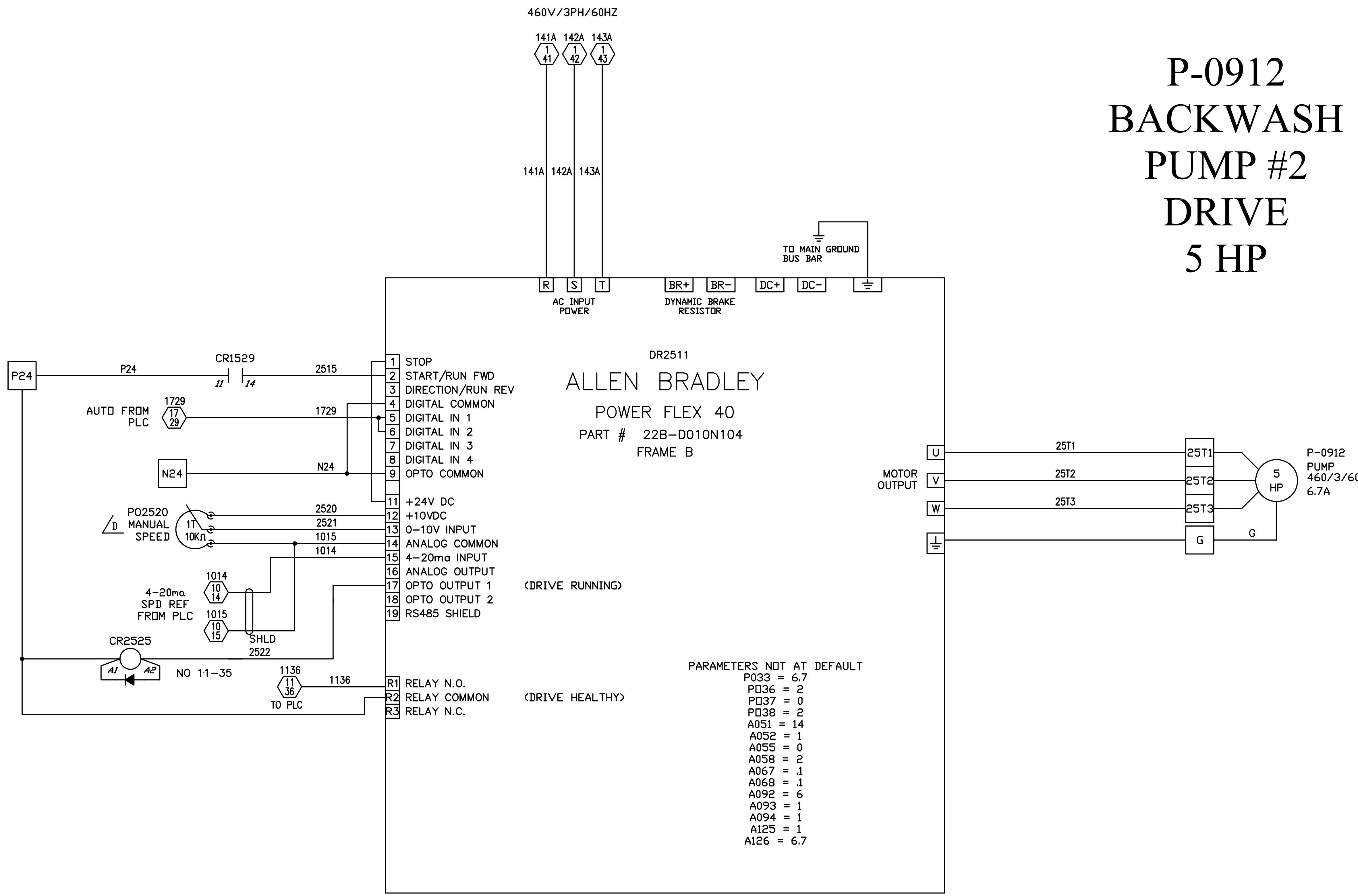
P-0912 BACKWASH PUMP #2 DRIVE 5 HP



CUSTOMER: BioProcess H2O, LLC
TITLE: P-0912 DRIVE SCHEMATIC
FILE NAME: 23651A25.DWG
DATE: 10/4/13
DRN CKD APP'D JAS/LV

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

23651A D
SHEET 25 OF 40

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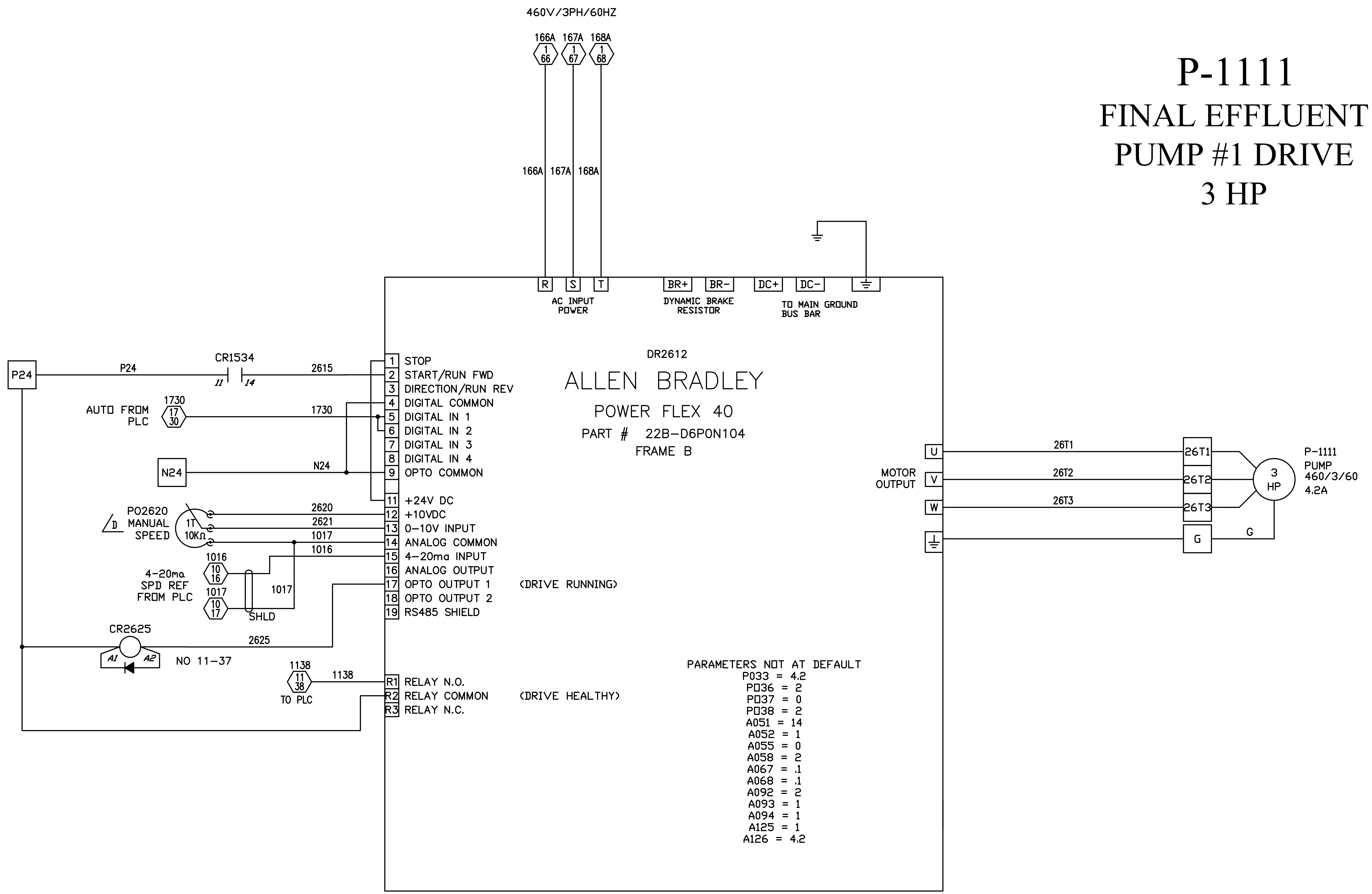
P-1111
FINAL EFFLUENT PUMP #1 DRIVE 3 HP



CUSTOMER:	BioProcess H2O, LLC
TITLE:	P-1111 DRIVE SCHEMATIC
FILE NAME:	23651A26.DWG
DATE:	10/4/13
DRN	JAS/LV
CKD	
APP'D	
SHEET	26 OF 40
	23651A D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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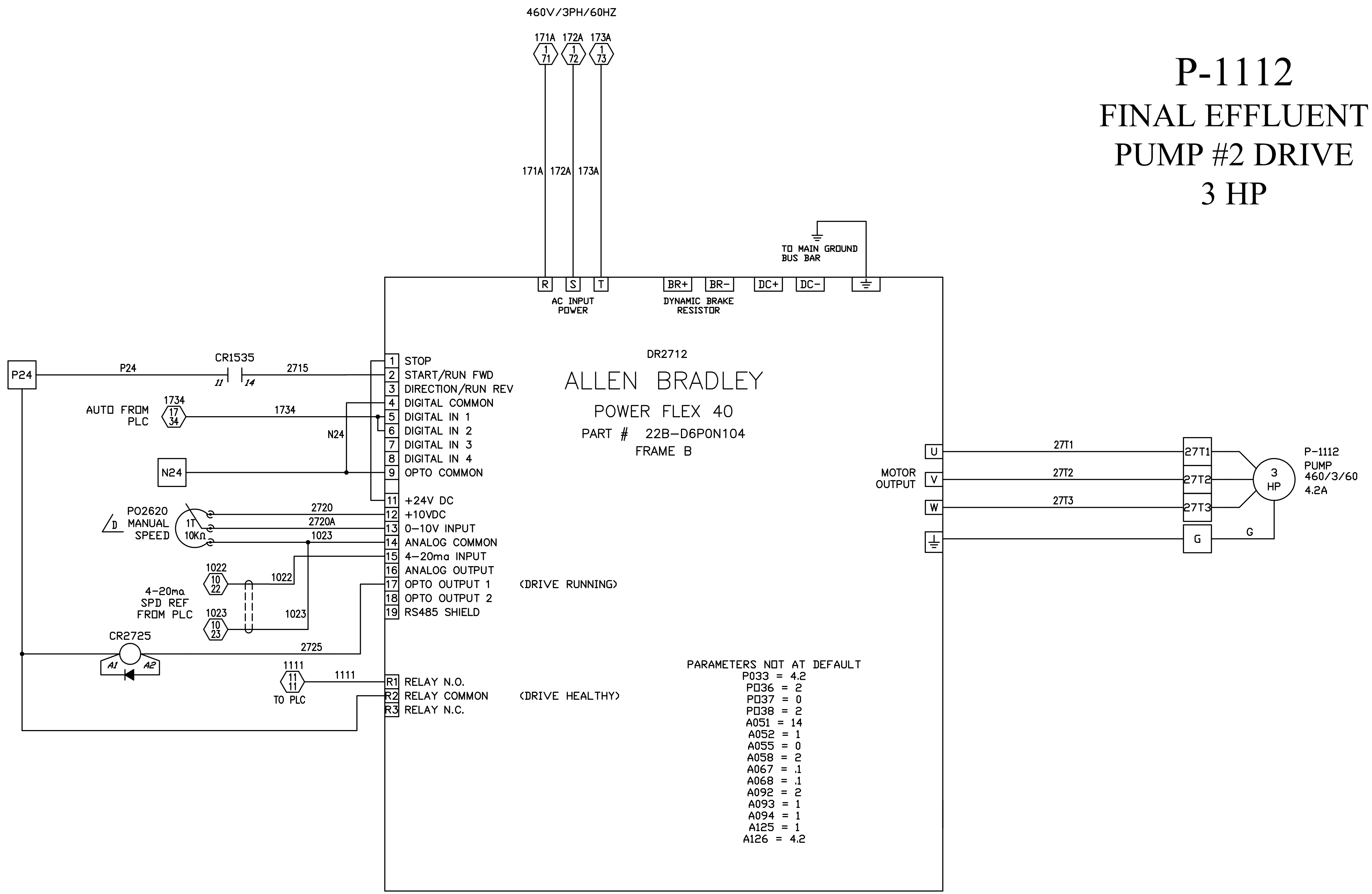
P-1112
FINAL EFFLUENT PUMP #2 DRIVE
3 HP



CUSTOMER: BioProcess H2O, LLC
TITLE: P-1112 DRIVE SCHEMATIC
FILE NAME: 23651A27.DWG
DATE: 10/4/13

23651A
D
SHEET 27 OF 40

DRN: JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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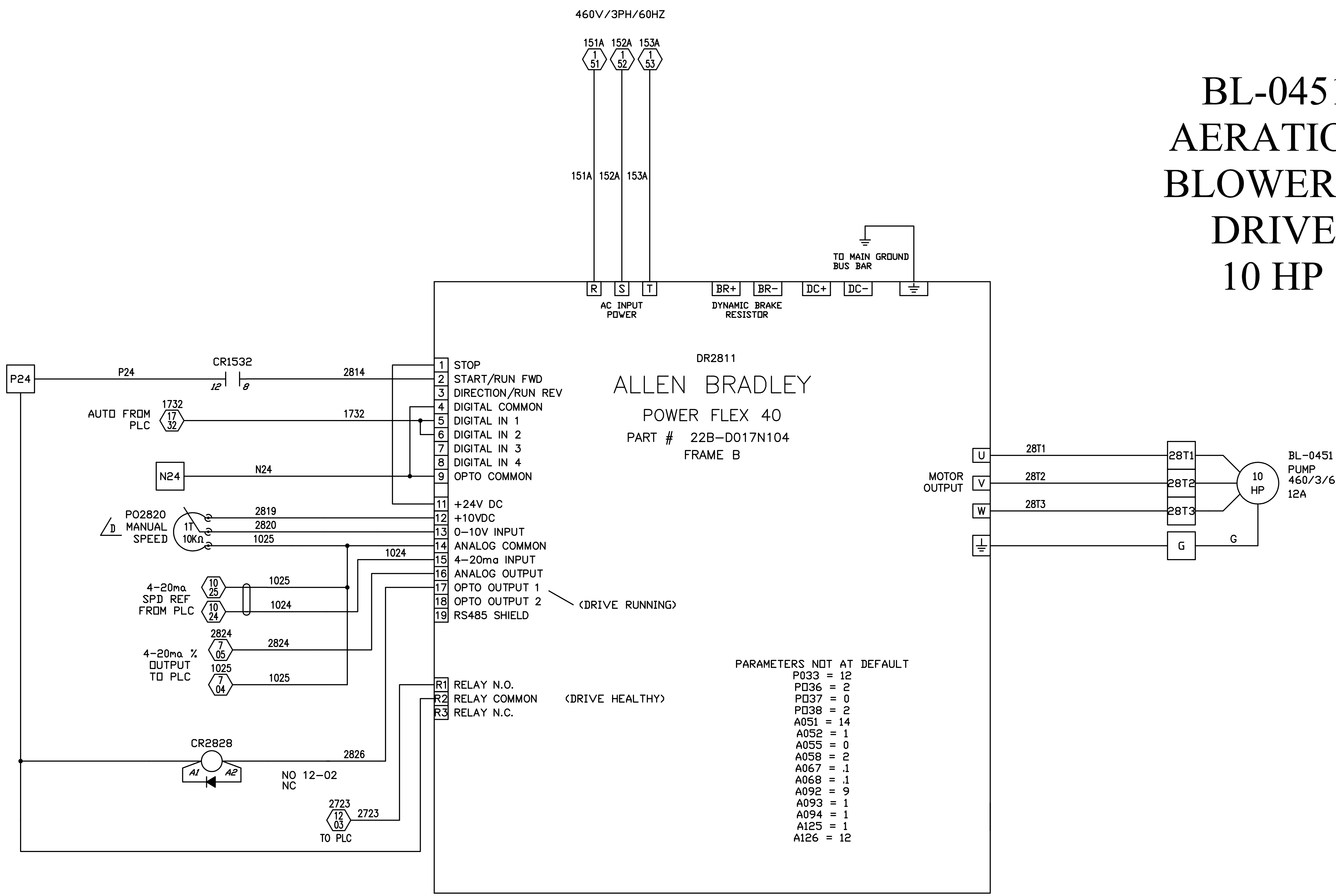
BL-0451
AERATION BLOWER #1 DRIVE
10 HP



23651A D
SHEET 28 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: BL-0451 DRIVE SCHEMATIC
FILE NAME: 23651A28.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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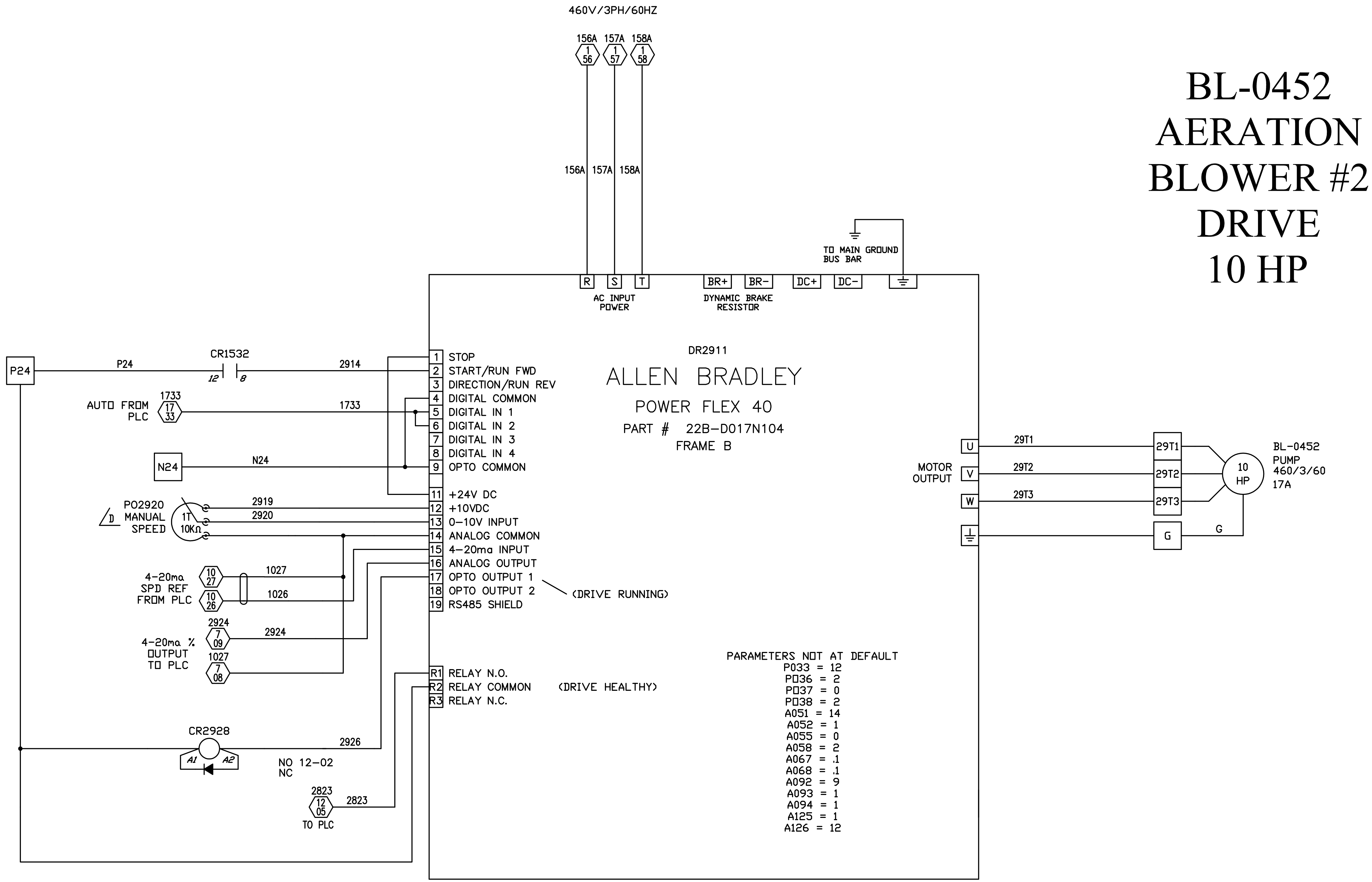
BL-0452 AERATION BLOWER #2 DRIVE 10 HP



CUSTOMER: BioProcess H2O, LLC
TITLE: BL-0451 DRIVE SCHEMATIC
FILE NAME: 23651A29.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D

23651A D
SHEET 29 OF 40

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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1319

REV		
C		
B	AS STARTED, JAS, 5/5/14	
A	AS SHIPPED, JAS, 2/12/14	

DRN	JAS/LV	CUSTOMER: BioProcess H2O, LLC
CKD		TITLE: SPARE DRAWING
APP'D		FILE NAME: 23651A30.DWG DATE: 10/4/13

23651A D
SHEET 30 OF 40

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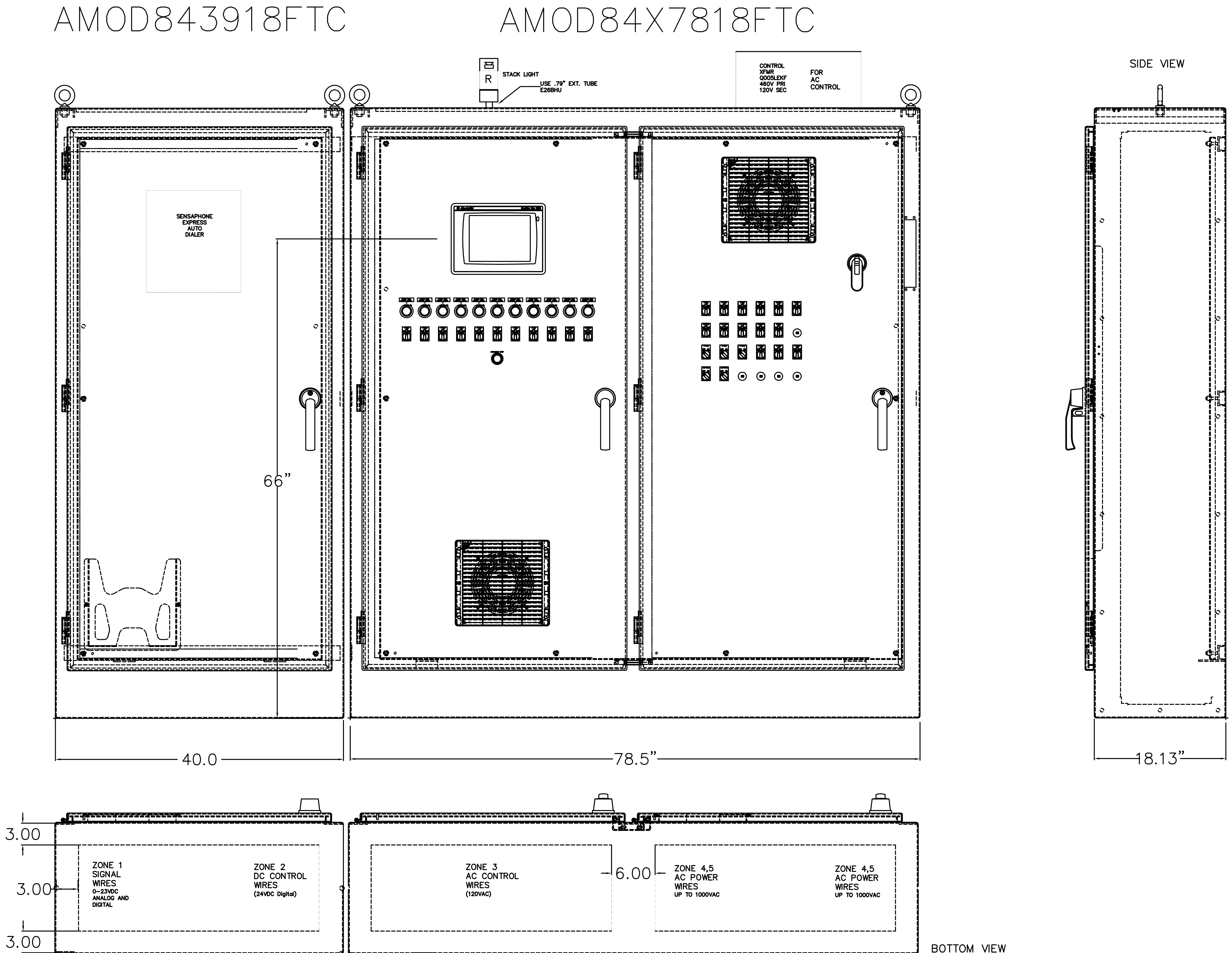

BOTTOM CUTOUT OF ENCLOSURE SHOWN IN DASHED LINES
ALL DIMENSIONS SHOWN IN INCHES UNLESS OTHERWISE SPECIFIED.

1320

CUSTOMER:	BioProcess H2O, LLC		
TITLE:	ENCLOSURE LAYOUT		
FILE NAME:	23651A31.DWG	DATE:	10/4/13
DRN	JAS/LV		
CKD			
APP'D			
23651A	D		
SHEET	31	OF	40

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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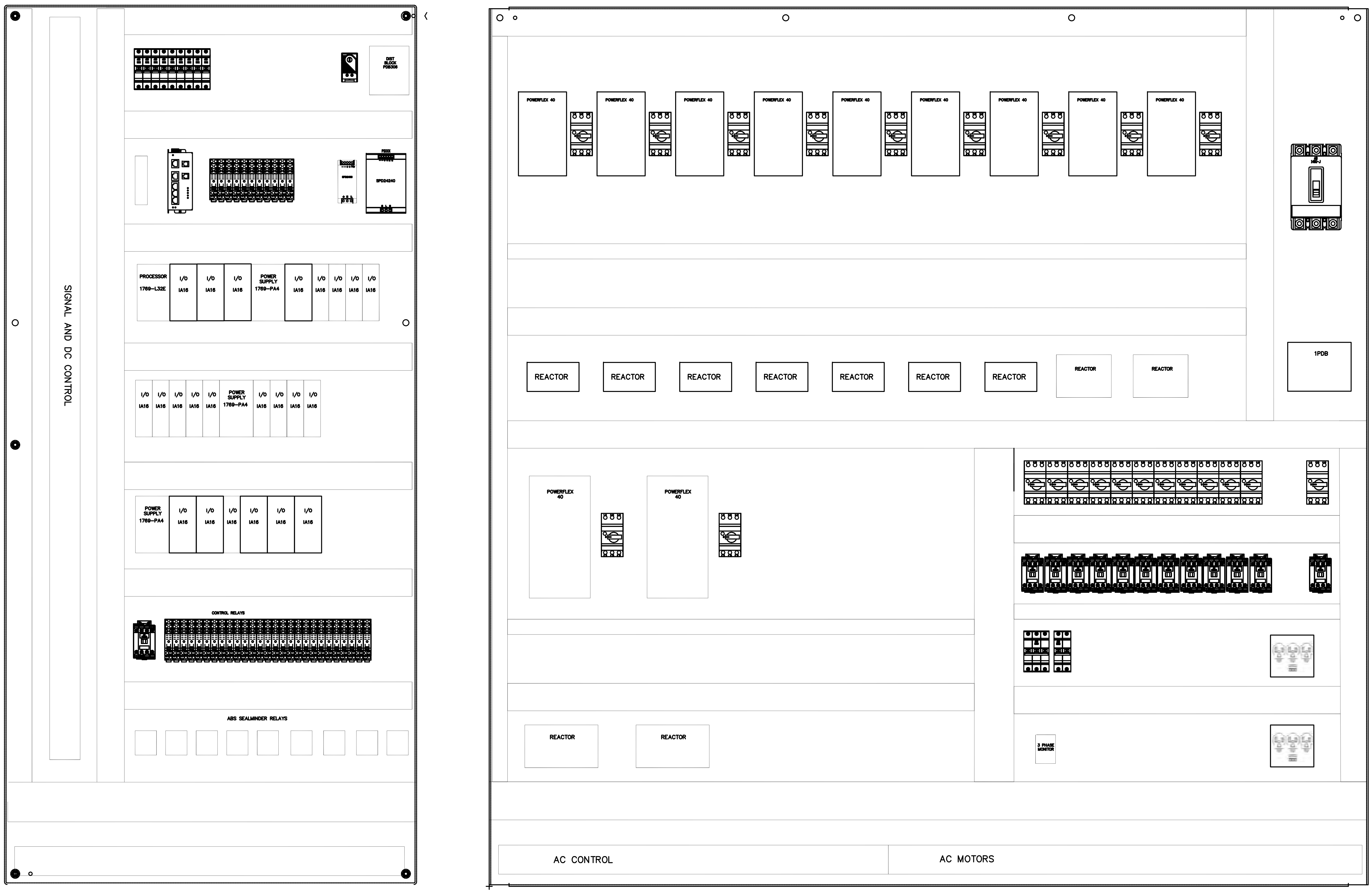

CUSTOMER:	BioProcess H2O, LLC
TITLE:	MAIN PANEL LAYOUT
FILE NAME:	23651A32.DWG
DATE:	10/4/13
DRN	JAS/LV
CKD	
APP'D	

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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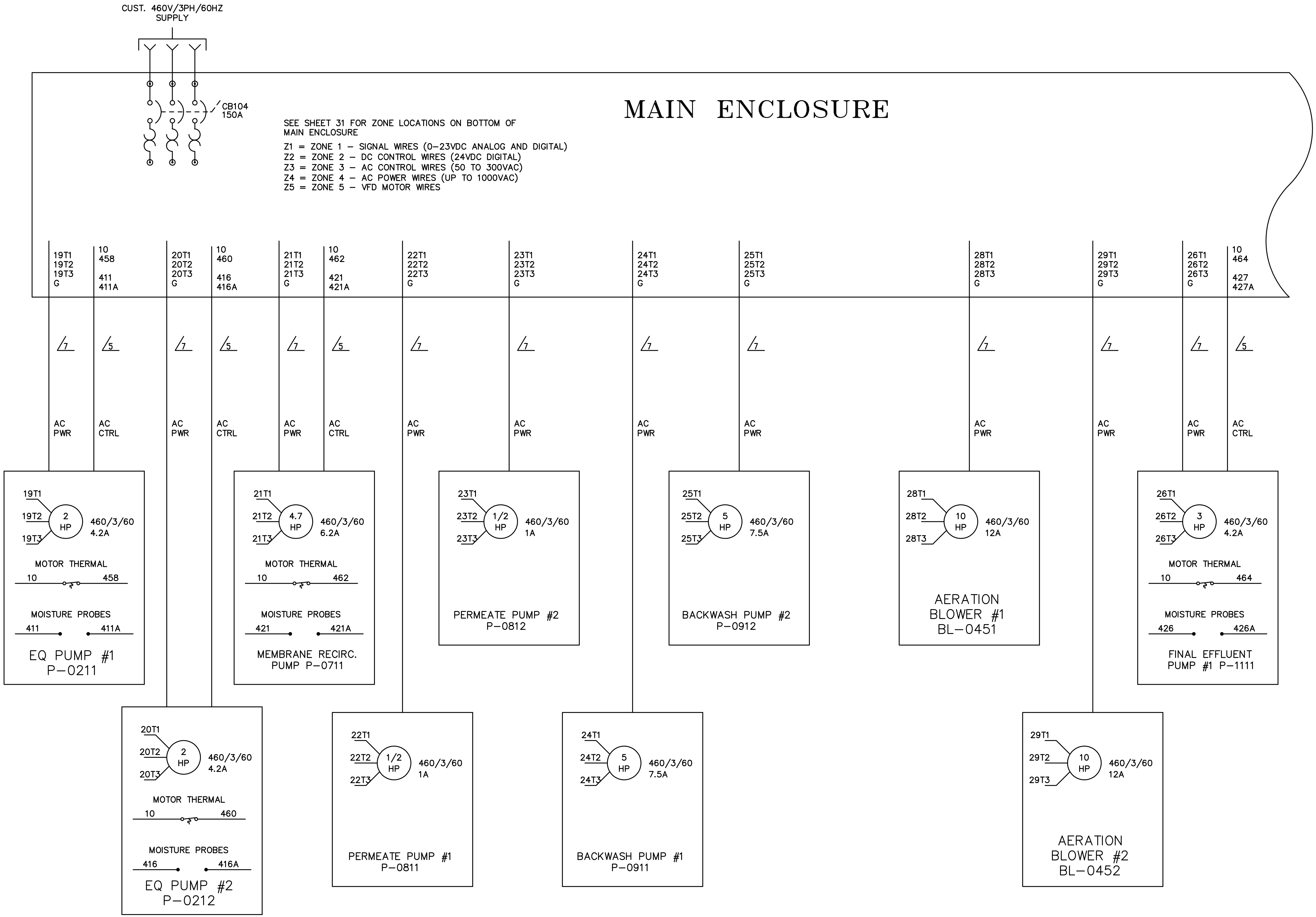
23651A D

SHEET 32 OF 40



1322

CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A33.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14

23651A D
SHEET 33 OF 40

TEKNIKOR
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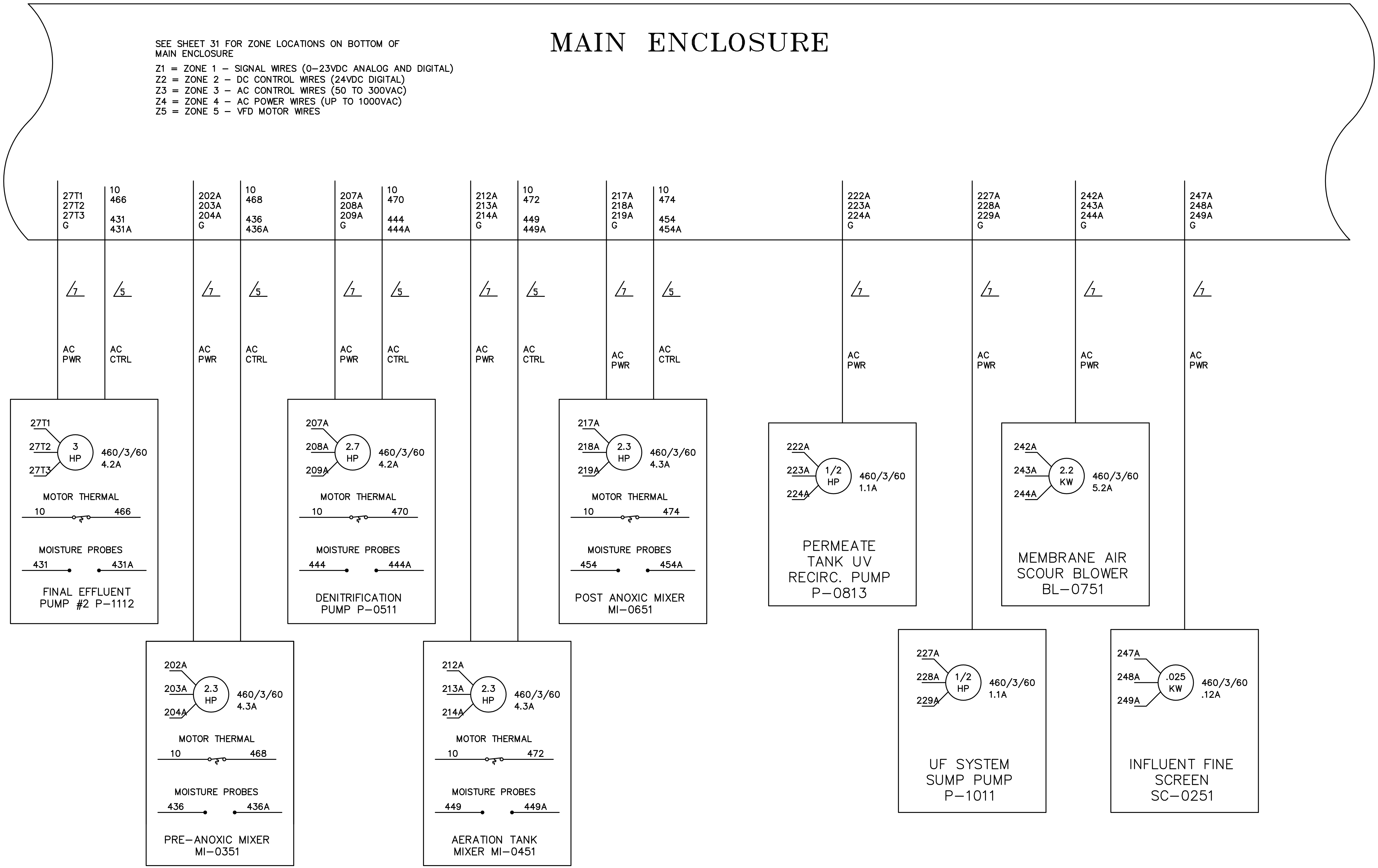

1323

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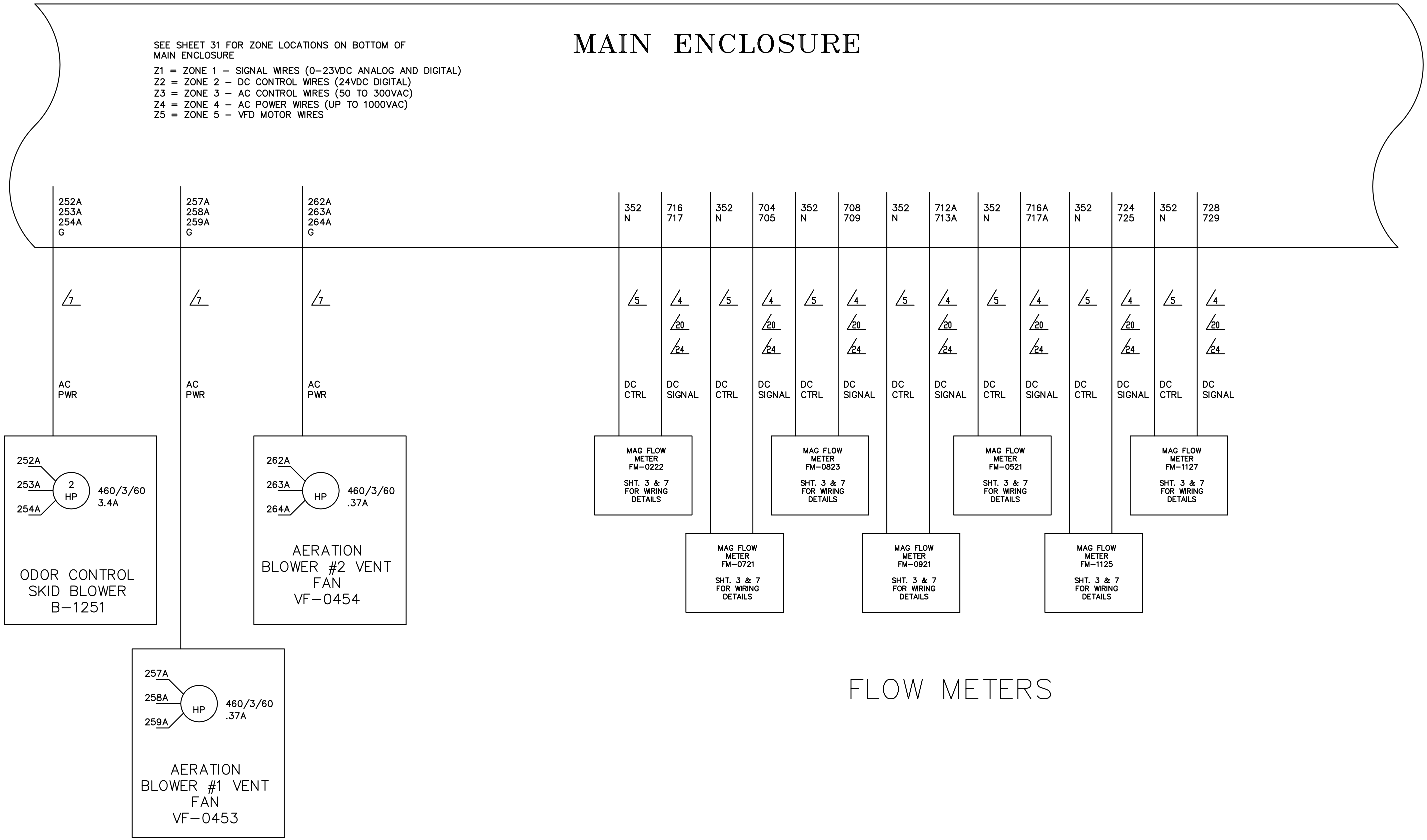
REV		
C		
B	AS STARTED, JAS, 5/5/14	
A	AS SHIPPED, JAS, 2/12/14	

DRN JAS/LV
CKD
APP'D

CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A34.DWG DATE: 10/4/13

23651A D
SHEET 34 OF 40



1324

CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A35.DWG
DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
REV
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14
TEKNIKOR AUTOMATION & CONTROLS Inc.
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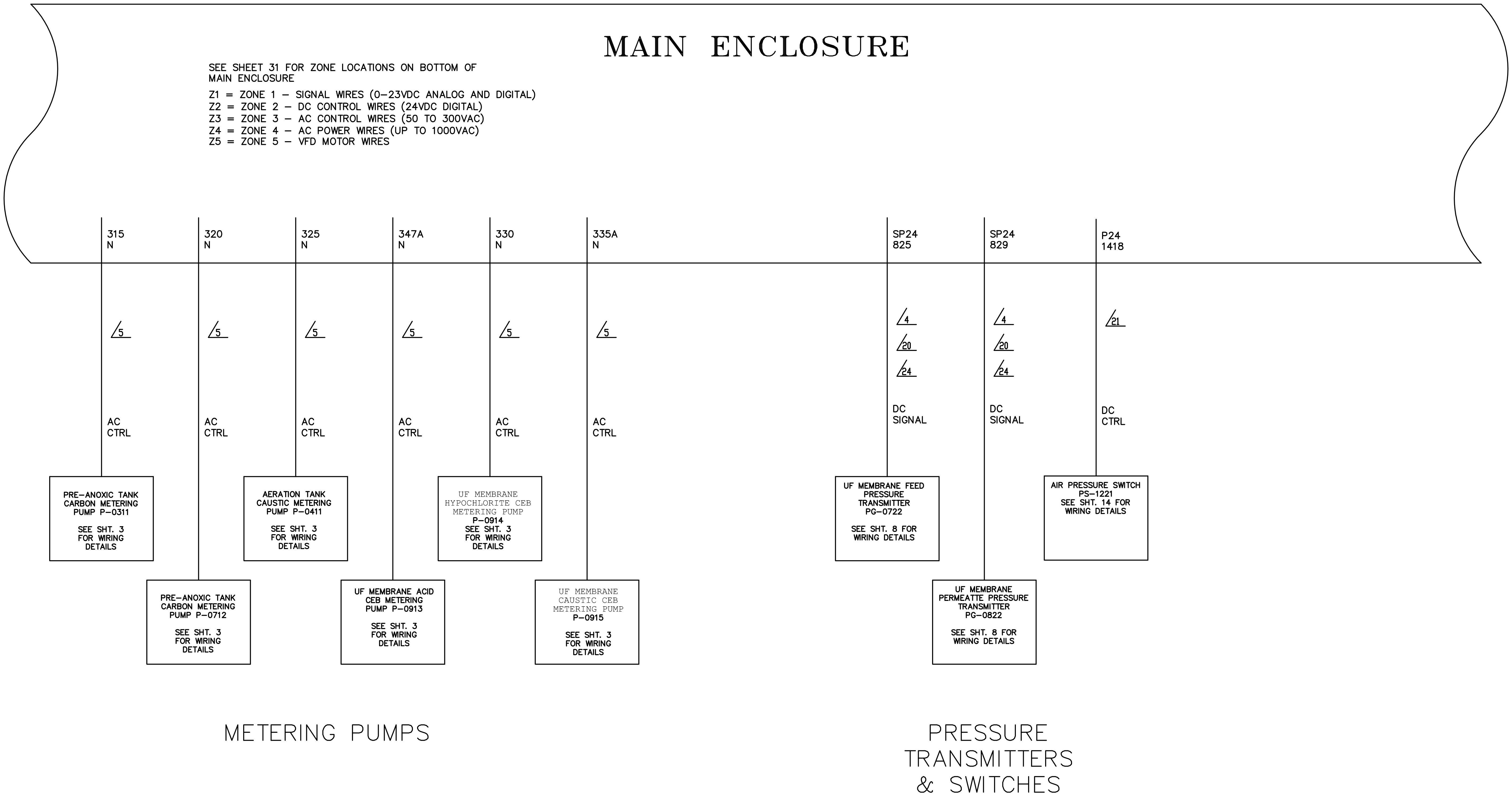
TEKNIKOR
23651A D
SHEET 35 OF 40



CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A36.DWG
DATE: 10/4/13
DRN: JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

23651A D
SHEET 36 OF 40

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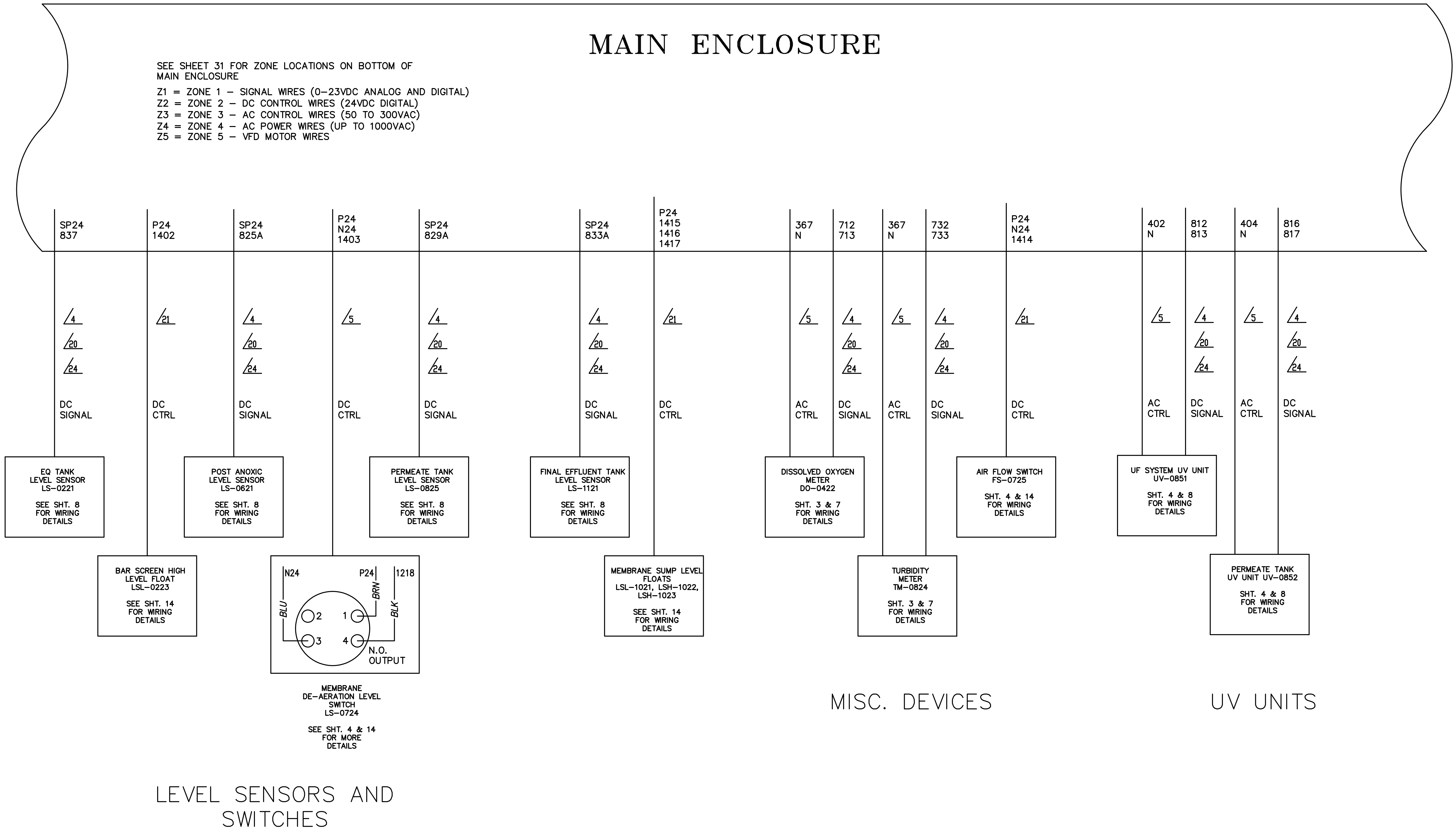

23651A D
SHEET 37 OF 40

CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A37.DWG
DATE: 10/4/13

DRN JAS/LV
CKD
APP'D

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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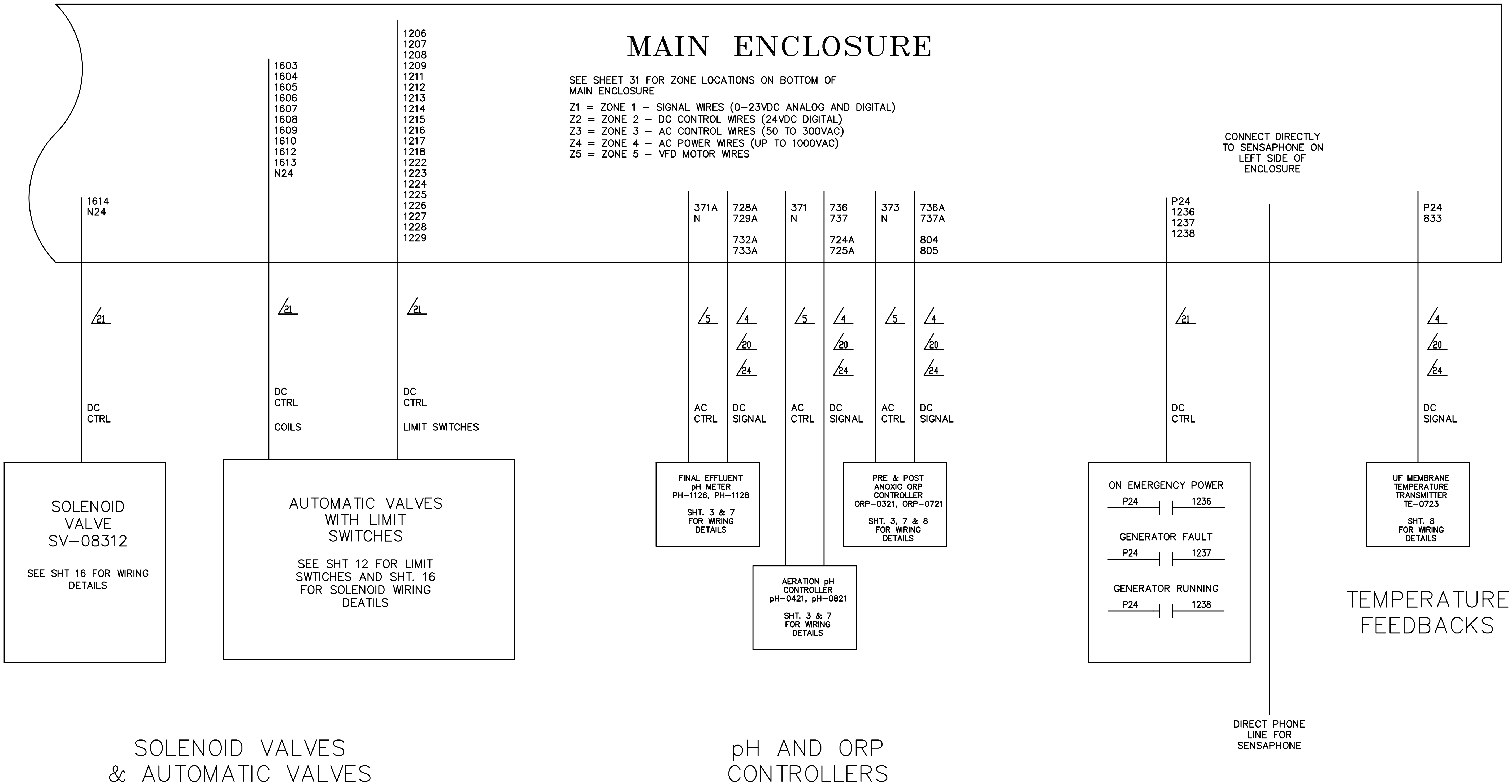

23651A D
SHEET 38 OF 40
CUSTOMER: BioProcess H2O, LLC
TITLE: INTERCONNECT DIAGRAM
FILE NAME: 23651A38.DWG DATE: 10/4/13
DRN JAS/LV
CKD
APP'D
C
B AS STARTED, JAS, 5/5/14
A AS SHIPPED, JAS, 2/12/14
REV
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1328

DRN	JAS/LV
CKD	
APP'D	
CUSTOMER:	BioProcess H2O, LLC
TITLE:	INTERCONNECT DIAGRAM
FILE NAME:	23651A39.DWG
DATE:	10/4/13
	23651A
	D
SHEET	39 OF 40

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

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STANDARD NOTES

THIS IS AN EXPLANATION OF ALL THE STANDARDIZED NOTES. ONLY THOSE INDICATED ON THE SCHEMATIC AND INTERCONNECTION DIAGRAMS WITH THE /xx SYMBOL APPLY TO THIS SET OF DRAWINGS

AC CONTROL NOTES

(50 TO 300V AC WIRING)

/5 USE #14 AWG WIRE MINIMUM IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE.

/10 USE #12 AWG WIRE MINIMUM IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE.

AC/DC POWER NOTES

(AC AND DC POWER CIRCUIT UP TO 1000V)

/6 USE OF GROUNDED SUPPLY MAINS MAY CAUSE DAMAGE TO DRIVE. CHECK ISOLATION TRANSFORMER SECONDARY. IF WYE CONNECTED, REMOVE GROUNDING STRAP. (IF ANY), BEFORE ENERGIZING THE DRIVE.

/7 POWER CONDUCTORS MUST CONFORM WITH THE CURRENT NATIONAL ELECTRIC CODE AND ANY OTHER APPLICABLE LOCAL ORDINANCES. AMPACITY OF FEEDERS MUST BE AT LEAST 125% OF MOTOR FULL LOAD CURRENT.

/8 CONSULT THE TRANSFORMER NAMEPLATE FOR PROPER CONNECTIONS.

/11 REFER TO THE DRIVE INSTRUCTION MANUAL FOR AC FEEDER AND MOTOR WIRE SIZES.

SIGNAL WIRE NOTE

(0 TO 23V ANALOG AND DIGITAL SIGNALS)

/4 USE SHIELDED CABLE. GROUND THE SHIELD AT CONTROLLER END ONLY.

/17 USE TWO CONDUCTOR TWISTED PAIR WITH A 1 TWIST–PER–INCH MINIMUM.

/18 USE THREE CONDUCTOR TWISTED PAIR WITH A 1 TWIST–PER–INCH MINIMUM.

/19 CONDUCTORS MUST BE RUN IN A SEPARATE SIGNAL CONDUIT. MUST NOT BE RUN WITH OTHER SIGNAL OR POWER WIRING.

/20 SIGNAL WIRES WITH THIS NOTE CAN BE RUN IN THE SAME SIGNAL CONDUIT.

/20-1 REFER TO NOTE #20. WHEN MORE THAN ONE SIGNAL CONDUIT IS REQUIRED, THE DASH–NUMBER IDENTIFIES THE WIRES IN EACH SIGNAL CONDUIT. DO NOT MIX CONDUIT GROUPS; (IE. 20–1 WIRES MUST BE IN A SEPARATE CONDUIT FROM 20–2 WIRES, ETC.).

DC CONTROL NOTES

(24 TO 50V ANALOG & CONTROL)

/21 USE #16 AWG WIRE MINIMUM IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE.

/22 USE #18 AWG WIRE MINIMUM IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE.

MOTOR NOTE

/1 MOTORS ARE SHOWN CONNECTED FOR CCW ROTATION FACING COMMUTATOR END. FOR OPPOSITE ROTATION, INTERCHANGE WIRES A1 & A2 AT AT THE MOTOR CONDUIT BOX. IF THE MOTOR USES A DC TACH, INTERCHANGE ITS' LEADS AS WELL. FOR AN ENCODER SWAP CHA AND CHA–NOT.

/2 IF MOTOR IS SUPPLIED WITH A SERIES FIELD, JUMPER MOTOR TERMINALS A2 & S1 TOGETHER AT THE MOTOR CONDUIT BOX. WIRE CONTROLLER TERMINALS A1 & A2 TO MOTOR TERMINALS A1 & S2 RESPECTIVELY.

/3 IF MOTOR THERMAL PROTECTOR IS NOT USED, JUMPER APPROPRIATE TERMINALS AT CONTROLLER TERMINAL BLOCK.

/12 DO NOT USE SERIES FIELD. INSULATE & TAPE S1 AND S2 LEADS SEPARATELY IN THE MOTOR CONDUIT BOX.

/16 CONNECT MOTOR TERMINALS T1,T2, & T3 TO CORRESPONDING CONTROLLER TERMINALS. IF RESULTANT MOTOR ROTATION IS NOT CORRECT, INTERCHANGE THE T1 & T3 CONNECTIONS.

LOCATION NOTE

/9 PART SUPPLIED SEPARATELY FOR INSTALLATION BY CUSTOMER

/13 SUPPLIED AND INSTALLED BY CUSTOMER.

/14 MOUNTED ON OPERATORS CONTROL STATION

/15 OPTIONAL PART OR CIRCUIT, MAY NOT BE USED IN THIS SYSTEM.

/D MOUNTED ON DOOR OF ENCLOSURE

FIELD WIRING NOTES

/23 COIL AND SOLENOID SUPPRESSION

1. ALL EXTERNAL RELAYS OR SOLENOIDS SHOULD HAVE ARC SUPPRESSION.
2. FOR AC CIRCUITS USE RC SNUBBERS AND FOR DC CIRCUITS USE DIODE SNUBBERS.
3. INSTALL THE SNUBBER AS CLOSE TO THE RELAY OR SOLENOID AS POSSIBLE. DIRECTLY ACCROSS THE RELAY OR SOLENOID TERMINALS IS IDEAL.
4. FAILURE TO INSTALL SNUBBER COULD LEAD TO PREMATURE FAILURE OF CONTROLLING DEVICE.

/24 SIGNAL WIRING NOTES:

1. SIGNAL WIRE SHOULD NOT BE TIED TO OR RUN WITH NON–SIGNAL WIRE AFTER ENTRY INTO THE ENCLOSURE.
2. SIGNAL AND POWER WIRING SHOULD NOT BE IN THE SAME CONDUIT, TRAY OR JUNCTION BOX.
3. SOME SIGNAL WIRES CAN RUN IN THE SAME CONDUIT. SEE THE INTERCONNECTION DIAGRAM FOR DETAILS.
4. THERMOCOUPLE WIRES SHOULD ALWAYS BE RUN IN A SEPARATE CONDUIT..
5. WHEN UNLIKE SIGNALS MUST CROSS IN TRAYS OR CONDUIT, THEY SHOULD CROSS AT 90 DEGREES.

STANDARD SYMBOLS

RC — R–C SNUBBER FOR AC RELAY COIL AND SOLENOID ARC SUPPRESSION

DIODE SNUBBER FOR DC RELAY COIL AND SOLENOID ARC SUPPRESSION.

INDICATES TWISTED PAIR WIRE

SHLD — INDICATES SHIELDED WIRE

INDICATES GROUND LUG CONNECTION

15 — DEVICE TERMINAL. USED FOR COMPONENTS, PCBS, AND MODULES

PLUG CONNECTION

L2 — DRIVE TERMINAL. IN SOME SYSTEMS, THESE ARE CUSTOMER TERMINALS.

105 — CUSTOMER TERMINAL. USED PRIMARILY IN MULTI–DRIVE SYSTEMS.

105 — CUSTOMER TERMINAL. USED PRIMARILY IN MULTIPLE OPERATOR STATIONS

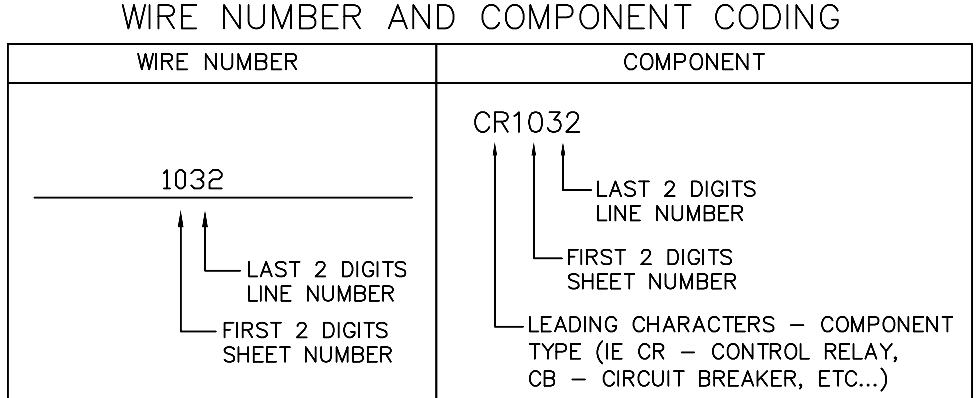
POTENTIOMETER, CURVED ARROW POINTS TO CLOCKWISE END OF ROTATION (OPERATORS VIEW).

THE FOLLOWING ARE CONDUCTOR GROUP IDENTIFIERS USED ON INTERCONNECTION DIAGRAMS.

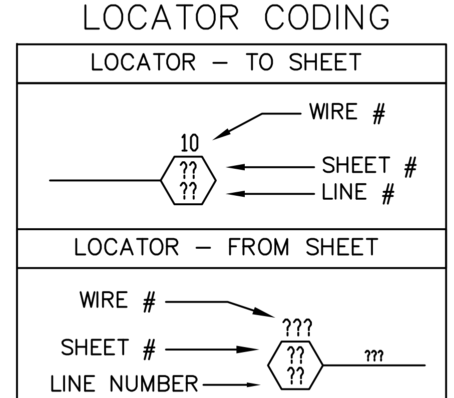
AC POWER WIRING — DC POWER WIRING

AC CONTROL WIRING — DC CONTROL WIRING

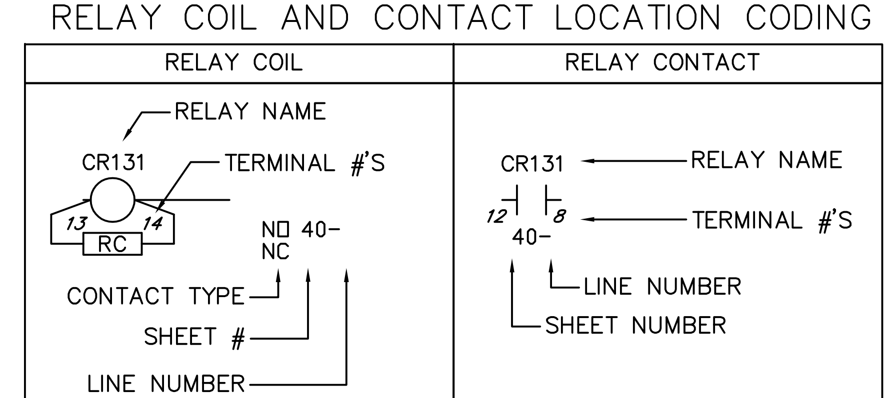
WIRE NUMBER AND COMPONENT CODING



LOCATOR CODING



RELAY COIL AND CONTACT LOCATION CODING



1329

23651A D

SHEET 40 OF 40

CUSTOMER:	BioProcess H2O, LLC
TITLE:	STANDARD NOTES
FILE NAME:	23651A40.DWG
DATE:	10/4/13
DRN	JAS/LV
CKD	
APP'D	

REV	
C	
B	AS STARTED, JAS, 5/5/14
A	AS SHIPPED, JAS, 2/12/14

TEKNIKOR AUTOMATION & CONTROLS Inc.
595 AIRPORT ROAD
FALL RIVER, MA 02720 USA

TEKNIKOR

Type 12 Modular Free-Stand Disconnect Enclosures and Accessories

Modular Disconnect Enclosure, Type 12

Industry Standards

UL 508A Listed; Type 12; File No. E61997 cUL Listed per CSA C22.2 No. 94; Type 12; File No. E61997

NEMA Type 12
CSA File No. 42186: Type 12
IEC 60529, IP55

Application

Modular disconnect enclosures provide configuration flexibility and versatility. One- and two-door models can be bolted together in any configuration. Slave enclosures can be added or removed as required.

Features

One-Door Disconnect Enclosure (left side open): Universal cutout on right flange provides mounting for most disconnect operators by using operator adapters. Right side is closed since disconnect operator cannot be obscured by a door. Master door is hinged on left. Defeater on master door requires a screwdriver to open. Master door activates mechanical interlock which prevents slave doors from being opened first. Doors may be closed in any order. Interlock is furnished.

Two-Door Disconnect Enclosure (left side open): Universal cutout on right flange provides mounting for most disconnect operators by using operator adapters. Right side is closed. Master door is right-hand door. Both doors hinged on left. Defeater on master door requires a screwdriver to open. Master door activates mechanical interlock which prevents slave doors from being opened first. Doors may be closed in any order. Removable centerpost permits easy panel installation. Interlock is furnished.

One-Door Slave Enclosure (both sides open): Door hinged on left. Interlock is furnished.

Two-Door Slave Enclosure (both sides open): Right-hand door hinged on right and left-hand door hinged on left. Removable centerpost permits easy panel installation. Interlock is furnished.

Specifications

- 10 gauge steel
- Seams are continuously welded and ground smooth
- Body stiffeners in larger enclosures for extra rigidity
- Body flange trough excludes liquids and contaminants
- Heavy-duty lifting eyes anchor into reinforced top
- Heavy gauge lift-off hinges
- Heavy-duty 3-point latching mechanism operated by padlocking handle on all doors
- Rollers on ends of latch rods for easier door closing
- Data pocket is high-impact thermoplastic
- Oil-resistant door gasket
- Panel supports
- Removable 10 gauge steel panels mount on collar studs
- Bonding provision on door
- Mechanical interlock standard on each enclosure. Parts required to connect interlock system between adjacent enclosures are provided.
- Interlock rods are furnished with enclosures. Gasket kits and end plate purchased separately.
- Models available with panel include painted panel; conductive panel sold separately

Finish

ANSI 61 gray finish inside and outside over pretreated surfaces. Panels have white or conductive finish. Flat end plates are ANSI 61 gray inside and outside.

Accessories

See also Accessories.
Blank Adapter Plates, Mild Steel
End Plates
PANELITE™ Enclosure Lights Overview
Operator Adapters for Universal Cutouts
Panels for Type 3R, 4, 4X, 12 and 13 Enclosures
Center Panel Supports

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

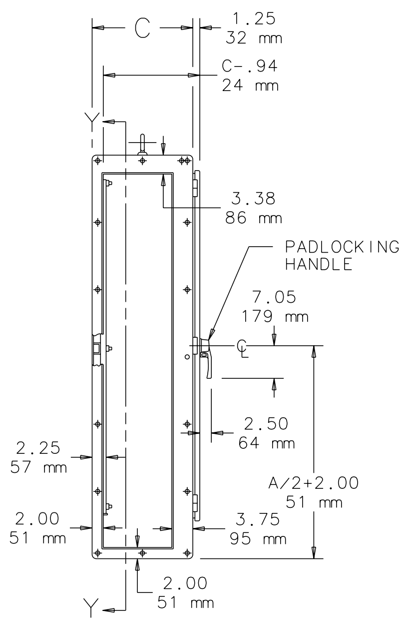
Bulletin: A34

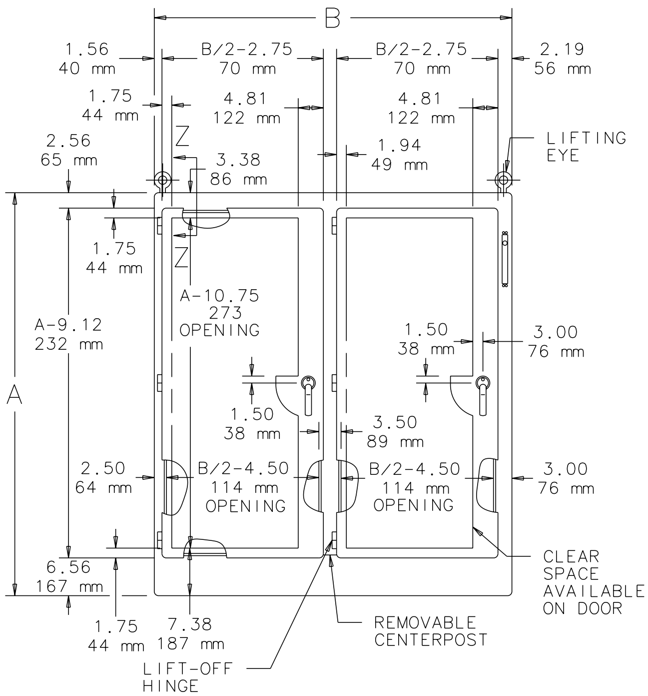
Type 12 Modular Free-Stand Disconnect Enclosures and Accessories

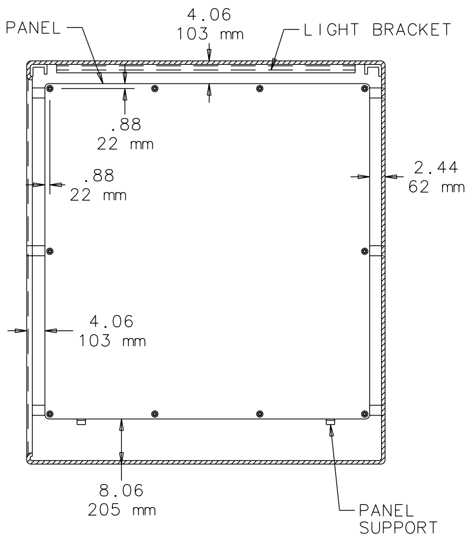
Standard Product **Master Modular Type 12 Enclosures for Flange-Mount Disconnects, Two-Door (left side open)**

Catalog Number	AxBxC in./mm	With or Without Panel	Panel	Conductive Panel	Panel Size D x E in./mm
AMOD72X7818FTC	72.12 x 78.50 x 18.12 1832 x 1994 x 460	With	A72PM78	A72PM78G	60.00 x 72.00 1524 x 1829
AMOD72X7818FTCLP	72.12 x 78.50 x 18.12 1832 x 1994 x 460	Without	—	—	— —
AMOD84X7818FTC	84.12 x 78.50 x 18.12 2137 x 1994 x 460	With	A84PM78	A84PM78G	72.00 x 72.00 1829 x 1829
AMOD84X7818FTCLP	84.12 x 78.50 x 18.12 2137 x 1994 x 460	Without	—	—	— —
AMOD84X7824FTC	84.12 x 78.50 x 24.12 2137 x 1994 x 613	With	A84PM78	A84PM78G	72.00 x 72.00 1829 x 1829
AMOD84X7824FTCLP	84.12 x 78.50 x 24.12 2137 x 1994 x 613	Without	—	—	— —

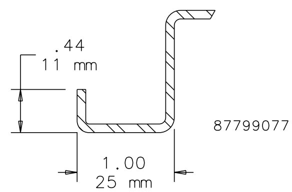
Enclosures with panel include a painted panel. Order conductive panels separately.







SECTION Y-Y



SECTION Z-Z

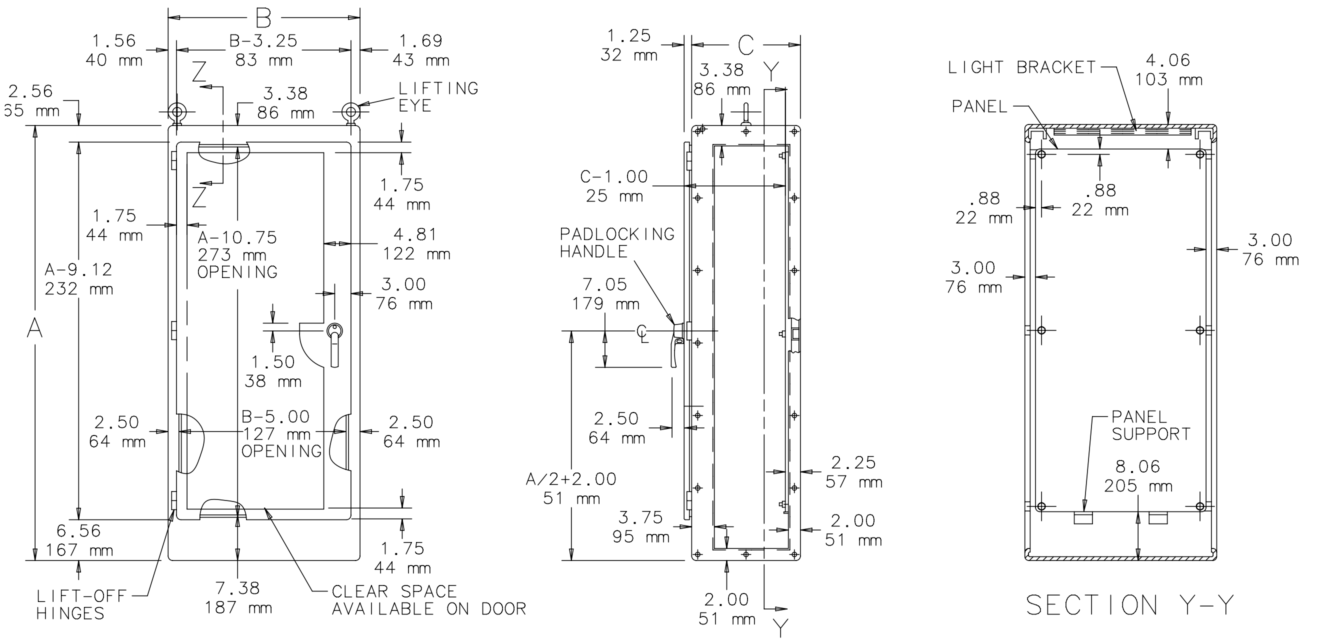
Type 12 Modular Free-Stand Disconnect Enclosures and Accessories

Standard Product **Slave Modular Type 12 Enclosures for Flange-Mount Disconnects, One-Door (both sides open)**

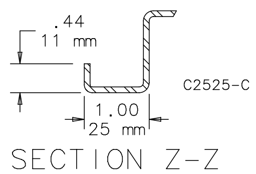
Catalog Number	AxBxC in./mm	With or Without Panel	Panel	Conductive Panel	Panel Size D x E in./mm
AMOD723918FTC	72.12 x 39.75 x 18.12 1832 x 1010 x 460	With	A72PM40	A72PM40G	60.00 x 33.75 1524 x 857
AMOD723918FTCLP	72.12 x 39.75 x 18.12 1832 x 1010 x 460	Without	—	—	— —
AMOD843918FTC	84.12 x 39.75 x 18.12 2137 x 1010 x 460	With	A84PM40	A84PM40G	72.00 x 33.75 1829 x 857
AMOD843918FTCLP	84.12 x 39.75 x 18.12 2137 x 1010 x 460	Without	—	—	— —
AMOD843924FTC	84.12 x 39.75 x 24.12 2137 x 1010 x 613	With	A84PM40	A84PM40G	72.00 x 33.75 1829 x 857
AMOD843924FTCLP	84.12 x 39.75 x 24.12 2137 x 1010 x 613	Without	—	—	— —

Enclosures with panel include a painted panel. Order conductive panels separately.

Single-Door Slave Enclosure (Both Sides Open)



NOTE: 1. 10 gauge steel panel is furnished with FTC enclosures. FTCLP models are less panel; panels can be purchased separately. See catalog number table for size.
2. Door hinged on left includes a removable 12.00 x 12.00 in. (305 x 305mm) data pocket.



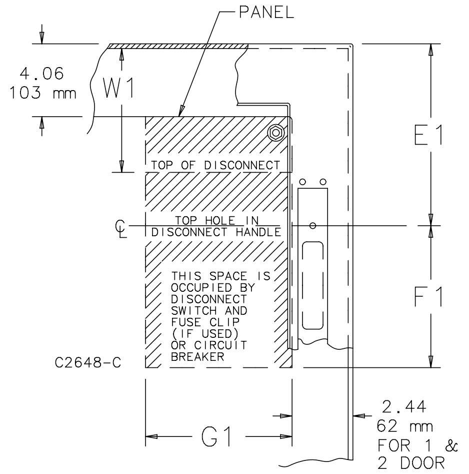
Disconnect Mounting Space

Disconnects are located by dimension E1. Wiring space W1 is available when disconnect is installed in the enclosure. See Technical Information section for E1 Spacing by Enclosure Height for various disconnect switch manufacturers.

W1 = Wiring Space.
See Technical Information section for wire bend space.

Refer to ***NATIONAL ELECTRICAL CODE®, 2005*** article 430-10(b) for wiring space required for line side conductors to be connected to disconnect. **Verify your application to determine whether wiring space is adequate.**

Consult Space Occupied by Disconnect drawing to determine whether the disconnect device you are using will fit the enclosure size you have selected.



Consult disconnect manufacturer or see Disconnect Ordering Information at hoffmanonline.com under Technical Resources for F1 and G1 dimensions of various brands of disconnects.

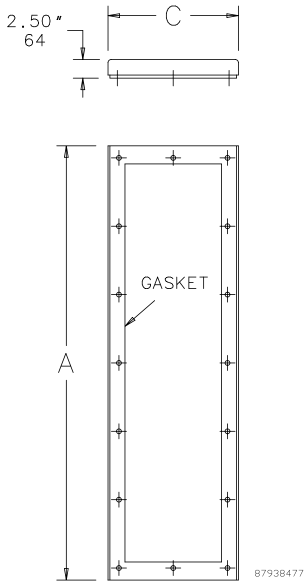
Type 12 Modular Free-Stand Disconnect Enclosures and Accessories

End Plates

Used to seal open end(s) of an assembly of modular enclosures. The 2.50-in. deep End Plates allow extra wiring space. Gasket and mounting bolts are included.

Bulletin: A34Y

Catalog Number	AxC in./mm
AMOD72EPT	72.12 x 18.12 1832 x 460
AMOD84EPT	84.12 x 18.12 2137 x 460
AMOD8424EPT	84.12 x 24.12 2137 x 613



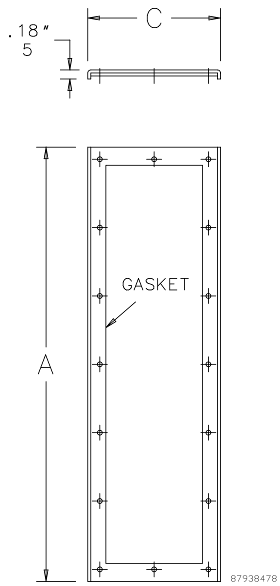
End Plate

Flat End Plates

Used to seal open end(s) of an assembly of modular enclosures. The Flat End Plate provides a low profile cover for the open end of a modular enclosure. Studs welded to the end plate eliminate bolt holes. Gasket and mounting hardware are furnished.

Bulletin: A34Y

Catalog Number	AxC in./mm
AMOD7218FEP	72.12 x 18.12 1832 x 460
AMOD8418FEP	84.12 x 18.12 2137 x 460
AMOD8424FEP	84.12 x 24.12 2137 x 613



Flat End Plate

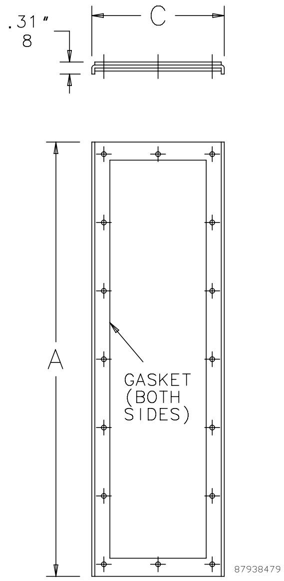
Type 12 Modular Free-Stand Disconnect Enclosures and Accessories

Barriers

Used to provide a barrier between individual enclosures in an assembly of modular enclosures. The flat plate is gasketed on both sides and inserted between two modular enclosures. Bolts and instructions are included.

Bulletin: A34Y

Catalog Number	AxC in./mm
AMOD7218BAP	72.12 x 18.12 1832 x 460
AMOD8418BAP	84.12 x 18.12 2137 x 460
AMOD8424BAP	84.12 x 24.12 2137 x 613



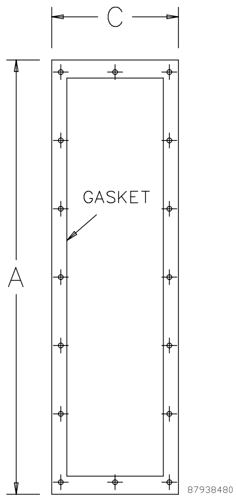
Barrier

Gasket Kit

Used to maintain enclosure rating when modular enclosures are joined together; includes a one-piece gasket, bolts and instructions.

Bulletin: A34Y

Catalog Number	AxC in./mm
AMOD7218FGK	72.12 x 18.12 1832 x 460
AMOD8418FGK	84.12 x 18.12 2137 x 460
AMOD8424FGK	84.12 x 24.12 2137 x 613



Gasket Kit

Free-Stand Universal-Cutout Disconnect Overview

Universal Cutout Overview

Application

The universal cutout is used in large freestand and floorstand enclosures, i.e., Bulletins A21(S), A28(S) and A34. Operator Adapter Kits are required in order to install the various manufacturers' hardware. Note that 400 A (or greater) disconnect switches and 600 A (or greater) circuit breakers need to use the "Large" or "High Amp" cutout, which is provided in the A21ABVA kit for Allen-Bradley variable-depth disconnect switches or the A21ITE kit for Siemens (and select other manufacturers) flex-cable devices. The "Large" or "High Amp" cutout accepts the larger operating handle whose mounting hole centers are 6.500-in. apart.

Universal cutouts are designed to house the following:

Allen-Bradley

- Bulletin 1494F flange-mount disconnect switches and Bulletin 1494D flange-mount operators for circuit breakers
- Bulletin 1494V disconnect switches with flange-mount variable-depth operating mechanisms and Bulletin 1494V flange-mount variable-depth operating mechanisms for circuit breakers
- Bulletin 140U flexible cable operating mechanisms for 140U molded case circuit breakers
- Bulletin 1494C cable-operated disconnect switches with flange-mount handles
- Bulletin 194RC cable-operated flange-mount handles for use with the NFPA 79 compliant 194R IEC rotary disconnect switches

Allen-Bradley Bulletin 1494V-R1, -R2 and -W2 operating handles and Allen-Bradley Bulletin 1494F disconnect devices or Bulletin 1494D circuit breaker operators will NOT fit these enclosures.

ABB Controls flange-mount variable-depth operating mechanisms for disconnect switches and circuit breakers. Also the cable version for circuit breakers.

Eaton Cutler-Hammer Type C361 disconnect switches and operator mechanisms, and Type C371 circuit breakers and circuit breaker operating mechanisms. Also Type SM safety handle mechanisms and FLEX SHAFT™ handle operators for circuit breakers.

General Electric Type STDA flange handles and variable-depth operating mechanisms for disconnect switches and circuit breakers. Also SPECTRAFLEX™ cable operators for circuit breakers.

Siemens ITE MAX FLEX® flange-mount variable-depth operating handles for disconnect switches and circuit breakers.

Schneider Square D® disconnect switches and circuit breakers used with Class 9422 flange-mount variable-depth operating mechanisms or cable mechanisms.
These enclosures will NOT receive Class 9422 bracket-mount disconnect devices, Class 9422TG1 or TG2 devices.

Disconnect Enclosures with Universal Cutout
Universal cutout requires an operator adapter for the brand and type of disconnect being used. See Disconnect Enclosure Accessories to select the operator adapter.

Ordering

The disconnect switch, operating handle and operating mechanism must be ordered separately. See Technical Information in the Hoffman Specifier's Guide for wire bend space available when various manufacturers' disconnect switches are installed, or Disconnect Ordering Information at hoffmanonline.com for disconnect ordering guidelines and wire bend space available. Check the enclosure dimension drawings to verify the chosen disconnect switch will fit in the enclosure.

All 24.12-in. (613-mm) and deeper enclosures using short connecting rods by the following manufacturers require a Hoffman platform assembly, catalog number ADSCPA, purchased separately.

- ABB Controls flange-operated devices
- Eaton Cutler-Hammer C361 devices
- Eaton Cutler-Hammer C371 mechanisms which use C371E, F, G, K operating mechanism (see Disconnect Enclosure Accessories)
- General Electric Type TDA devices (see Disconnect Enclosure Accessories)
- Schneider Square D® Class 9422 devices (see Disconnect Enclosure Accessories)

The platform assembly can be omitted if long connecting rods are ordered in place of short connecting rods.

- For Eaton Cutler-Hammer operating mechanisms C371E and C371F order catalog number C371CS1 connecting rod. For C371G and C371K order catalog number C371CS2 connecting rod.
- For General Electric devices, order catalog number TDSR extended length drive rod
- For Schneider Square D devices, order catalog number 9422-R2 extra long operating rod(s). Some devices require two rods.

Consult factory for space occupied on panel when platform is used.

Allen-Bradley

100-C, 4-Pole Contactors – 9…85A

The 100-C line of MCS contactors has now expanded its offering of 4-pole contactors. With the addition of the new 100-C40 and 100-C90, we are able to offer 4-pole contactors through 85A (AC-3), 130A (AC-1). They are available in various configurations of N.O. and N.C. power poles with AC or DC coil control.

Features

- Contactor range from 9…85A in three frame sizes
  - 100-C09…C23 – 45 mm wide
  - 100-C40 – 59 mm wide
  - 100-C90 – 95 mm wide
- AC and DC coil control
- Common accessories with other 100-C contactors
- IP2X finger protection
- Provisions for adding two conductors per terminal
- Meets IEC, CE, UL and CSA standard requirements

Applications

Four pole contactors are ideal for applications where switching a neutral, in addition to 3-phase power, is required. They are also used in lighting circuits, resistive heating and dynamic braking applications.

Product Selection

I_e [A]		Ratings for Switching AC Motors AC-2, AC-3										Contact Configuration, Main Pole		Cat. No.
		3 ∅ kW (50 Hz) ❶				Hp (60 Hz)								
						1 ∅		3 ∅ ❶						
AC-3	AC-1	230V	400V/415V	500V	690V	115V	230V	200V	230V	460V	575V	N.O.	N.C.	
9	32	3	4	4	4	1/2	1-1/2	2	2	5	7-1/2	4	0	100-C09⊗400
												3	1	100-C09⊗300
												2	2	100-C09⊗200
12	32	4	5.5	5.5	5.5	1/2	2	3	3	7-1/2	10	4	0	100-C12⊗400
												3	1	100-C12⊗300
												2	2	100-C12⊗200
16	32	5.5	7.5	7.5	7.5	1	3	5	5	10	15	4	0	100-C16⊗400
												3	1	100-C16⊗300
												2	2	100-C16⊗200
23	32	7.5	11	13	10	2	3	5	7-1/2	15	15	4	0	100-C23⊗400
												3	1	100-C23⊗300
												2	2	100-C23⊗200
37	75	11	18.5/20	20	18.5	3	5	10	10	25	30	4	0	100-C40⊗400
												2	2	100-C40⊗200
85	130	25	45	55	45	7-1/2	15	25	30	60	50	4	0	100-C90⊗400
												2	2	100-C90⊗200

❶ Three-phase ratings only apply to contactors with at least three N.O. power poles.

MCS PLUS

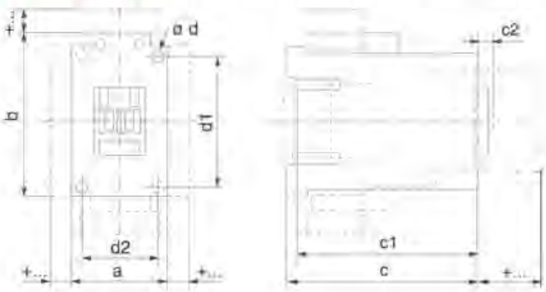
⊗ Coil Voltage Code

The Cat. No. as listed is incomplete. Select a coil voltage code from the table below to complete the Cat. No.
Example: 120V, 60 Hz: **Cat. No. 100-C09⊗400** becomes **Cat. No. 100-C09D400.**

HZ \ V		24	110	120	200-220	208	208-240	220-230	230	240	277	380	380-400	400	400-415	440	480	500	550	600
50 Hz		K	D	-	L	-	-	F	-	T	-	-	N	-	G	B	-	M	C	-
60 Hz		J	-	D	-	H	L	-	-	A	T	E	-	-	-	-	B	-	-	C
50/60Hz		KJ	-	-	-	-	-	-	KF	-	-	-	-	KN	-	-	-	-	-	-
DC Voltages												12	24	48	110	115	125	220	230	250
100-C09…C40	Standard											ZQ	ZJ	ZY	ZD	ZP	ZS	ZA	ZF	ZT
100-C09…C40	with Integrated Diode											-	DJ	-	-	-	-	-	-	-
100-C90	with Integrated Diode											DQ	DJ	DY	DD	DP	DS	DA	DF	DT

Dimensions

Dimensions are shown in millimeters (inches). Dimensions are not intended for manufacturing purposes.



AC Contactors

Cat. No.	a	b	c	c1	c2	∅d	d1	d2
100-C09…100-C23	45 (1-25/32)	81 (3-3/16)	80.5 (3-11/64)	75.5 (2-31/32)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
100-C40	59 (2-21/64)	81 (3-3/16)	100.5 (3-61/64)	95.5 (3-49/64)	6.5 (1/4)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	45 (1-25/32)
100-C90	95 (3-47/64)	122 (4-51/64)	117 (4-39/64)	111.5 (4-25/64)	8.5 (21/64)	4 - 5.4 (4 - 7/32)	100 (3-15/16)	55 (2-11/64)

DC Contactors

Cat. No.	a	b	c	c1	c2	∅d	d1	d2
100-C09Z…100-C16Z	45 (1-25/32)	81 (3-3/16)	106.5 (4-3/16)	101.5 (4)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
100-C23Z	45 (1-25/32)	81 (3-3/16)	123.5 (4-55/64)	118.5 (4-43/64)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
100-C40Z	59 (2-21/64)	81 (3-3/16)	144.5 (5-11/16)	139.5 (5-1/2)	6.5 (1/4)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	45 (1-25/32)
100-C90D	95 (3-47/64)	122 (4-51/64)	117 (4-39/64)	111.5 (4-25/64)	8.5 (21/64)	4 - 5.4 (4 - 7/32)	100 (3-15/16)	55 (2-11/64)

www.rockwellautomation.com

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Publication 100-PP025A-EN-P — March 2004

Rockwell Automation

Product Details and Certifications

Representative Photo Only (actual product may vary based on configuration selections)

Product: 100-C09J10
Description: MCS-C Contactor, IEC, 9A, 24V 60Hz, Single Pack

CONTACTOR DATA	
Terminal Type	Screw Terminals
Maximum Ampere Rating	9A
Coil Voltage	24V 60Hz
Coil Termination	Line Side
Contact Configuration	1 N.O. 0 N.C.
Packaging	Single Pack

APPLICATION DATA	
Electrical Standards	UL

LOAD DATA [OPTIONAL]	
Utilization Category	AC-3 Squirrel-cage motor starting and stopping
Load FLA (Nameplate Value)	0 A
NEC FLA	0 A
Minimum Required FLA	0 A

LIFE DATA [OPTIONAL]	
Minimum Required Life	0 Mil. Oper.
Actual Life	Actual Life Cannot be Calculated (more information)...

1339

ADDITIONAL INFORMATION	
Notice	See Pub. 0100C-1.0.1 for additional electrical life information.

TERMINAL MARKING POSITIONS USED	
100-C or 104-C Contactor	1_
Front Mounted Auxiliary Contact	None
Left Side Auxiliary Contact	None
Right Side Auxiliary Contact	None
Interlock	None

Certifications and Approvals	
UL	
CSA	
IEC	
CE	
For UL Certifications Directory:	http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.htm

Dimensions and Weight	
Weight (kg / lbs)	0.39 / 0.86

Recommended Spare Parts	
TA-013	(1) COIL, 24V 60HZ FOR CONTACTOR OR RELAY

Tools & Resources|Locations|Contact Us|Sitemap|Legal Notices

Rockwell Automation

Catalogs > Industrial Controls Catalog > Motor Control, IEC > Molded Case Circuit Breakers > Bulletin 140U J-Frame

BULLETIN 140U J-FRAME

Product Selection — 250 A, J-Frame Accessories — 250 A, J-Frame Approximate Dimensions — 250 A, J-Frame

Product Selection — 250 A, J-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA
  CCC (Pending)

Note: Terminal box lugs must be ordered separately. See Terminal Lugs

Breaker Frames

Rated Current I_n [A]	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.	
	220…240V		380…415V		525V		690V		240V	480V	600V		
250	65	65	25	25	18	12	12	6	65	25	18	140U-J2X3	
	85	85	45	45	18	12	12	6	85	35	18	140U-J3X3	
	100	100	70	70	25	13	14	7	100	65	25	§	140U-J6X3
	200	200	100	100	35	18	16	12	200	100	35	§	140U-J0X3

§ Current limiting

Trip Units

Thermal-Magnetic

Rated Current I_n [A]	Adjustment Range [A]		Cat. No.
	Thermal Trip $I_r = I_n$ (Fixed)	Magnetic Trip I_m = 5...10 x I_r	
90	90	450...900	140U-JTD3-C90
100	100	500...1000	140U-JTD3-D10
125	125	600...1250	140U-JTD3-D12
150	150	750...1500	140U-JTD3-D15
175	175	875...1750	140U-JTD3-D17
200	200	1000...2000	140U-JTD3-D20
225	225	1125...2250	140U-JTD3-D22
250	250	1250...2500	140U-JTD3-D25

Electronic				
Rated Current I_n [A]	Adjustment Range [A]		Protection Type	Cat. No.
	Thermal Trip I_r = 0.4...1.0 x I_n	Magnetic Trip I_m = 2...14 x I_r		
50	20...50	40...700	LS	140U-JTL3-C50
50	20...50	40...700	LSI	140U-JTH3-C50
50	20...50	40...700	LSG	140U-JTG3-C50
50	20...50	40...700	LSIG	140U-JTI3-C50
100	40...100	80...1400	LS	140U-JTL3-D10
100	40...100	80...1400	LSI	140U-JTH3-D10
100	40...100	80...1400	LSG	140U-JTG3-D10
100	40...100	80...1400	LSIG	140U-JTI3-D10
160	63...160	126...2240	LS	140U-JTL3-D16
160	63...160	126...2240	LSI	140U-JTH3-D16
160	63...160	126...2240	LSG	140U-JTG3-D16
160	63...160	126...2240	LSIG	140U-JTI3-D16
250	100...250	200...3500	LS	140U-JTL3-D25
250	100...250	200...3500	LSI	140U-JTH3-D25
250	100...250	200...3500	LSG	140U-JTG3-D25
250	100...250	200...3500	LSIG	140U-JTI3-D25

Assembled Circuit Breakers with Thermal-Magnetic Trip Units

Rated Current I_n [A]	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.
	400V	480V		400V	480V		400V	480V	
90	25	25	140U-J2D3-C90	40	35	140U-J3D3-C90	70	65	140U-J6D3-C90
100	25	25	140U-J2D3-D10	40	35	140U-J3D3-D10	70	65	140U-J6D3-D10
125	25	25	140U-J2D3-D12	40	35	140U-J3D3-D12	70	65	140U-J6D3-D12
150	25	25	140U-J2D3-D15	40	35	140U-J3D3-D15	70	65	140U-J6D3-D15
175	25	25	140U-J2D3-D17	40	35	140U-J3D3-D17	70	65	140U-J6D3-D17
200	25	25	140U-J2D3-D20	40	35	140U-J3D3-D20	70	65	140U-J6D3-D20
225	25	25	140U-J2D3-D22	40	35	140U-J3D3-D22	70	65	140U-J6D3-D22
250	25	25	140U-J2D3-D25	40	35	140U-J3D3-D25	70	65	140U-J6D3-D25

‡ Interrupting ratings shown are for 400V and 480V, respectively. The complete range of ratings can be found in the frame rating table on Breaker Frames.

Assembled Circuit Breakers with Electronic Trip Units

Rated Current I_n [A]	Protection Type	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]‡		Cat. No.
		400V	480V		400V	480V		400V	480V	
50	LS	25	25	140U-J2L3-C50	40	35	140U-J3L3-C50	70	65	140U-J6L3-C50
50	LSI	25	25	140U-J2H3-C50	40	35	140U-J3H3-C50	70	65	140U-J6H3-C50
50	LSG	25	25	140U-J2G3-C50	40	35	140U-J3G3-C50	70	65	140U-J6G3-C50
50	LSIG	25	25	140U-J2I3-C50	40	35	140U-J3I3-C50	70	65	140U-J6I3-C50
100	LS	25	25	140U-J2L3-D10	40	35	140U-J3L3-D10	70	65	140U-J6L3-D10
100	LSI	25	25	140U-J2H3-D10	40	35	140U-J3H3-D10	70	65	140U-J6H3-D10
100	LSG	25	25	140U-J2G3-D10	40	35	140U-J3G3-D10	70	65	140U-J6G3-D10
100	LSIG	25	25	140U-J2I3-D10	40	35	140U-J3I3-D10	70	65	140U-J6I3-D10
160	LS	25	25	140U-J2L3-D16	40	35	140U-J3L3-D16	70	65	140U-J6L3-D16
160	LSI	25	25	140U-J2H3-D16	40	35	140U-J3H3-D16	70	65	140U-J6H3-D16
160	LSG	25	25	140U-J2G3-D16	40	35	140U-J3G3-D16	70	65	140U-J6G3-D16
160	LSIG	25	25	140U-J2I3-D16	40	35	140U-J3I3-D16	70	65	140U-J6I3-D16
250	LS	25	25	140U-J2L3-D25	40	35	140U-J3L3-D25	70	65	140U-J6L3-D25
250	LSI	25	25	140U-J2H3-D25	40	35	140U-J3H3-D25	70	65	140U-J6H3-D25
250	LSI	25	25	140U-J2G3-D25	40	35	140U-J3H3-D25	70	65	140U-J6G3-D25
250	LSIG	25	25	140U-J2I3-D25	40	35	140U-J3I3-D25	70	65	140U-J6I3-D25

‡ Interrupting ratings shown are for 400V and 480V, respectively. The complete range of ratings can be found in the frame rating table on Breaker Frames.

Molded Case Switch — UL 489

Rated Current I_n [A]	Thermal Trip $I_r = I_n$ [A]	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600V	
250	—	2500	100	100	70	70	42	20	7	3	100	65	25	140U-J6S3-D25

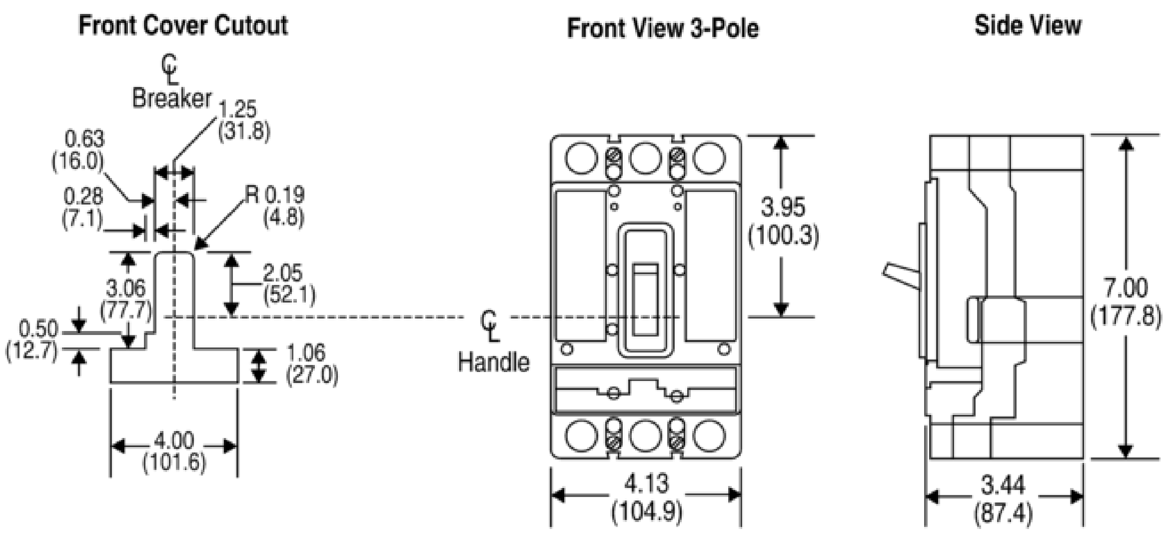
Catalogs > Industrial Controls Catalog > Motor Control, IEC > Molded Case Circuit Breakers > Bulletin 140U J-Frame

BULLETIN 140U J-FRAME

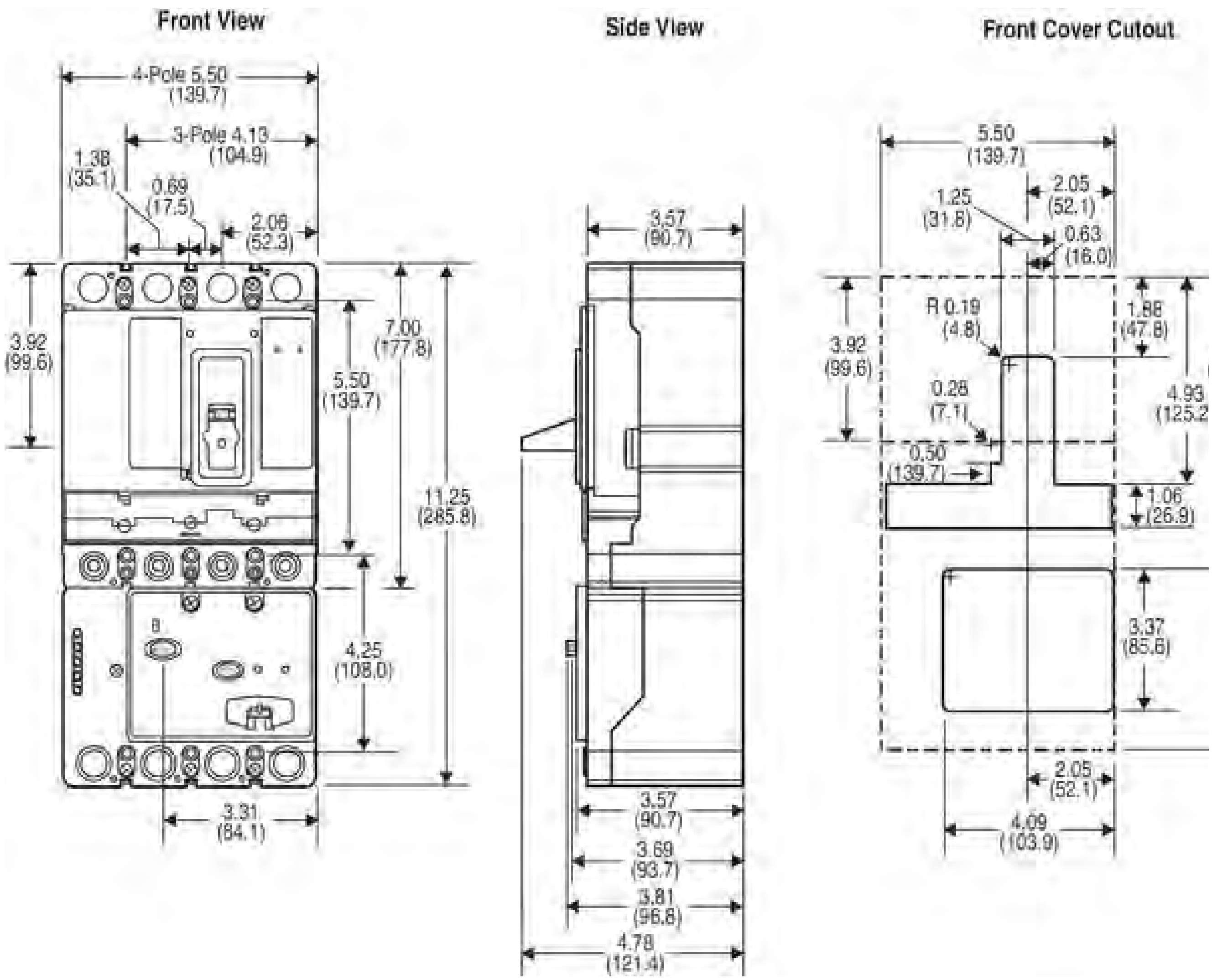
Product Selection — 250 A, J-Frame   Accessories — 250 A, J-Frame   Approximate Dimensions — 250 A, J-Frame

Approximate Dimensions — 250 A, J-Frame

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.



J-Frame with Earth Leakage Module



Front View
Side View
Front Cover Cutout
4-Pole 5.50 (139.7)
3-Pole 4.13 (104.9)
1.38 (35.1)
0.69 (17.5)
2.06 (52.3)
3.92 (99.6)
7.00 (177.8)
5.50 (139.7)
11.25 (285.8)
4.25 (108.0)
3.31 (84.1)
3.57 (90.7)
3.57 (90.7)
3.69 (93.7)
3.81 (96.8)
4.78 (121.4)
5.50 (139.7)
2.05 (52.1)
1.25 (31.8)
0.63 (16.0)
R 0.19 (4.8)
3.92 (99.6)
1.88 (47.8)
0.28 (7.1)
0.50 (139.7)
1.06 (26.9)
3.37 (85.6)
2.05 (52.1)
4.09 (103.9)

BULLETIN 193 E1 PLUS SOLID-STATE OVERLOAD RELAYS

E1 Plus Solid-State Overload Relays

- Self-powered
- Phase loss protection
- Wide adjustment range (5:1)
- Over-molded power connections
- 1 N.O. and 1 N.C. isolated auxiliary contacts (B600 Rated)
- Low energy consumption (150 mW)
- Ambient temperature compensation
- Visible trip indication

193-ED version offers:

- 0.1…45 A current range
- Fixed Trip Class 10
- Manual reset

193-EE version offers:

- 0.1…800 A current range
- Selectable Trip Class (10, 15, 20, or 30)
- Selectable manual/auto-manual reset
- Single- and three-phase devices

Your order must include 1) the Cat. No. of overload relay selected, and 2) if required, Cat. No. of any accessories.

Standards Compliance and Certifications

1347

Standards Compliance

IEC/EN 60947-4-1 IEC/EN 60947-5-1 CSA 22.2 No. 14 UL 508

Certifications

CE cULus Listed C-Tick CCC

Product Overview

Accurate, Reliable Performance

Current measurement-based protection

While electromechanical overload relays pass motor current through heating elements to provide an indirect simulation of motor heating, the E1 Plus Overload Relay directly measures motor current. Current measurement-based overload protection more accurately models a motor's thermal condition. Furthermore, ambient temperature does not impact the performance of current measurement-based designs over the specified temperature operating range.

Electronic design

Thermal modeling is performed electronically with precision solid-state components, where at the heart of the E1 Plus Overload Relay is an application-specific integrated circuit (ASIC). The ASIC continually processes motor current data to accurately maintain the time-current status of the motor thermal capacity utilization value.

Thermal memory

A thermal memory circuit allows the E1 Plus Overload Relay to model the heating and cooling effects of motor on and off periods. This ensures accurate protection for both hot and cold motors.

Enhanced phase loss protection

A separate phase loss detection circuit incorporated into the E1 Plus Overload Relay allows it to respond quickly to phase loss conditions; typical reaction time is 3 seconds.

Easy to Select and Apply

Straightforward installation

The self-powered design means that the E1 Plus Overload Relay installs in the same manner as traditional overload relays. Device setup is accomplished by simply dialing the setting potentiometer to the motor FLA rating. The low energy consumption of the electronic design minimizes temperature rise issues inside control cabinets.

Wide adjustment range

A wide 5:1 adjustment range results in the need for half as many catalog numbers as the bimetallic alternative in order to cover the same current range. This helps to reduce inventory carrying costs and affords greater installation flexibility for dual voltage machines. Evenly spaced setting tick marks enhance the ease of installation setup.

Rugged Construction

Over-molded power connections

The unique line-side over-molded power connections make for a sturdy two-component starter assembly that is unmatched in the industry. The pre-formed power connections allow easy starter assembly — every time.

Current transformers

The current transformers are secured separately in the overload housing to ensure the greatest degree of resistance to shock and vibration conditions. Varnished laminations ensure consistent performance and provide additional protection against corrosion.

Latching relay

The robust design of the bi-polar latching relay provides reliable trip and reset performance for the most demanding of applications. The self-enclosed relay offers additional environmental protection for use in industrial applications.

Application Flexibility

Isolated Contacts

The isolated contact configuration allows the N.C. and N.O. contacts to be applied in circuits operating at different voltage levels and without polarity restrictions. The B600 contact rating affords application in circuits rated to 600V.

DIP switch settings

Bul. 193-EE devices offer DIP switch settings to select the trip class (10, 15, 20 or 30) and the reset mode (manual or automatic), making these devices extremely versatile.

Pass-Thru Option

The E1 Plus Pass-Thru consumes 48% less panel space compared to a standard E1 Plus mounted in a panel mount adapter. The design provides an integrated DIN Rail mount and panel mounting holes and is intended for the following aplications: DIN Rail and Panel Mount Applications, Bulletin 100-K mini contactor, external current transformers, and for use with non Allen-Bradley Contactors. The E1 Plus Pass-Thru Electronic Overload Relay provides all of the same expandable protection & communication capabilities as a standard E1 Plus, and eliminates the need for a separate panel mount adapter, which saves money and valuable panel space.

Side-Mount Expansion Modules

Through the use of optional side-mount expansion modules, functionality of the E1 Plus overload relays can be cost effectively expanded and machine operation and protection enhanced. Direct mounting to the left side of the 193-EE and 592-EE E1 Plus overload relays means that only 18 mm is added to the overall product width. The side-mounted accessory modules electronically interface with the E1 Plus overload relay so that all control circuit connections are made at the E1 Plus overload relay terminals.

E1 Plus DeviceNet™ Communication Module

The Bul. 193-EDN DeviceNet Communication Side-Mount Module provides a cost-effective, seamless deployment of motor starters onto the Integrated Architecture™ as an accessory for the E1 Plus electronic overload relay. The DeviceNet module provides Integrated I/O (2 inputs and 1 output) providing local connection of motor starter-related I/O. The DeviceNet module offers expanded protective functions including overload warning, jam protection, and underload warning. The DeviceNet module also allows access to average motor current (percentage of FLA setting), percentage of thermal capacity usage, device status, trip & warning identification, and trip history which allows continual monitoring of motor performance.

E1 Plus Remote Reset Module

The Bul. 193-ERR Remote Reset Module is available for applications that require remote reset of the E1 Plus overload relays after a trip occurs.

E1 Plus Jam Protection Module with Remote Reset

The Bul. 193-EJM Jam Protection Module provides front-accessible DIP switches which offers flexibility to provide jam protection to match application requirements. Selections are available for enabling or disabling the jam protection function and remote reset operation. Jam trip level settings are available at 150%, 200%, 300%, and 400% of full load current setting. Trip delay settings of 1/2, 1, 2, and 4 seconds are available to minimize nuisance tripping in applications where intermittent short-duration overloading is permissible.

E1 Plus Ground Fault Module with Remote Reset

The Bul. 193-EGF Ground Fault Protection Module offers front-accessible DIP switches providing flexibility to configure ground fault protection to match application requirements. Selections are available for enabling or disabling the ground fault protection function and remote reset operation. Ground fault trip level settings are available in four ranges: 20…100 mA (resistive loads only, for motor loads consult your local Rockwell Automation sales office or Allen–Bradley distributor), 100…500 mA, 0.2…1 A, and 1…5 A. Within each range, the specific ground fault trip level can be set (20%, 35%, 50%, 65%, 80%, 90%, or 100% of the maximum ground fault setting). Trip delay is fixed at 50 ms ± 20 ms.

E1 Plus Ground Fault/Jam Module with Remote Reset

The Bul. 193-EGJ Ground Fault/Jam Protection Module offers front-accessible DIP switches to provide flexibility to configure ground fault and jam protection to match application requirements. The ground fault selections are the same as the Bul. 193-EGF Ground Fault Protection Module. In addition to ground fault, this module offers selectable fixed jam protection. The user can enable or disable jam protection from the DIP switches. The jam protection is fixed at 400% of the full load current setting with a 0.5 second trip delay.

E1 Plus PTC Module with Remote Reset

The Bul. 193-EPT PTC Side-Mount Module provides two terminals for the connection of positive temperature coefficient (PTC) thermistor sensors. PTC sensors are commonly embedded in the motor stator windings to monitor winding temperature. PTC sensors react to actual temperature, so enhanced motor protection can be provided to address conditions like obstructed cooling and high ambient temperature.

E1 Plus EtherNet/IP Module

The Bul. 193-ETN EtherNet/IP network communication module delivers seamless control and direct access to motor performance and diagnostic data on an Ethernet-based network. It supports I/O and explicit messaging for data access by a programmable automation controller, and contains predefined ControlLogix® style tags for direct software access. The integrated web and e-mail server contains a web server to allow users to read information and configure parameters via a web browser. The device also uses a simple mail transfer protocol (SMTP) server to send e-mail or text messages in the event of a warning or trip condition.

E1 Plus PROFIBUS Module

The Bul. 193-EPRB PROFIBUS network communication module delivers direct access to motor performance and diagnostic data on a field bus based network in addition to seamless control. The PROFIBUS communication module supports both PROFIBUS DP-V0 and DP-V1. Protective functions include overload warning, jam protection, and underload warning. The PROFIBUS network communication module monitors the motor current by electronically interfacing to the E1 Plus overload relay's current-sensing circuit. As a result, the side-mount module is able to identify the cause of the trip and provides warnings for overload, underload, phase loss, and jam. The module continuously monitors the motor's performance for average motor current, thermal capacity usage, and device status, and also provides a trip history for the five previous trips. Integrated I/O provides convenient local termination of motor-related inputs and outputs, simplifying the control architecture.

Catalog Number Explanation

193	-	EE	C	B
a		b	c	d

193 - ED1 A B
193 - ED1 C B
193 - ED1 D B
193S - EE R B

a — Bulletin Number

Code	Description
193	IEC Three-Phase
193S	IEC Single-Phase
592	NEMA Three-Phase
592S	NEMA Single-Phase

b — Type

Code	Description
ED1‡	Fixed Trip Class 10
EE	Selectable Trip Class

‡ Bulletin 193 overload relays only.

c — Adjustment Range (A)

Three-Phase

Code	Description
A	0.1…0.5
B	0.2…1.0
C	1.0…5.0
D	3.2…16
E	5.4…27
F	9…45
G	18…90
H	30…150
J	40…200
K	60…300
L	100…500
M	120…600

d — Bulletin 100 Contactor Size

Code	Description
B	C09…C23
D	C30…C43
E	C60…C85, C60…C97
F	D95…D180, D115…D180
G	D210…D420
H	D630…D860

Bulletin 500 NEMA Contactor Size

Code	Description
T	Size 00
C	Size 0…2
D	Size 3

Panel/DIN Rail Mount

Code	Description

N	160...800
Single-Phase	
Code	**Description**
P	1.0...5.0
R	3.2...16
S	5.4...27
T	9...45
U	18...90
V	60...120

P	Integrated panel mount and pass-through wiring
Z	**Panel mount with external current transformers**

Product Selection

Bulletin 193-ED – Three-Phase Devices

- Fixed Trip Class 10
- Manual reset
- Screw-type control terminals

Mounts to Contactor	Adjustment Range [A]	Cat. No.
100-C09...100-C23	0.1...0.5	193-ED1AB
	0.2...1.0	193-ED1BB
	1.0...5.0	193-ED1CB
	3.2...16	193-ED1DB
	5.4...27	193-ED1EB
100-C30...100-C43	5.4...27	193-ED1ED
	9...45	193-ED1FD
Integrated panel/DIN Rail mount and pass-thru wiring	1.0...5.0	193-ED1CP
	3.2...16	193-ED1DP
	5.4...27	193-ED1EP

Bulletin 193-EE – Three-Phase Devices

- Selectable Trip Class (10, 15, 20, 30)
- Selectable manual/auto-manual reset
- Screw-type control terminals

Mounts to Contactor	Adjustment Range [A]	Cat. No.
100-C09...100-C23	0.1...0.5	193-EEAB
	0.2...1.0	193-EEBB
	1.0...5.0	193-EECB
	3.2...16	193-EEDB
	5.4...27	193-EEEB
100-C30...100-C43	5.4...27	193-EEED
	9...45	193-EEFD
100-C60...100-C97	18...90	193-EEGE
	60...120	193-EEVE
100-D95...100-D180	18...90	‡ 193-EEGF
	30...150	‡ 193-EEHF
	40...200	‡ 193-EEJF
	60...120	‡ 193-EEVF
100-D210...100-D420	40...200	‡ 193-EEJG
	60...300	‡ 193-EEKG
	100...500	‡ 193-EELG
100-D630...100-D860	120...600	‡ 193-EEMH
	160...800	‡ 193-EENH
Integrated panel/DIN Rail mount and pass-thru wiring	1.0...5.0	193-EECP
	3.2...16	193-EEDP
	5.4...27	193-EEEP

Package Quantity = 1

‡ Does not include terminal lugs. See .

Bulletin 193S-EE – Single-Phase Devices

- Selectable Trip Class (10, 15, 20, 30)
- Selectable manual/auto-manual reset
- Screw-type control terminals

Mounts to Contactor	Adjustment Range [A]	Cat. No.
100-C09...100-C23	1.0...5.0	193S-EEPB
	3.2...16	193S-EERB
	5.4...27	193S-EESB

100-C30…100-C43	9…45	193S-EETD
100-C60…100-C97	18…90	193S-EEUE
Integrated panel/DIN Rail mount and pass-thru wiring	1.0…5.0	193S-EEPP
	3.2…16	193S-EERP
	5.4…27	193S-EESP

Bulletin 193 Panel Mount Devices for use with External Current Transformers ♣ Δ

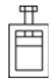
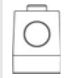
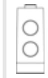
- Selectable Trip Class (10, 15, 20, 30)
- Selectable manual/auto-manual reset

CT Ratio	Adjustment Range [A]	Cat. No.
150:5	30…150	193-EEHZ
200:5	40…200	193-EEJZ
300:5	60…300	193-EEKZ
400:5	80…400	193-EEWZ
500:5	100…500	193-EELZ
600:5	120…600	193-EEMZ
800:5	160…800	193-EENZ

Δ Current Transformers supplied by customer, refer to External Current Transformers (for use with cat. nos. 193-EE_Z) for proper current transformer selection.
♣ Order panel adapter, **Cat. No. 193-EPB**, separately.

Side-Mount Expansion Modules ✶

Function	E1 Plus§ (Cat. No. 193/592 -EE_)	E1 Plus w/ Jam Module (Cat. No. 193-EJM)	E1 Plus w/ Ground Fault Module✶ (Cat. No. 193-EGF)	E1 Plus w/ Ground Fault/Jam Module✶ (Cat. No. 193-EGJ)	E1 Plus w/ PTC Module (Cat. No. 193-EPT)	E1 Plus w/ Remote Reset Module (Cat. No. 193-ERR)	E1 Plus w/ DeviceNet Module (Cat. No. 193-EDN)
Manual/Automatic Reset	X	X	X	X	X	X	X
Selectable Trip Class	10	X	X	X	X	X	X
	15	X	X	X	X	X	X
	20	X	X	X	X	X	X

Rated Operating Voltage (U_e) IEC/UL		690V AC/600V AC			1000V AC/600V AC		
Rated Operating Frequency		50/60 Hz (sinusoidal)			50/60 Hz (sinusoidal)		
Terminal Cross-Sections	Terminal Type						 
	Terminal Screws	M5		M8	Lug		
Flexible-Stranded with Ferrule	Single Conductor Torque	2.5…16 mm^2 2.5 N•m	2.5…16 mm^2 2.5 N•m	4…35 mm^2 24 N•m	—	—	—
	Two Conductor Torque	2.5…10 mm^2‡ 3.4 N•m	2.5…10 mm^2‡ 3.4 N•m	4…25 mm^2 4 N•m	—	—	—
Coarse-Stranded/Solid	Single Conductor Torque	2.5…25 mm^2 2.5 N•m	2.5…25 mm^2 2.5 N•m	4…50 mm^2 4 N•m	16…150 mm^2 28 N•m	—	—
	Two Conductor Torque	6…16 mm^2‡ 3.4 N•m	6…16 mm^2‡ 3.4 N•m	4…35 mm^2 4 N•m	—	25…185 mm2 28 N•m	70…240 mm2 45 N•m
	Four Conductor Torque	6…16 mm^2‡ 3.4 N•m	6…16 mm^2‡ 3.4 N•m	4…35 mm^2 4 N•m	—	—	70…240 mm2 45 N•m
Stranded/Solid	Single Conductor Torque	14…6 AWG 22 lb•in	14…6 AWG 22 lb•in	12…1 AWG 35 lb•in	6…300 MCM 250 lb•in	—	—
	Two Conductor Torque	14…6 AWG‡ 30 lb•in	14…6 AWG‡ 30 lb•in	6…2 AWG 35 lb•in	—	4…350 MCM 250 lb•in	2/0…500 MCM 400 lb•in
	Four Conductor Torque	14…6 AWG‡ 30 lb•in	14…6 AWG‡ 30 lb•in	6…2 AWG 35 lb•in	—	—	2/0…500 MCM 400 lb•in
Pozidriv Screwdriver Size		2	2	—	—	—	—
Slotted Screwdriver (mm)		1 x 6	1 x 6	—	—	—	—
Hexagon Socket Size (mm)		—	—	4	8	8	8
Control Circuits							
Rated Insulation Voltage (U_i)		690V AC					
Rated Impulse Strength (U_{imp})		6 kV AC					
Rated Operating Voltage (U_e) IEC/UL		690V AC / 600V AC					
Rating Designation		B600					
Rated Operating Current I_e		**N.O./N.C.**					
AC-15	12…120V	3/2					
	220…240V	1.5/1.5					
	380…480V	0.75/0.75					
	500…600V	0.6/0.6					
Thermal Current I_{the}		5 A					

	mm 275 lb•in, 16 N•m		mm 600 lb•in, 68 N•m	mm 600 lb•in, 68 N•m

Environmental Ratings		
Ambient Temperature	Storage Operating	-40…+85 °C (-40…+185 °F) -20…+60 °C (-4…+140 °F)
Humidity	Operating Damp Heat	5…95% Non-condensing per IEC 68-2-3 and IEC 68-2-30
Vibration (per IEC 68-2-6)		3 G
Shock (per IEC 68-2-27)		30 G
Max. Altitude		2000 m
Pollution Environment		Pollution Degree 3
Degree of Protection		IP20
Protection		
Type of Relay		Ambient Compensated, Time Delay, Phase Loss Sensitive
Nature of Relay		Solid-State
Trip Rating		120% FLA
Trip Class	Type ED	10
	Type EE	10, 15, 20, 30
Reset Mode	Type ED	Manual
	Type EE	Automatic or Manual
Electromagnetic Compatibility		
Electrostatic Discharge Immunity	Test Level	8 kV Air Discharge, 6 kV Contact Discharge
	Performance Level	1 § ‡
RF Immunity	Test Level	10 V/m
	Performance Level	1 § ‡
Electrical Fast Transient/Burst Immunity	Test Level	4 kV
	Performance Level	1 § ‡
Surge Immunity	Test Level	2 kV (L-E), 1 kV (L-L)
	Performance Level	1 § ‡

§ Performance Criteria 1 requires the device under test (DUT) to experience no degradation or loss of performance.

‡ Environment 2.

General

	Cat. No. 193-ED1_B, 193-EE_B	**Cat. No. 193-EE_D**	**Cat. No. 193-EE_E**

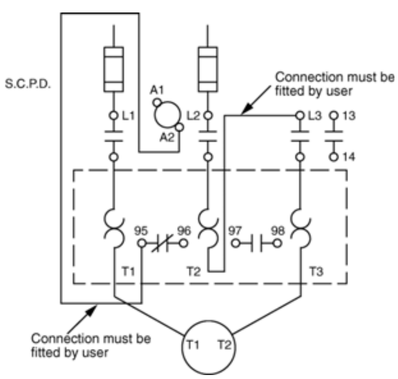
Standards	UL508, CSA C22.2 No. 14, NEMA ICS 2-1993 Part 4, EN 60947-4-1, EN 60947-5-1		
Certifications	CE, cULus, C-Tick, CCC		
Approximate Weights (unpackaged)	0.25 kg (0.55 lb)	0.25 kg (0.55 lb)	0.52 kg (1.06 lb)

External Current Transformers (for use with cat. nos. 193-EE_Z)

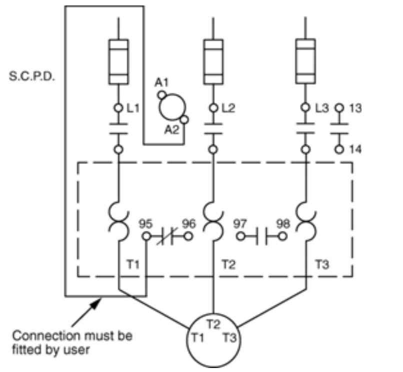
The user shall provide one current transformer (CT) for each motor phase, and shall connect the CT's secondary leads to the appropriate E1 Plus overload relay power terminals, as shown in current transformer's wiring diagrams. The CT shall have the appropriate ratio (refer to the product nameplate or product description). Additionally, the CT shall be selected to be capable of providing the required VA to the secondary load, which includes the E1 Plus overload relay burden at the rated secondary current and the wiring burden. Finally, the CT shall be rated for protective relaying to accomodate the high inrush currents associated with motor startup, and shall have an accuracy of <±2% over its normal operating range. Typical CT ratings include (Instrument Transformers, Inc. — Model #23 or equivalent):

ANSI (USA)	**Class C5B0.1**
CSA (Canada)	**Class 10L5**
IEC (Europe)	**5 VA Class 5P10**

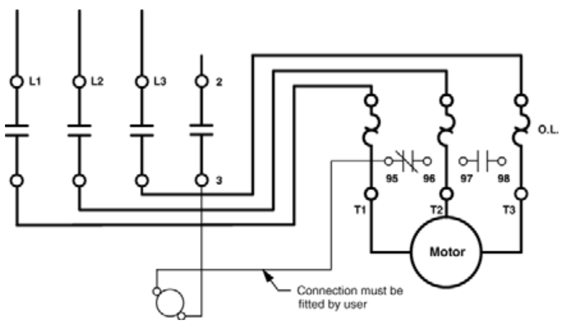
Wiring Schematic



Typical Wiring for 1-Phase IEC Applications



Typical Wiring for 3-Phase IEC Applications

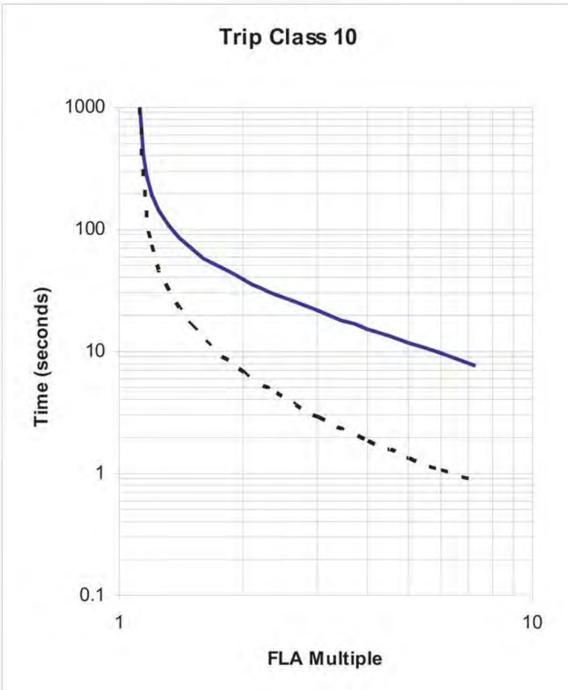


Typical Wiring for NEMA Applications

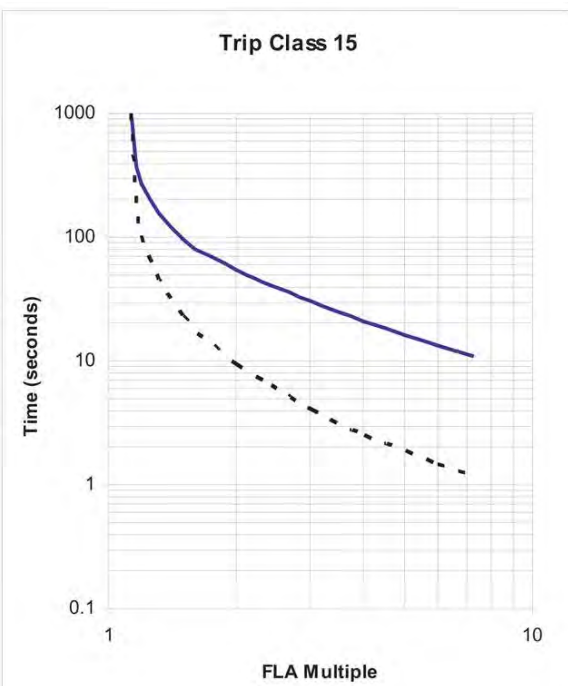
Trip Curves

Typical reset time for 193-EE devices set to automatic reset mode is 120 seconds.

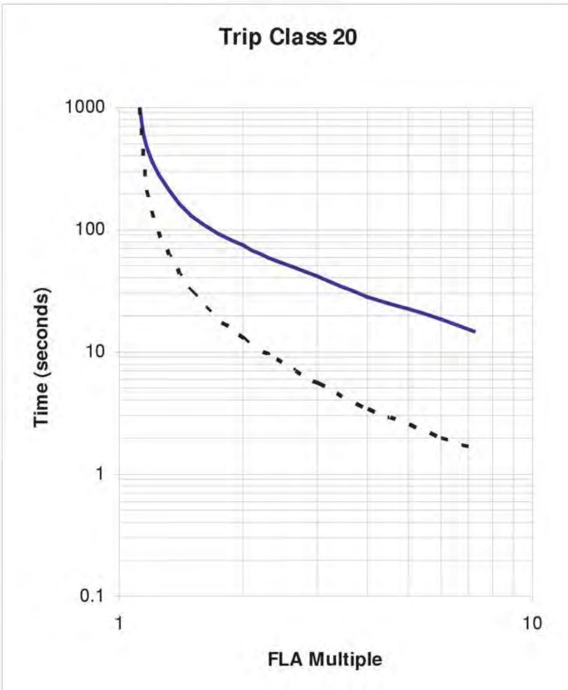
Trip Class 10



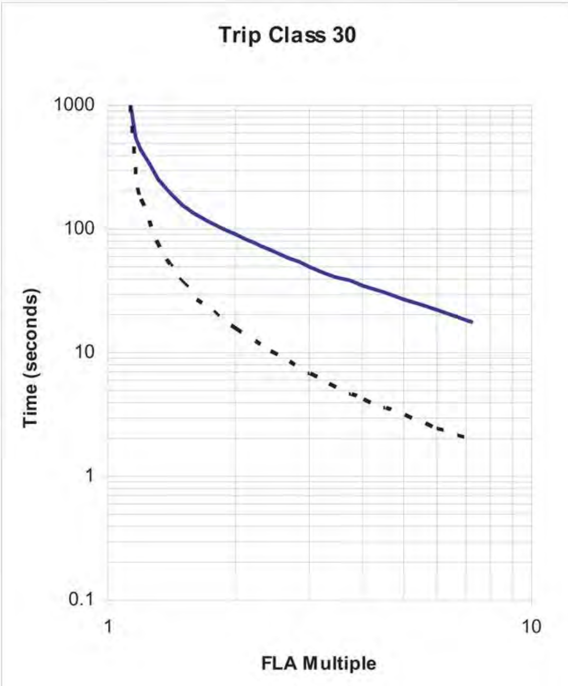
Trip Class 15



Trip Class 20



Trip Class 30

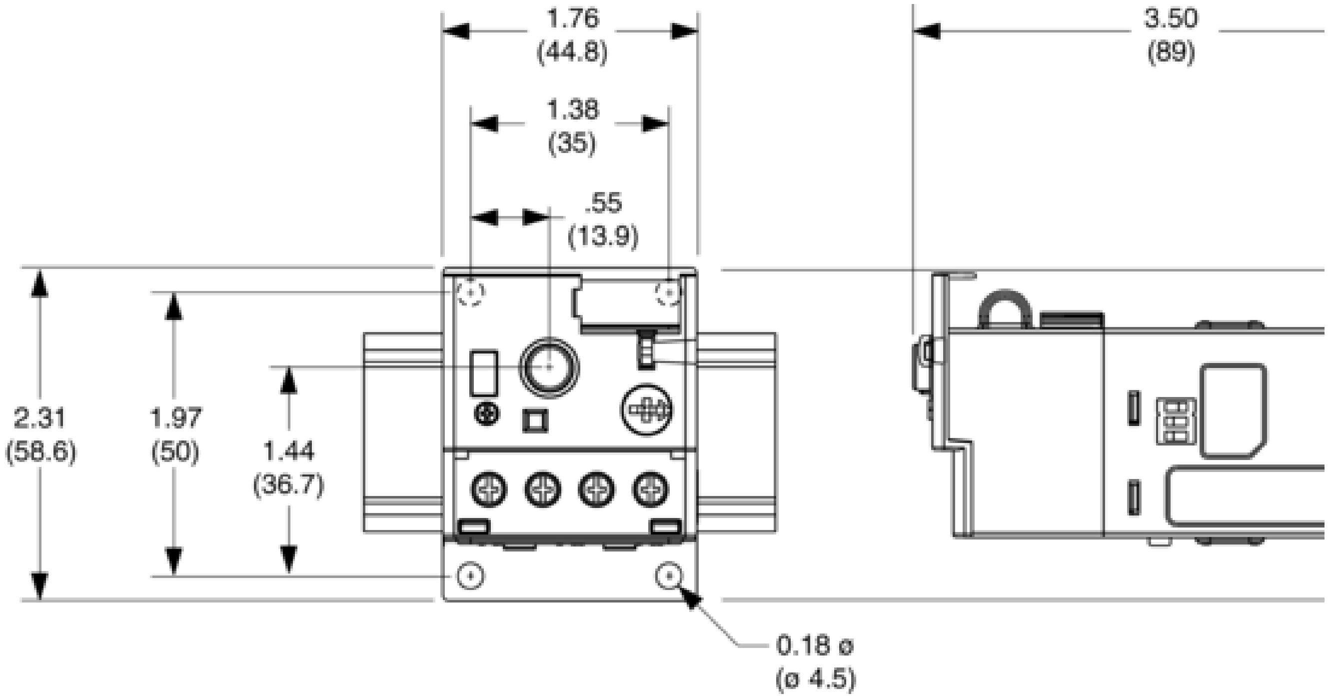


Trip Curve Legend: Cold Trip ————
Hot Trip - - - - - - - - -

Approximate Dimensions

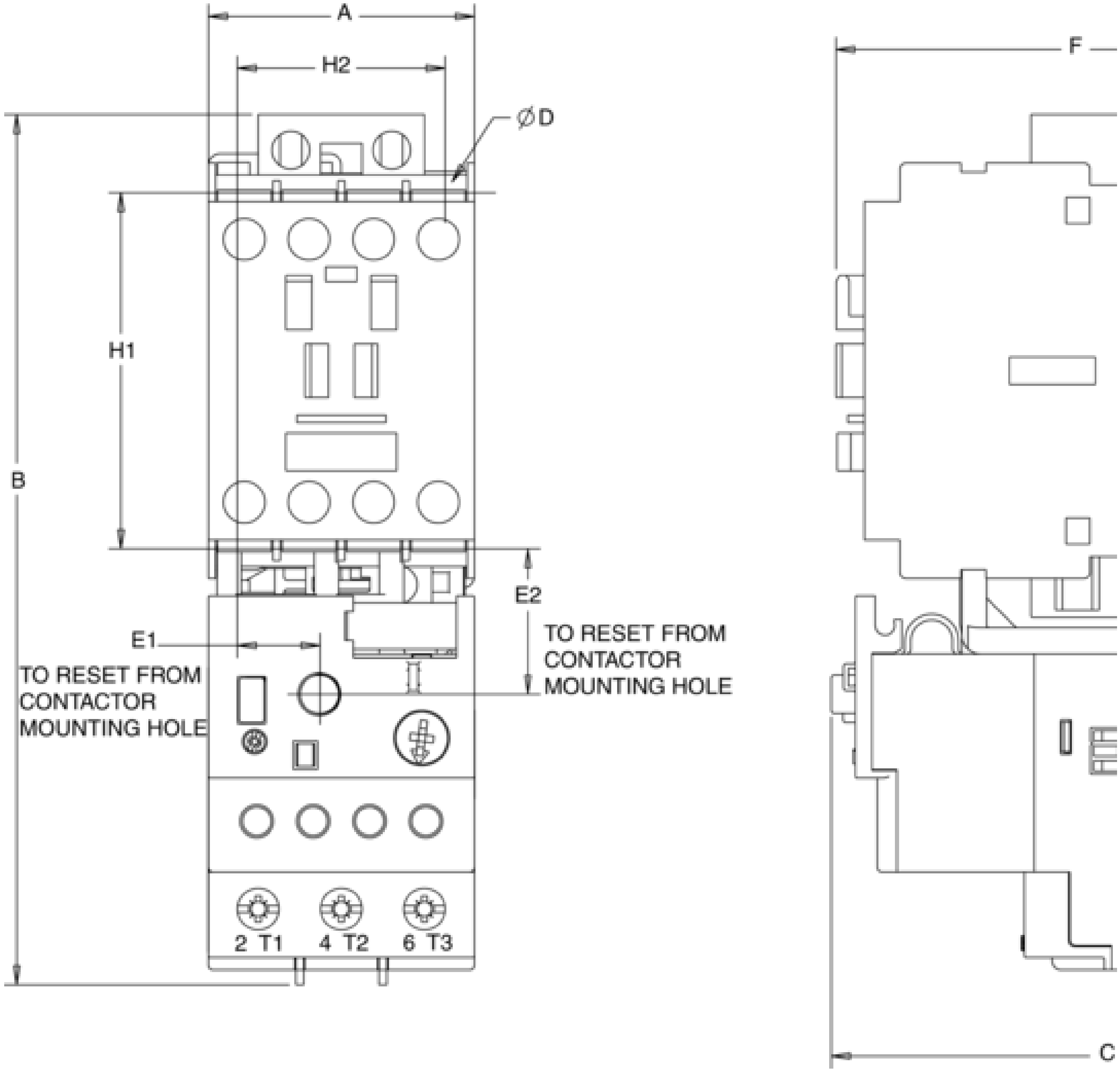
Approximate dimensions are shown in millimeters (inches). Dimensions are not to be used for manufacturing purposes.

E1 Plus Pass-thru Style



Approximate dimensions are shown in millimeters (inches). Dimensions are not to be used for manufacturing purposes.

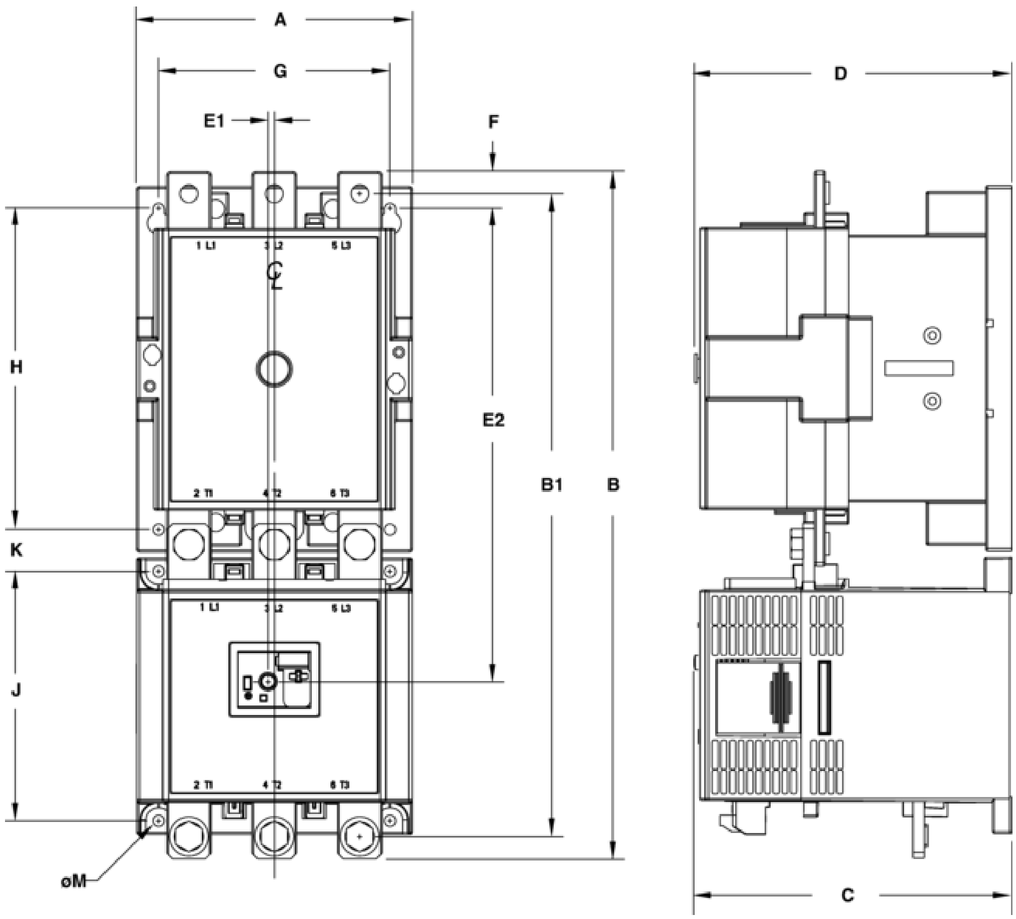
Bulletin 100-C Contactor Mounted



Overload Cat. No.	Contactor Cat. No.	Width A	Height B	Depth C	D	E1	E2	F	H1	H2
193-ED__B 193-EE__B 193R-EE__B 193S-EE__B	100-C09, -C12, -C16, -C23	45 (1-25/32)	146.6 (5-25/32)	85.2 (3-23/64)	4.5 (3/16)	13.9 (35/64)	24.5 (31/32)	86.5 (3-13/32)	60 (2-23/64)	35 (1-3/8)
193-EE__D 193R-EE__D 193S-EE__D	100-C30, -C37	45 (1-25/32	146.6 (5-25/32)	101.2 (3-63/64)	4.5 (3/16)	13.9 (35/64)	24.5 (31/32)	104 (4-3/32)	60 (2-23/64)	35 (1-3/8)

193-EE__D 193R-EE__D 193S-EE__D	100-C43	54 (2-1/8)	146.6 (5-25/32)	101.2 (3-63/64)	4.5 (3/16)	18.9 (3/4)	24.5 (31/32)	104 (4-3/32)	60 (2-23/64)	45 (1-25/32)
193-EE__E 193R-EE__E 193S-EE__E	100-C60, -C72, -C85	72 (2-53/64)	192.3 (7-37/64)	120.4 (4-3/4)	5.4 (7/32)	23.8 (15/16)	29 (1-9/64)	125.5 (4-15/16)	100 (3-15/16)	55 (2-11/64)

Bulletin 100-D Contactor Mounted



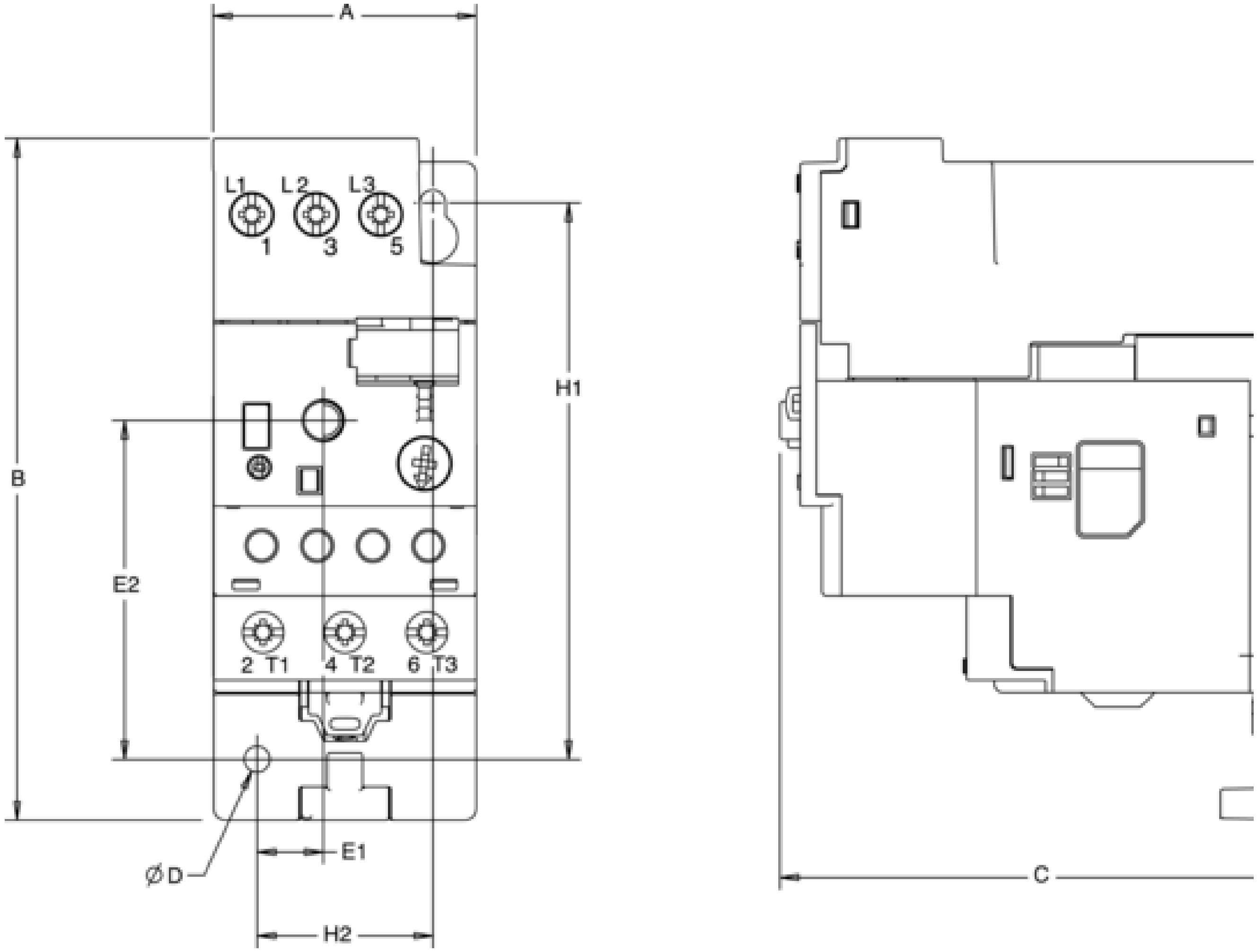
Overload Cat. No.	Contactor Cat. No.	Width A	Height B		Height B1	Depth C	D	E1	E2
			Without Terminal Covers	With Terminal Covers		(Reset)			
193-EE__F	100-D95, -D110	120 (4.72)	336.3 (13.24)	418 (16.46)	311.8 (12.27)	152.7 (6.01)	156 (6.14)	3.6 (0.14)	226.3 (8.91)
193-EE__F	100-D140, -D180	120 (4.72)	339.8 (13.38)	418 (16.46)	317.8 (12.51)	152.7 (6.01)	156 (6.14)	3.6 (0.14)	226.3 (8.91)

193-EE__G	100-D210, -D250, -D300, -D420	155 (6.10)	385.8 (15.19)	487.4 (19.19)	360.8 (14.2)	176.5 (6.95)	180 (7.09)	3.6 (0.14)	265.2 (10.44)
193-EE__H	100-D630, -D860	255 (10.04)	552 (21.73)	915 (36.02)	508 (20)	269.3 (10.6)	270.7 (10.66)	3.6 (0.14)	384.1 (15.12)

Overload Cat. No.	Contactor Cat. No.	F	G	H	J	K	øM
193-EE__F	100-D95, -D110	45 (1-25/32)	100 (3.94)	145 (5.71)	135 (5.31)	22.3 (0.88)	8 - 5.6 (8 - 0.22)
193-EE__F	100-D140, -D180	45 (1-25/32	100 (3.94)	145 (5.71)	135 (5.31)	22.3 (0.88)	8 - 5.6 (8 - 0.22)
193-EE__G	100-D210, -D250, -D300, -D420	54 (2-1/8)	130 (5.12)	180 (7.09)	140 (5.51)	23.5 (0.93)	8 - 6.5 (8 - 0.26)
193-EE__H	100-D630, -D860	52.5 (2.07)	226 (8.90)	230 (9.06)	108 (4.25)	109 (4.29)	8 - 13 (8 - 0.51)

Panel Adapter Mounted

Approximate dimensions are shown in millimeters (inches). Dimensions are not to be used for manufacturing purposes.



Panel Adapter Cat. No.	Overload Cat. No.	Width A	Height B	Depth C	D	E1	E2	F	H1	H2	H3	J
193-EPB	193-ED__B 193-EE__B 193R-EE__B 193S-EE__B	45 (1-25/32	116.5 (4-19/16)	92.7 (3-21/32)	4.4 (11/64)	11.4 (0.45)	57.9 (2-9/32)	62.5 (2-15/32)	95 (3-3/4)	30 (1-3/16)	75 (2-31/32)	52.1 (2-3/64)
193-EPD	193-EE__D 193R-EE__D 193S-EE__D	45 (1-25/32	112.4 (4-7/16)	108.7 (4-9/32)	4.4 (11/64)	11.4 (0.45)	57.9 (2-9/32)	62.5 (2-15/32)	95 (3-3/4)	30 (1-3/16)	75 (2-31/32)	52.1 (2-3/64)
193-EPE	193-EE__E 193R-EE__E 193S-EE__E	72 (2-53/64)	107.4 (4-15/64)	127 (5/32)	5.5 (5/32)	26.4 (1-1/32)	54.5 (2-9/64)	48.3 (1-29/32)	90 (3-23/64)	60 (2-23/64)	—	43.3 (1-45/64)

DIN Rail / Panel Adapter - Terminal Cross Sections

		Cat. No. 193-EPB ‡	Cat. No. 193-EPD ‡	Cat. No. 193-EPE
Flexible-Stranded with Ferrule	Single Conductor	1.0…4.0 mm^2	2.5…16 mm^2	4.0…35 mm^2
	Torque	1.8 N•m	2.3 N•m	4.0 N•m
	Two Conductor	1.0…4.0 mm^2	2.5…10 mm^2	4.0…25 mm^2
	Torque	1.8 N•m	2.3 N•m	4.0 N•m
Coarse-Stranded/Solid	Single Conductor	1.5…6.0 mm^2	2.5…25 mm^2	4.0…50 mm^2
	Torque	1.8 N•m	2.3 N•m	4.0 N•m
	Two Conductor	1.5…6.0 mm^2	2.5…16 mm^2	4.0…35 mm^2
	Torque	1.8 N•m	2.3 N•m	4.0 N•m
Stranded/Solid	Single Conductor	14…8 AWG	16…6 AWG	12…1 AWG
	Torque	16 lb•in	20 lb•in	35 lb•in
	Two Conductor	14…10 AWG	16…6 AWG	12…2 AWG
	Torque	16 lb•in	20 lb•in	35 lb•in

‡ For multiple conductor applications, the same size and style wire must be used.

Technical Data

Miniature circuit-breakers for branch circuit protection according to UL 489, CSA C 22.2 No. 5

When connecting aluminum conductors, ensure that the contact surfaces of the conductors are cleaned, brushed and greased.

For finely stranded conductors, use a connector sleeve for best results.

Conditions for Delivery and Sale

For domestic business, the Standard Terms for Delivery of Products and Services of the Electrical Industry (ABB Form 2292) shall apply in connection with the Standard Sale Terms (ABB Form 2327) in their then applicable version. For foreign business, the Standard Terms for Delivery of Products and Services of the Electrical Industry (ABB Form 2293 German-English, or ABB-Form 2294 German- French) shall apply in connection with the Standard Sale Terms (ABB-Form 2381 English) in their then applicable version.

Warranty

We assume warranty in accordance with the Standard Sale and Delivery Terms.
Complaints shall be made in writing within eight days following receipt of the goods.

Technical information and illustrations are not binding and subject to change without notice.

Table of contents

Contents Page

The new generation of miniature circuit breakers.
System pro *M* compact® S 200 Series.

The new S 200 Series cover all your circuit breaker needs up to 63 amps. We have redesigned our popular supplementary protectors and additionally introduce now a brand new range of miniature molded case circuit breakers suitable for use as branch circuit protection according to UL 489.

Alongside the redesigned S 200 and S 200 P supplementary protectors; the new S 200 U and S 200 UP miniature MCCBs offer the familiar ABB advantages; small size, exemplary protection and easy installation with double terminal technologie.

S200 U and UP series are UL 489, CSA C 22.2 No. 5 approved as well as IEC 947-2. For the first time one circuit breaker fulfills North American and global approval requirements.
Global circuit breakers for OEMs building global equipment.

The new S 200 Series is the first truly compact and modular full circuit breaker solution for use in both North American and global markets.

Signal contacts S2C-S6RU
It signals the tripping caused by overload earth fault or short circuit current however there is no signal when the M.C.B. is switched OFF manually. With a red handle which allows resetting of the trip signal without the M.C.B. being switched on.

Auxiliary contact S2C-H6RU
The switching position of the auxiliary contact depends on the position of the M.C.B. (ON-OFF). Because of coupling to the switching mechanism of the M.C.B. the auxiliary contact offers an trip free feature.

System pro *M* compact® - all you need ...

Brand new Miniature Moulded Case Circuit Breakers for use as branch circuit protection devices

Supplemental Protective Device
UL 1077
CSA C 22.2 No. 235

Branch Circuit Protector
UL 489 / UL 489 A
CSA C 22.2 No. 5

The S 200 U/S 200 UP components are modular and cover voltages and currents used worldwide, including 240 VΔ (S 200 U), 480Y/277 V (S 200 UP) in the US and the 230/400 V IEC standard, with models catering to the full range of current 0.2 – 63 A. For control circuits of the production range S 201 DC to 60 V AC/DC.

	S 200	S 200 P	S 201 DC	S 200 U	S 200 UP
Amperage	0.5 – 63 A	0.2 – 63 A	1 – 25 A	0.2 – 63 A	0.2 – 25 A
Voltage	480Y /277 V AC	480Y /277 V AC	60 V AC DC	240 V AC	480Y /277 V AC
Poles	1-, 2-, 3-, 4-poles	1-, 2-, 3-, 4-poles	1-poles	1-, 2-, 3-, 4-poles	1-, 2-, 3-, 4-poles
Trip characteristics	B, C, D, K, Z	B, C, D, K, Z	K, Z	K, Z	K, Z
Approvals	6 kA : IEC 60898* 6 kA : CSA C22.2 No. 235 6 kA : UL 1077	>10 kA : IEC 947-2* 10 kA : CSA C22.2 No. 235 10 kA : UL 1077	10 kA : IEC 947-2 10 kA : UL 489	10 kA : IEC 947-2* 10 kA : CSA C 22.2 No. 5 10 kA : UL 489	10 kA : IEC 947-2* 10 kA : CSA C 22.2 No. 5 10 kA : UL 489

* IEC ratings at 230/400 V AC

Miniature Moulded Case Circuit Breakers
S 200 U series
acc. to UL 489, CSA C 22.2 No. 5

S 200 U-K
240 V AC

K

10 000

2CDC 021 314 F0004

2CDC 021 315 F0004

Selection table

No. of poles	Rated current I_n A	Ordering details Type No.	Order code	bbn 40 16779 EAN	Price 1 piece €	Price group	Weight 1 piece kg	Pack. unit pcs.
1	0.2	**S 201 U-K 0.2**	2CDS 271 417 R0087	**61922 6**			0.14	10
	0.3	**S 201 U-K 0.3**	2CDS 271 417 R0117	**61923 3**			0.14	10
	0.5	**S 201 U-K 0.5**	2CDS 271 417 R0157	**61924 0**			0.14	10
	0.75	**S 201 U-K 0.75**	2CDS 271 417 R0187	**61925 7**			0.14	10
	1	**S 201 U-K 1**	2CDS 271 417 R0217	**61926 4**			0.14	10
	1.6	**S 201 U-K 1.6**	2CDS 271 417 R0257	**61927 1**			0.14	10
	2	**S 201 U-K 2**	2CDS 271 417 R0277	**61928 8**			0.14	10
	3	**S 201 U-K 3**	2CDS 271 417 R0317	**61929 5**			0.14	10
	4	**S 201 U-K 4**	2CDS 271 417 R0337	**61930 1**			0.14	10
	5	**S 201 U-K 5**	2CDS 271 417 R0357	**61931 8**			0.14	10
	6	**S 201 U-K 6**	2CDS 271 417 R0377	**61932 5**			0.14	10
	8	**S 201 U-K 8**	2CDS 271 417 R0407	**61933 2**			0.14	10
	10	**S 201 U-K 10**	2CDS 271 417 R0427	**61934 9**			0.14	10
	15	**S 201 U-K 15**	2CDS 271 417 R0457	**61936 3**			0.14	10
	16	**S 201 U-K 16**	2CDS 271 417 R0467	**61937 0**			0.14	10
	20	**S 201 U-K 20**	2CDS 271 417 R0487	**61938 7**			0.14	10
	25	**S 201 U-K 25**	2CDS 271 417 R0517	**61939 4**			0.14	10
	30	**S 201 U-K 30**	2CDS 271 417 R0527	**61940 0**			0.14	10
	32	**S 201 U-K 32**	2CDS 271 417 R0537	**61941 7**			0.14	10
	40	**S 201 U-K 40**	2CDS 271 417 R0557	**61942 4**			0.14	10
	50	**S 201 U-K 50**	2CDS 271 417 R0577	**61943 1**			0.14	10
	60	**S 201 U-K 60**	2CDS 271 417 R0587	**61944 8**			0.14	10
	63	**S 201 U-K 63**	2CDS 271 417 R0607	**61945 5**			0.14	10
2	0.2	**S 202 U-K 0.2**	2CDS 272 417 R0087	**61946 2**			0.28	5
	0.3	**S 202 U-K 0.3**	2CDS 272 417 R0117	**61947 9**			0.28	5
	0.5	**S 202 U-K 0.5**	2CDS 272 417 R0157	**61948 6**			0.28	5
	0.75	**S 202 U-K 0.75**	2CDS 272 417 R0187	**61949 3**			0.28	5
	1	**S 202 U-K 1**	2CDS 272 417 R0217	**61950 9**			0.28	5
	1.6	**S 202 U-K 1.6**	2CDS 272 417 R0257	**61951 6**			0.28	5
	2	**S 202 U-K 2**	2CDS 272 417 R0277	**61952 3**			0.28	5
	3	**S 202 U-K 3**	2CDS 272 417 R0317	**61953 0**			0.28	5
	4	**S 202 U-K 4**	2CDS 272 417 R0337	**61954 7**			0.28	5
	5	**S 202 U-K 5**	2CDS 272 417 R0357	**61955 4**			0.28	5
	6	**S 202 U-K 6**	2CDS 272 417 R0377	**61956 1**			0.28	5
	8	**S 202 U-K 8**	2CDS 272 417 R0407	**61957 8**			0.28	5
	10	**S 202 U-K 10**	2CDS 272 417 R0427	**61958 5**			0.28	5
	15	**S 202 U-K 15**	2CDS 272 417 R0457	**61960 8**			0.28	5
	16	**S 202 U-K 16**	2CDS 272 417 R0467	**61961 5**			0.28	5
	20	**S 202 U-K 20**	2CDS 272 417 R0487	**61962 2**			0.28	5
	25	**S 202 U-K 25**	2CDS 272 417 R0517	**61963 9**			0.28	5
	30	**S 202 U-K 30**	2CDS 272 417 R0527	**61964 6**			0.28	5
	32	**S 202 U-K 32**	2CDS 272 417 R0537	**61965 3**			0.28	5
	40	**S 202 U-K 40**	2CDS 272 417 R0557	**61966 0**			0.28	5
	50	**S 202 U-K 50**	2CDS 272 417 R0577	**61967 7**			0.28	5
	60	**S 202 U-K 60**	2CDS 272 417 R0587	**61968 4**			0.28	5
	63	**S 202 U-K 63**	2CDS 272 417 R0607	**61969 1**			0.28	5

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Miniature Moulded Case Circuit Breakers S 200 U series acc. to UL 489, CSA C 22.2 No. 5

S 200 U-K

240 V AC

K

10 000

Selection table

No. of poles	Rated current I_n A	Ordering details Type No.	Order code	bbn 40 16779 EAN	Price 1 piece €	Price group	Weight 1 piece kg	Pack. unit pcs.
3	0.2	**S 203 U-K 0.2**	2CDS 273 417 R0087	**61970 7**			0.42	3
	0.3	**S 203 U-K 0.3**	2CDS 273 417 R0117	**61971 4**			0.42	3
	0.5	**S 203 U-K 0.5**	2CDS 273 417 R0157	**61972 1**			0.42	3
	0.75	**S 203 U-K 0.75**	2CDS 273 417 R0187	**61973 8**			0.42	3
	1	**S 203 U-K 1**	2CDS 273 417 R0217	**61974 5**			0.42	3
	1.6	**S 203 U-K 1.6**	2CDS 273 417 R0257	**61975 2**			0.42	3
	2	**S 203 U-K 2**	2CDS 273 417 R0277	**61976 9**			0.42	3
	3	**S 203 U-K 3**	2CDS 273 417 R0317	**61977 6**			0.42	3
	4	**S 203 U-K 4**	2CDS 273 417 R0337	**61978 3**			0.42	3
	5	**S 203 U-K 5**	2CDS 273 417 R0357	**61979 0**			0.42	3
	6	**S 203 U-K 6**	2CDS 273 417 R0377	**61980 6**			0.42	3
	8	**S 203 U-K 8**	2CDS 273 417 R0407	**61981 3**			0.42	3
	10	**S 203 U-K 10**	2CDS 273 417 R0427	**61982 0**			0.42	3
	15	**S 203 U-K 15**	2CDS 273 417 R0457	**61984 4**			0.42	3
	16	**S 203 U-K 16**	2CDS 273 417 R0467	**61985 1**			0.42	3
	20	**S 203 U-K 20**	2CDS 273 417 R0487	**61986 8**			0.42	3
	25	**S 203 U-K 25**	2CDS 273 417 R0517	**61987 5**			0.42	3
	30	**S 203 U-K 30**	2CDS 273 417 R0527	**61988 2**			0.42	3
	32	**S 203 U-K 32**	2CDS 273 417 R0537	**61989 9**			0.42	3
	40	**S 203 U-K 40**	2CDS 273 417 R0557	**61990 5**			0.42	3
	50	**S 203 U-K 50**	2CDS 273 417 R0577	**61991 2**			0.42	3
	60	**S 203 U-K 60**	2CDS 273 417 R0587	**61992 9**			0.42	3
	63	**S 203 U-K 63**	2CDS 273 417 R0607	**61993 6**			0.42	3
4	0.2	**S 204 U-K 0.2**	2CDS 274 417 R0087	**61994 3**			0.56	2
	0.3	**S 204 U-K 0.3**	2CDS 274 417 R0117	**61995 0**			0.56	2
	0.5	**S 204 U-K 0.5**	2CDS 274 417 R0157	**61996 7**			0.56	2
	0.75	**S 204 U-K 0.75**	2CDS 274 417 R0187	**61997 4**			0.56	2
	1	**S 204 U-K 1**	2CDS 274 417 R0217	**61998 1**			0.56	2
	1.6	**S 204 U-K 1.6**	2CDS 274 417 R0257	**61999 8**			0.56	2
	2	**S 204 U-K 2**	2CDS 274 417 R0277	**62000 0**			0.56	2
	3	**S 204 U-K 3**	2CDS 274 417 R0317	**62001 7**			0.56	2
	4	**S 204 U-K 4**	2CDS 274 417 R0337	**62002 4**			0.56	2
	5	**S 204 U-K 5**	2CDS 274 417 R0357	**62003 1**			0.56	2
	6	**S 204 U-K 6**	2CDS 274 417 R0377	**62004 8**			0.56	2
	8	**S 204 U-K 8**	2CDS 274 417 R0407	**62005 5**			0.56	2
	10	**S 204 U-K 10**	2CDS 274 417 R0427	**62006 2**			0.56	2
	15	**S 204 U-K 15**	2CDS 274 417 R0457	**62008 6**			0.56	2
	16	**S 204 U-K 16**	2CDS 274 417 R0467	**62009 3**			0.56	2
	20	**S 204 U-K 20**	2CDS 274 417 R0487	**62010 9**			0.56	2
	25	**S 204 U-K 25**	2CDS 274 417 R0517	**62011 6**			0.56	2
	30	**S 204 U-K 30**	2CDS 274 417 R0527	**62012 3**			0.56	2
	32	**S 204 U-K 32**	2CDS 274 417 R0537	**62013 0**			0.56	2
	40	**S 204 U-K 40**	2CDS 274 417 R0557	**62014 7**			0.56	2
	50	**S 204 U-K 50**	2CDS 274 417 R0577	**62015 4**			0.56	2
	60	**S 204 U-K 60**	2CDS 274 417 R0587	**62016 1**			0.56	2
	63	**S 204 U-K 63**	2CDS 274 417 R0607	**62017 8**			0.56	2

Series type S 201 DC-K and S 201 DC-Z with or without integrated auxiliary switch

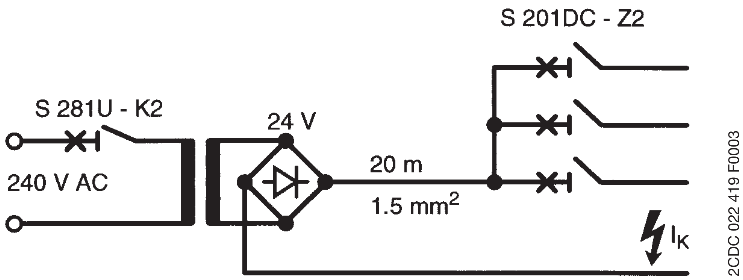
This series – 1-pole with K- and Z-type characteristics for 60 V AC/DC – has been designed for control circuits in machinery and plant that have to meet the requirements provided for in **UL 489,** i.e. **branch circuit protection**.

Planning notes

Overcurrent protection according to EN 60 204-1, protection of damageable components:
A high degree of protection is only possible if the undelayed release trips.
The parameters to be taken into account are:

– loop resistance ($R_i + R_L$)
(R_i = internal resistance MCB at 20 °C/ 63 °F and R_L = output resistance at 20 °C / 63 °F)
– copper temperature: 80 °C / 176 °F in the case of a short circuit / voltage drop, contact resistance
– Result: a total derating factor of 2/3

example 1: standard power supply unit



$R_i = 0.62\ \Omega$

$R_L = \dfrac{40\text{ m}}{1.5 \times 56} = 0.48\ \Omega$

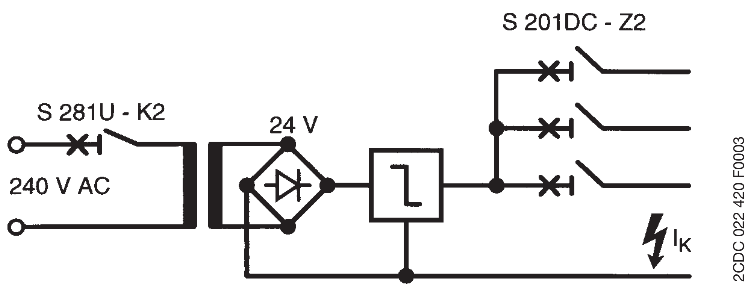
$R = (0.62 + 0.48)\ \Omega = 1.1\ \Omega$

$I_K = \dfrac{24\text{ V} \times 2/3}{1.1\ \Omega} = 14.5\text{ A}$

response value unchanged of S 201 DC-Z2 = 4.5 In = 9 A

result: trips within milliseconds

example 2: switched mode power supply unit

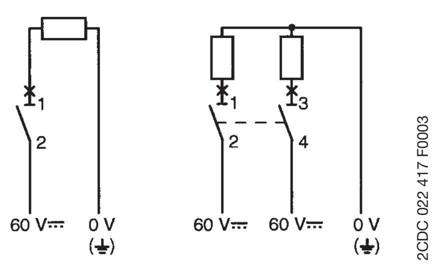


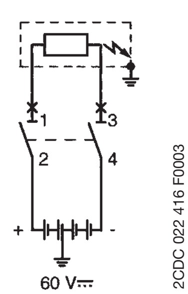
MCB S 201 needs < 100 ms for undelayed tripping. If the switched mode power supply unit adjusts downwards undelayed when a short circuit occurs, the PSU adjusts quicker than the S 201-... is able to respond.

consequence: no selective fault recognition.

result: The output of the switched mode PSU must adjust in a delayed mode (> 100 ms) and the protection device must be adapted to this delayed reduced value in order to ensure selective fault recognition.

example for admissible voltages between conductors





Miniature circuit breakers S 201 DC series acc. to UL 489

Technical Data

specifications:	DIN VDE 0641 -11, IEC 60898, EN 60898, VDE 0660 -101 IEC 60947-2, EN 60 947 -2, UL 489
No. of poles:	1
trip characteristics:	K, Z
rated current I_n:	K and Z 1 ... 25 A
rated voltage U_n:	1-pole 60 V DC / 60 V AC
min. operating voltage U_{Omin} :	12 V-
rated switching capacity:	10 kA
insulation coordination:	according to DIN VDE 0110 Part 1 und 2
– overvoltage category:	III
– pollution degree:	2
– surge voltage U_{imp} (1.2/50 µs):	4 kV (test voltage 6.2 kV at N.N., 5 kV at 2000 m)
– surge alternating voltage:	2.5 kV (50/60 Hz)
housing:	insul. mat. group I (CTI ≥ 600) acc. to DIN IEC 112/VDE 0303 Part 1, RAL 7035
operating lever:	insulating material group II (400 ≤ CTI < 600) black, sealable
protection according to DIN VDE 0100:	IP 20, in the consumer unit IP 40
degree of protection:	IP XXB
design:	according to DIN 43880, size code 1
depth:	68 mm
overall dimensions w x h x d:	17.5 x 85 x 69 mm (with auxiliary contact 17.5 x 102.5 x 69)
mounting position:	optional
fixing:	snap-on on top-hat rail EN 60 715, 35 mm screw fixing onto mounting rail
connection:	bi-directional cylinder lift terminal (two-terminal chamber) at top and bottom. Suitable for the connection of single, multi- or finely stranded conductors up to 25 mm² (with simultaneous busbar connection)
tightening torque:	2.5 Nm
mechanical service life :	20.000 switchovers
service life at rated load	20.000 switchovers
climatic resistance	constant climate 23/73/83, 40/104/93, 55/131/20 [°C/°F/RH]
according to DIN IEC 68 Part 2-30:	alternating climate 25/77/95 - 40/104/93 [°C/°F/RH]
storage temperature:	T_{max} + 70 °C/ 158 °F, T_{min} – 40 °C/– 40 °F
ambient temperature:	T_{max} + 55 °C/ 131 °F, T_{min} – 25 °C/– 13 °F
shock protection:	30 g, at least 2 impacts impact duration 13 ms
vibration resistance according to DIN IEC 68-2-6:	5 g, 20 frequency cycles 5 ... 150 ... 5 Hz at 0.8 I_n

Technical data of the integrated auxiliary contact

contact complement:	1NO (1 normally open) 1NC (1 normally closed)
contact rating:	DC 12 identical DC 13 DC 13 30 V 2 A, 50 V 1 A
min. contact load:	24 V, 4 mA
min. rated voltage:	12 V AC/DC at 0.1 VA
short circuit protection:	with S 201 DC-K2 or -Z2
electrical service life:	> 4000 switchovers

safe disconnection of auxiliary circuit and main circuit according to VDE 0106 Part 101

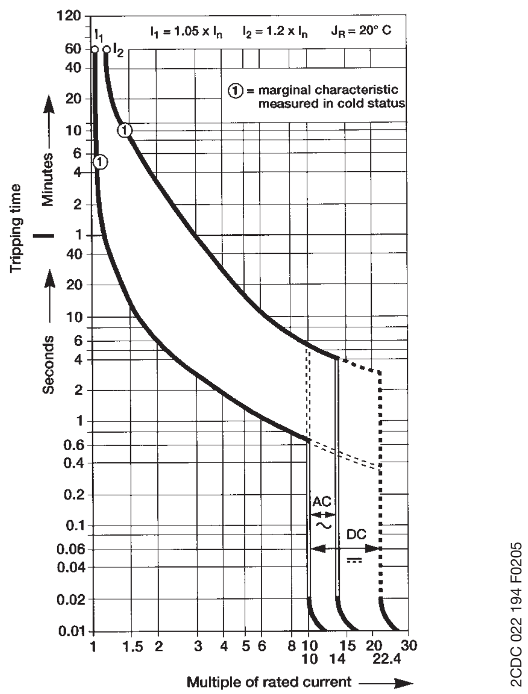
connection capacity:	0.75 up to 2.5 mm² (use connector sleeves for finely-stranded conductors)
tightening torque:	0.5 Nm

Note: busbar system according to UL 489 under preparation

Miniature circuit breakers
S 201 DC series
acc. to UL 489

K-type trip characteristic

Reference temperature 20 °C/68 °F
Deviating ambient temperatures influence the tripping behaviour by 6% per 10 °C / 50 °F



Z-type trip characteristic

Reference temperature 20 °C/68 °F
Deviating ambient temperatures influence the tripping behaviour by 6% per 10 °C / 50 °F

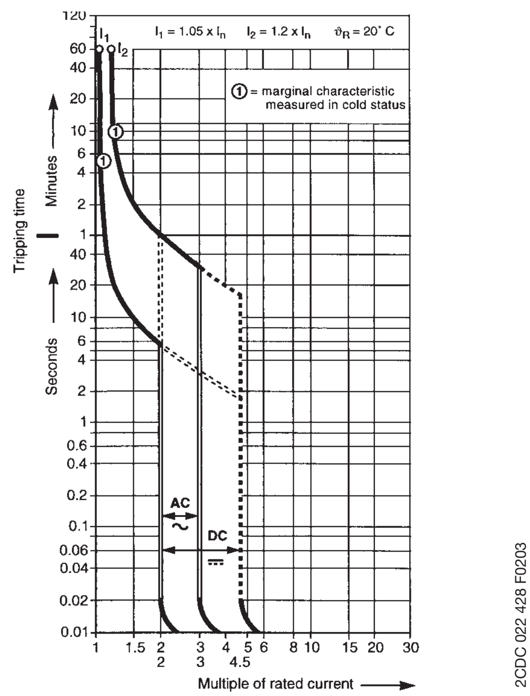


Diagram of let-through values I²t of S 200-K

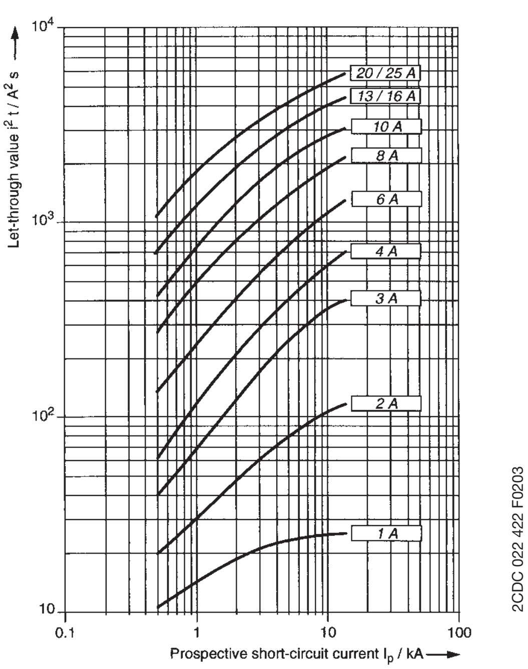
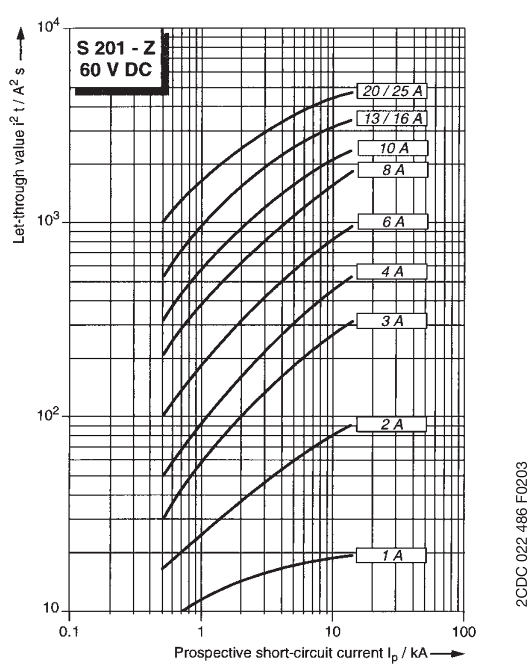


Diagram of let-through values I²t of S 200-Z



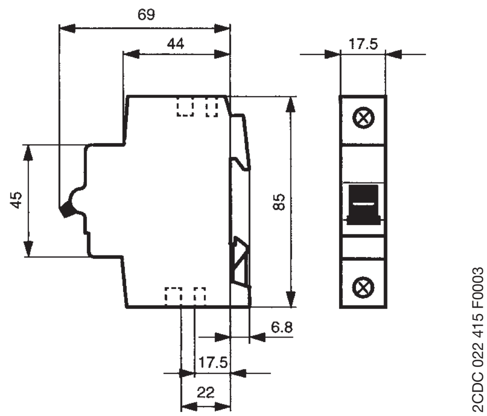
Miniature circuit breakers S 201 DC series acc. to UL 489

Internal resistance and power loss of MCBs

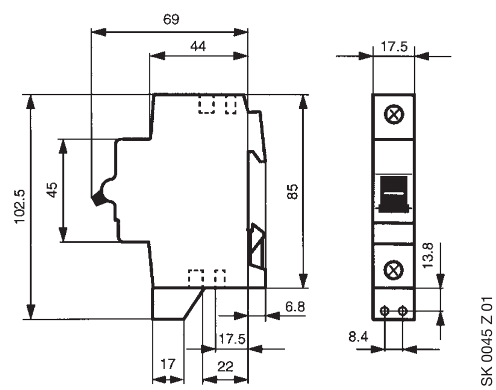
Internal resistance per pole in mΩ, power loss per pole in W

type	rated current	cb series **K**		**Z**	
	I_n A	mΩ	W	mΩ	W
S 200 DC	1	1550	1.6	2270	2.3
	1.6	695	1.8	1100	2.8
	2	460	1.9	619	2.5
	3	165	1.5	202	1.8
	4	120	2.0	149	2.4
	6	52	1.9	104	3.7
	8	38	2.5	53.9	3.45
	10	12.6	1.26	17.5	1.7
	13	12.6	1.26	–	–
	16	7.7	2.0	10.9	2.8
	20	6.7	2.7	6.0	2.4
	25	4.6	2.9	4.1	2.6

Dimensions of S 201 DC

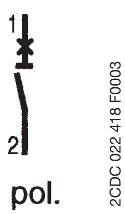


Dimensions of S 201 DC.. H10

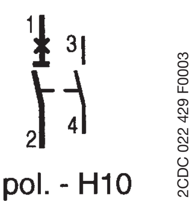


Connection

Feeder optional from top or bottom, terminals designated according to EN 50 005



1 pol.



1 pol. - H10

Miniature Moulded Case Circuit Breakers S 200 U and S 200 UP series acc. to UL 489, CSA C 22.2 No. 5

Technical data	S 200 U	S 200 UP
Specifications:	UL 489, CSA C 22.2 No. 5, IEC 60 947-2	
UL File-Number:	E 2123233	
No. of poles:	1, 2, 3 und 4	
tripping characteristics:	K and Z	
rated current I_n:	0.2 (K) 0.5 (Z) ... 63 A	0.2 (K) 0.5 (Z) ... 25 A
rated voltage U_n:	1-pole: 240 V AC multipole: 240 V AC	1-pole: 277 V AC multipole: 480 Y/277 V AC
short circuit rupturing capacity:	10 kA	
frequency:	50/60 Hz	
degree of protection:	IP 20	
mounting position:	optional	
fixing:	35 mm DIN rail	
clamps only for Co:	18 … 4 AWG (0.75 … 25 mm^2)	
service life, mech. and at rated load:	20.000 operations	
tightening torque:	25 in. lbs (2.8 Nm)	
reference temperature:	25 °C	
ambient temperature:	– 25 … + 55 °C	
shock resistance:	10 g at least 2 impacts shock duration 13 ms	
resistance to vibration acc. to IEC 60 068-2-6	5 g, 20 frequency cycles, 5 … 150 … 5 Hz bei 0.8 I_n	

These two equipment rows are calling oneself different rated current range, the rated voltage and the equipment measurement through hers.

Auxiliary contact S2C-H6RU and Signal contact S2C-S6RU for Miniature Moulded Case Circuit Breakers S 200 U and S 200 UP

rated current I_n:	10
rated voltage AC / DC:	24
short-circuit withstand capacity / 230 V AC:	1000 A bei S 201 K4
insulation coordination:	acc. to DIN VDE 0110 part 1 and 2
– overvoltage category:	III
– surge voltage:	4 kV (1.2/50 µs)
– pollution degtree:	2
contact:	1 change over
connection capacity mm^2	0.75...2.5
tightening torque:	1.2 Nm
shock resistance acc. to DIN IEC 68-2-6:	5 g, 20 frequency cycles 5...150...5 Hz at 24 V AC/DC, 5 mA auto-reclosing < 10 ms
mechanical service life :	10.000 operations
dimensions:	68 x 74 x 99 mm

AC 14	U_e	400V	230 V
	I_e	1 A	2 A

DC 12	U_e	220 V	110 V
	I_e	1 A	1.5 A

DC	U_e	60 V	24 V
	I_e	2 A	4 A

Shunt trip		**Type**	**S 2C-A1 U**	**S 2C-A2 U**
Rated voltage	AC DC	V V	12 ... 60 12 ... 60	110 ... 415 110 ... 250
Max. release duration		ms	<10	<10
Min. release voltage	AC DC	V V	7 10	55 80
Consumption on release	AC DC	VA VA	40 ... 200 40 ... 200	55 ... 210 55 ... 110
Coil resistance		Ω	3.7	225
Terminals		mm^2	16	16
Tightening torque		Nm	2	2
Dimensions (H x D x W)		mm	100 x 69 x 17.5	100 x 69 x 17.5

Undervoltage release		**Type**	**S 2C-UA 12 DC**	**S 2C-UA 24 AC**	**S 2C-UA 24 DC**	**S 2C-UA 48 AC**	**S 2C-UA 48 DC**	**S 2C-UA 110 AC**	**S 2C-UA 110 DC**	**S 2C-UA 230 AC**	**S 2C-UA 230 DC**	**S 2C-UA 400 AC**
Standards			IEC/EN 60947-1									
Rated voltage	AC	V		24		48		110		230		400
	DC	V	12		24		48		110		230	
Frequency		Hz	50 ... 60									
Release trip		V	0.35 UnOVO 0.7 Un									
Terminals		mm^2	2 x 1.5									
Consumption		VA	0.2	3.6	2	3.6	2.1	3.5	2.2	3.7	2.3	2.4
R esistance to corrosion		°C/RH	constant atmosphere: 23/83 – 40/93 – 55/20; variable atmosphere: 25/95 – 40/93									
Protection degree			IPXXB / IP2X									
Tightening torque		Nm	0.4									
Dimensions (H x D x W)		mm	85 x 69 x 17.5									

Miniature Moulded Case Circuit Breakers S 200 U and S 200 UP series acc. to UL 489, CSA C 22.2 No. 5

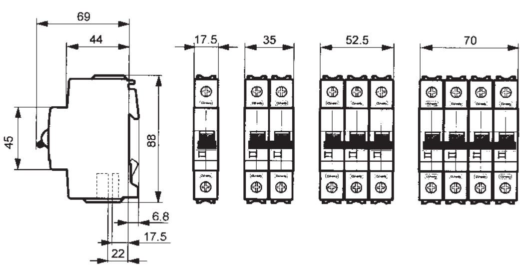
Short circuit rupturing capacity

series **trip characteristic** **rated current**	A	**alternating current** 1phase 120 V AC kA/cos φ	240 V AC kA/cos φ	2/3phase 240 V AC 120/240 V AC kA/cos φ	400 V 277/480 V AC kA/cos φ	Back-up ① max. Fuse gG/gL
S 200 U-K, Z	0.2/0.5 ... 2	unlimited				not required
	3					25 A
	4, 5					35 A
	6					63 A
	8	10/0.25	10/0.25	10/0.25		80 A
	10 ... 20					100 A
	25, 30					125 A
	32 ... 63					160 A
S 200 UP-K, Z	0.2/0.5 ... 2	unlimited				not required
	3					25 A
	4, 5					35 A
	6	10/0.25	10/0.25	10/0.25	10/0.25	63 A
	8					80 A
	10 ... 20					100 A
	25					125 A

① Back-up protection is necessary only if the solid short-circuit current to be expected at the place of installation may exceed the switching capacity indicated.

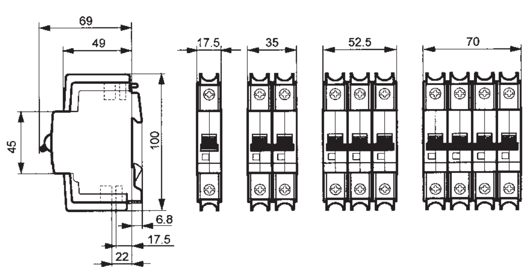
Dimension drawings in mm

S 200 U



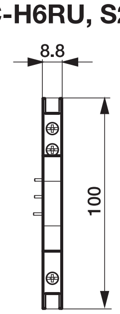
2CDC 022 291 F0004

S 200 UP



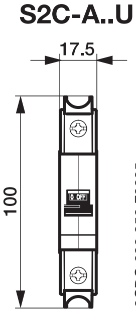
2CDC 022 218 F0004

S2C-H6RU, S2C-S6RU



2CDC 092 045 F0005

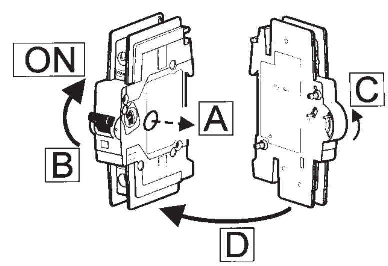
S2C-A..U



2CDC 092 050 F0005

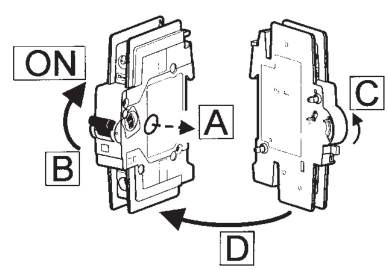
Mounting

built-on of a S2C-H6RU



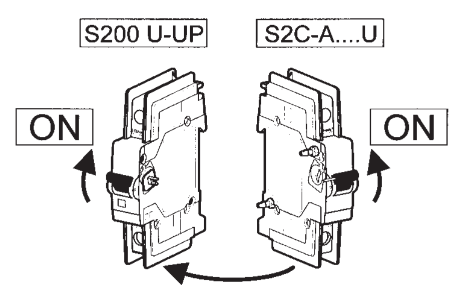
2CDC 022 290 F0004

built-on of a S2C-S6RU



2CDC 022 289 F0004

built-on of a S2C-A..U



2CDC 022 578 F0004

Miniature Moulded Case Circuit Breakers S 200 U and S 200 UP series acc. to UL 489, CSA C 22.2 No. 5

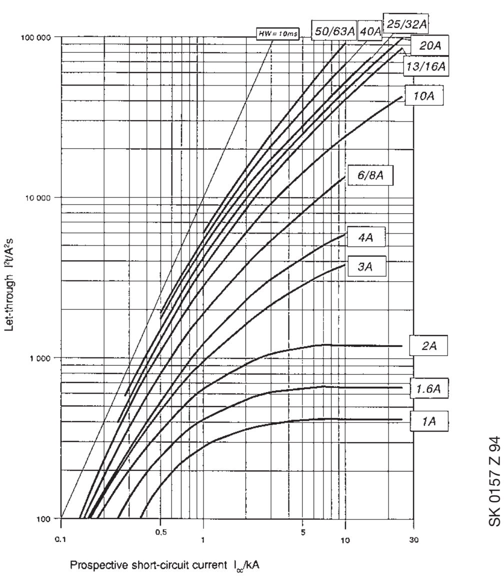
Internal resistance and power loss of the Miniature Moulded Case Circuit Breakers

Internal resistance per pole in mΩ, power loss per pole in W

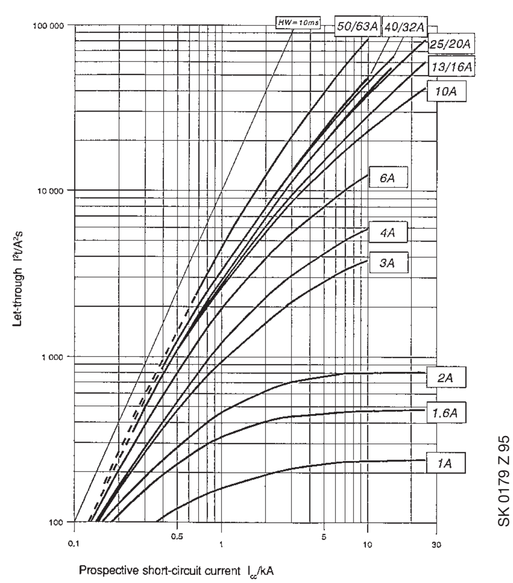
Type	rated current I_n A	device series K mΩ	K W	Z mΩ	Z W
S 200 U	0.2	42500	1.7	–	–
S 200 UP	0.3	20000	1.8	–	–
	0.5	6340	1.6	10100	2.5
	0.75	2500	1.4	–	–
	1	1400	1.4	2270	2.3
	1.6	625	1.6	1100	2.8
	2	460	1.8	619	2.5
	3	211	1.9	211	1.9
	4	163	2.6	163	2.6
	6	67	2.4	104	3.7
	8	45	2.9	55	3.5
	10	19	1.9	21	2.1
	13	–	–	–	–
	16	8.2	2.1	10.9	2.8
	20	7.3	2.9	7.3	2.9
	25	5.6	3.5	5.6	3.5
	32	4.1	4.2	4.1	4.2
	40	4.0	6.4	4.0	6.4
	50	1.2	3.0	1.8	4.4
	63	1.3	5.2	1.3	5.2

Diagrams of let through values I^2 t at 230/400 V AC

K



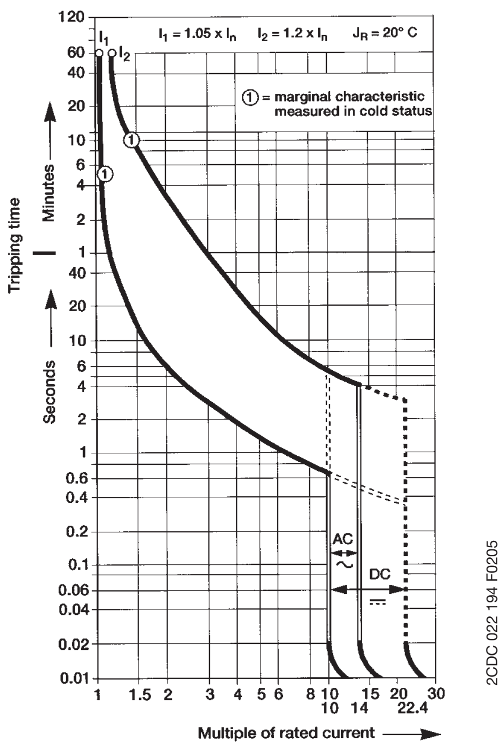
Z



Miniature Moulded Case Circuit Breakers S 200 U and S 200 UP series acc. to UL 489, CSA C 22.2 No. 5

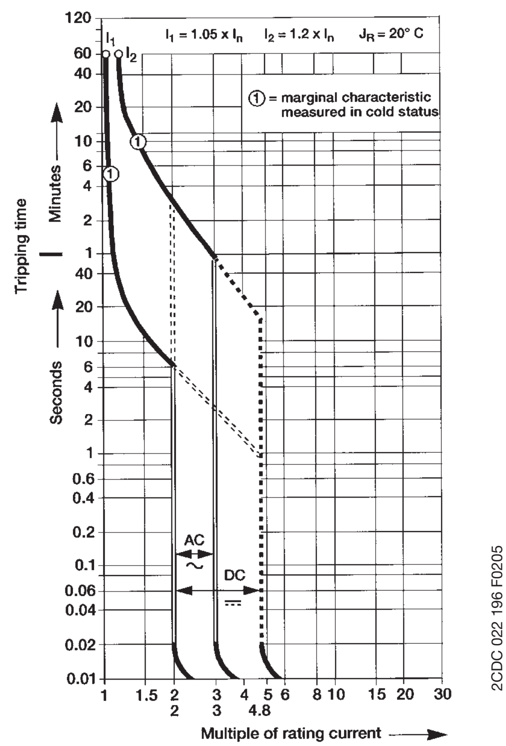
Tripping characteristic K

reference temperature 20 °C
The tripping device changes at a divergent ambient temperature by 6 % je 10 °C



Tripping characteristic Z

reference temperature 20 °C
The tripping device changes at a divergent ambient temperature by 6 % je 10 °C



Max. operating current values depending on the ambient temperature for a cicruit-breaker in load circuit of characteristics type K and Z

K and Z	Ambient temperature T (°C/°F)										
I_n (A)	– 40	– 30	– 20	– 10	0	10	20	30	40	50	60	70
0.5	0.66	0.64	0.61	0.59	0.56	0.53	0.50	0.47	0.43	0.40	0.35	0.31
1.0	1.32	1.27	1.22	1.17	1.12	1.06	1.00	0.94	0.87	0.79	0.71	0.61
1.6	2.12	2.04	1.96	1.88	1.79	1.70	1.60	1.50	1.39	1.26	1.13	0.98
2.0	2.65	2.55	2.45	2.35	2.24	2.12	2.00	1.87	1.73	1.58	1.41	1.22
3.0	4.0	3.8	3.7	3.5	3.4	3.2	3.0	2.8	2.6	2.4	2.1	1.8
4.0	5.3	5.1	4.9	4.7	4.5	4.2	4.0	3.7	3.5	3.2	2.8	2.4
6.0	7.9	7.6	7.3	7.0	6.7	6.4	6.0	5.6	5.2	4.7	4.2	3.7
8.0	10.8	10.2	9.8	9.4	8.9	8.5	8.0	7.5	6.9	6.3	5.7	4.9
10.0	13.2	12.7	12.2	11.7	11.2	10.6	10.0	9.4	8.7	7.9	7.1	6.1
13.0	17.2	16.6	15.9	15.2	14.5	13.8	13.0	12.2	11.3	10.3	9.2	8.0
16.0	21.2	20.4	19.6	18.8	17.9	17.0	16.0	15.0	13.9	12.6	11.3	9.8
20.0	26.5	25.5	24.5	23.5	22.4	21.2	20.0	18.7	17.3	15.8	14.1	12.2
25.0	33.1	31.9	30.6	29.3	28.0	26.5	25.0	23.4	21.7	19.8	17.7	15.3
32.0	42.3	40.8	39.2	37.5	35.8	33.9	32.0	29.9	27.7	25.3	22.6	19.6
40.0	52.9	51.0	49.0	46.9	44.7	42.4	40.0	37.4	34.6	31.6	28.3	24.5
50.0	66.1	63.7	61.2	58.6	55.9	53.0	50.0	46.8	43.3	39.5	35.4	30.6
63.0	83.3	80.3	77.2	73.9	70.4	66.8	63.0	58.9	54.6	49.8	44.5	38.6

Mutual thermal interference when an even load is applied at the same time.
A correction factor must be taken into account in the case of butt-mounted MCBs and an evenly applied, high load: 2 and 3 MCBs multiply with factor 0.9 / 4 and 5 MCBs with factor 0.8 / 6 and more MCBs with factor 0.75

Busbars
and accessories
acc. to UL 489, CSA C 22.2 No. 5

PS 3/6/16 BP

2CDC 061 423 F0004

conn. capac. mm²	No. of pins	phases	order details type code	order code	bbn 40 16779 EAN	Cu-No.	price 1 pc. €	price group	weight 1 pc. kg	pack units pc.

UL approved busbars
Preassembled busbars not cutable

1-phase busbars, pin distance 17.6 mm, UL 489

16	6	1	**PS 1/6/16 BP**	2CDL 210 489 R1606	**64496 9**	0.035				1
16	12	1	**PS 1/12/16 BP**	2CDL 210 489 R1612	**64497 6**	0.070				1
16	18	1	**PS 1/18/16 BP**	2CDL 210 489 R1618	**64498 3**	0.105				1

2-phase busbars, pin distance 17.6 mm, UL 489

16	6	2	**PS 2/6/16 BP**	2CDL 220 489 R1606	**64499 0**	0.070				1
16	12	2	**PS 2/12/16 BP**	2CDL 220 489 R1612	**64500 3**	0.140				1
16	18	2	**PS 2/18/16 BP**	2CDL 220 489 R1618	**64501 0**	0.210				1

3-phase busbars, pin distance 17.6 mm, UL 489

16	6	3	**PS 3/6/16 BP**	2CDL 230 489 R1606	**64502 7**	0.110				1
16	12	3	**PS 3/12/16 BP**	2CDL 230 489 R1612	**64503 4**	0.221				1
16	18	3	**PS 3/18/16 BP**	2CDL 230 489 R1618	**64504 1**	0.332				1

Feeder terminals

for S 200 U

6 – 50	angled feeding	**SZ-Ast 50 U**	2CDL 200 489 R5001						
6 – 50	straight feeding	**SZ-Ast 55 U**	2CDL 200 489 R5002						

for S 200 UP

6 – 35	angled feeding	**SZ-Ast 50 UP**	2CDL 200 489 R3511						
6 – 35	straight feeding	**SZ-Ast 55 UP**	2CDL 200 489 R3512						

SZ-BSK SK 0100 B99

conn. capac. mm²	module	phases	order details type code	order code	bbn 40 16779 EAN	price 1 pc. €	price group	weight 1 pc. kg	pack. units pc.

Shock-protection caps for PS... busbar blocks

		5-parts	**SZ-BSK**	2CDL 200 001 R0011	**42000 6**			0.003	10

Ring-tongue terminal SZ-Ast 55UP RT

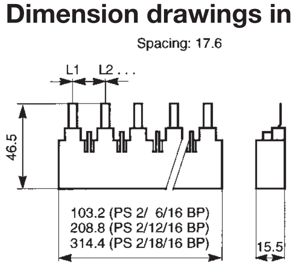
The terminal SZ-Ast 55UP RT is for connection of copper ring-tongue to our MCBs S 200 UP.

Technical data	**SZ-Ast 55UP RT**
Max. electrical load	100 A
Max. operating voltage	600 V AC
Max. torque	3 Nm
Insulation	Cycoloy C 2100 UL–V0

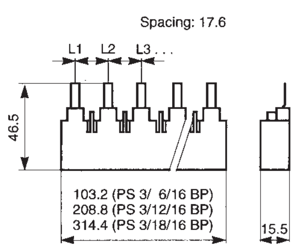
Use single UL listed or CSA certified insulated ring terminal only with max. width 0.46 inch (12 mm).

			SZ-Ast 55UP RT	2CDL 201 489 R0012	**65011 3**			0.011	50

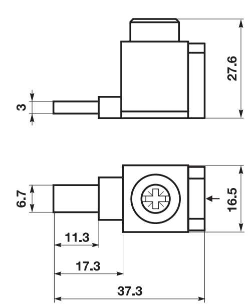
Dimension drawings in mm



2CDC 062 614 F0204



2CDC 062 111 F0204



SZ-Ast 55UP RT

2CDC 062 130 F0005

1384

Miniature circuit-breakers for line and device protection as well as their respective areas of applications

Areas of application	S 200 S 200M	S 201 DC	S 280 UC S 200 P	S 220	S 500	S 610	S 700 WT 63 ①
industrial networks **690 V~** **1000 V~**				S 220	S 500 S 500 HV		WT 63
motor protection transformer	S 200-K		S 200P-K	S 220-K	S 500-K	S 610-K	S 700-K
USV 250 V⎓ to photovoltaics 1200 V⎓			S 280 UC		S 500 UC		
semicon-ductor control circuits 24 V DC	S 200-Z		S 200P-Z				
high discrimination							S 700
disconnector and main circuit breaker capabilities			S 200 P	S 220	S 500	S 610	S 700
USA, Canada UL 1077 CSA **480 V AC** **500 V DC**	S 200		S 200 P S 280 UC	S 220	S 500		
USA, Canada UL 489 **60 V DC/AC** **240 V AC** **480Y/277 V AC**		S 201 DC	S 200 U S 200 UP				
nautical classificationen **GL** **LRS** **BV** **DNV**	S 200		S 200 P S 280 UC	S 220	S 500	S 611 K (bis 63 A)	S 700 (GL)
rated current switching capacity (230/400 V) **I_{cn}/A** **I_n /A**	6 000 10 000 ≤ 63	14 000 ≤ 25	25 000 ≤ 25	10 000 ≤ 32	50 000 ≤ 63	50 000 ≤ 100	25 000 ≤ 100
innovative cost reduction **System pro *M* compact®**	S 200 S 200M	S 201 DC	S 200 P				

① as selective group or full automat

Pub. No. 2CDC 002 052 D0203

ABB STOTZ-KONTAKT GmbH

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www.abb.de/stotz-kontakt

APC Back-UPS® Pro 1000

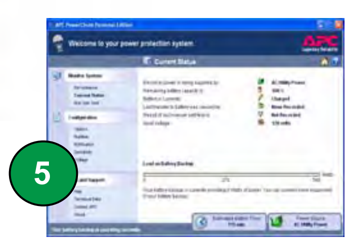
Power-Saving, high performance power protection for office computers

The Back-UPS Pro provides abundant battery backup power, so you can work through medium and extended length power outages. It safeguards your equipment against damaging surges and spikes that travel along utility and data lines. And it features automatic voltage regulation (AVR), which instantly adjusts high and low voltages to safe levels, so you can work indefinitely during brownouts and overvoltages.

The Back-UPS Pro also includes unique "green" features, like power-saving outlets that automatically turn off idle peripherals. A high efficiency charging system and "AVR Bypass" also reduce power consumption. With the rest of the Back-UPS Pro's standard features, this is the perfect unit to protect your productivity from the constant threat of bad power and lost data.

Product Features:

1. **LCD (Liquid Crystal Display)** gives the status of over 20 different utility and battery backup conditions.
2. **Automatic Voltage Regulation (AVR)** instantly corrects voltages fluctuations so you can work indefinitely through brownouts and overvoltages.
3. **4 "Battery Backup & Surge Protected" Outlets** keep a CPU, monitor and other critical devices running when the power goes out or fluctuates outside safe levels. (Includes one power-saving "*Controlled*" outlet).
4. **4 "Surge Only" Outlets** protect printers, faxes or other equipment without reducing battery capacity. (Includes two power-saving "*Controlled*" outlets).
5. **Auto Shutdown Software** allows management of the Back-UPS from your computer via USB or serial interface:
   - Saves files and shuts down system when battery is low
   - Records utility power and battery conditions
   - Allows for customized set up.
6. **Data Line Surge Protection** guards against surges and spikes traveling over Ethernet or coax cable lines.
7. **Push Button Circuit Breaker** enables quick recovery from overloads.
8. **3 Yr Warranty**, $150,000 Equipment Protection Policy and free technical support via phone or web.
9. **Automatic Diagnostic Testing** ensures your unit is ready when you need it.



APC by Schneider Electric

Back-UPS Pro 1000 Specifications

Model Number	BR1000G
Output	
Output Capacity	1000 VA / 600 Watts
Output Voltage, Freq. (on utility)	120V, 50 or 60 Hz, +/- 3Hz (auto sensing)
Output Voltage, Freq. (on battery)	115V +/-8%, 60Hz
Output Connections	8 total NEMA 5-15R outlets: 4 battery & surge (including 1 *Master* & 1 *Controlled*) 4 surge protection only (including 2 *Controlled* outlets)
Waveform Type	Stepped Approximation to Sine Wave
Input	
Input Voltage, Frequency	120V, 50 or 60 Hz, +/- 3 Hz (auto sensing)
Input Connection	6 ft cord with NEMA 5-15 plug
Surge Protection	
AC Power Surge Protection	All outlets
Data Line Surge Protection	Network: to 1000 Base-T Ethernet (gigabit) Coax cable (CATV, SATV, modem, A/V)
Physical	
Unit Dimensions (H x W x D)	9.8 x 3.9 x 15.0” (25.0 x 10.0 x 38.2 cm)
Unit Weight	23.6 lbs (10.7 kg)
Shipping Dims. (H x W x D)	15.0 x 9.0 x 19.0” (38.1 x 22.9 x 48.3 cm)
Shipping Weight	28.0 lbs (12.7 kg)
Color	Black
UPC Code	731304278788
Battery	
Battery Type	Sealed, lead-acid, maintenance-free
Extended run battery pack compatibility	No
Management	
Alarms	Visual (LCD) and audible alarms
Auto-Shutdown Software	PowerChute Personal Edition (via USB and serial interface)
Safety	
Certification/Approvals	FCC Part 15 Class B, TUV, UL Listed

APC ***by Schneider Electric***
132 Fairgrounds Rd
West Kingston, RI 02892
Tel: 800-800-4272
www.apc.com

Switching Power Supply
Type SPD 24 120
DIN Rail mounting

- Installation on DIN Rail 7.5 or 15mm
- Short circuit protection
- PFC available
- High efficiency
- Power ready output
- Parallel versions available
- Compact dimensions
- UL, cUL listed and TUV/CE approved

SP D 24 30 1

SP D 24 120 1

Product Description

The Switching power supplies SPD series are specially designed to be used in all automation application where the installation is on a DIN rail and compact dimensions and performance are a must.

Ordering Key

SP D 24 120 1 BFP

Model
Mounting (D = Din rail)
Output voltage
Output power
Input Type
Optional features

Input type: 1= single phase

Approvals

Optional Features

Description	code
Plug-in connectors	Bxx
With P.F.C.	xFx
With Parallel function	xxP

Output data

Output nominal voltage	**24Vdc***
Current	**5A**
Output voltage range	**22.5 to 30Vdc [1)]**
Line regulation	**± 0.5%**
Load regulation Non parallel model Parallel model	 **± 1%** **± 5%**
DC indicator ON	**21 – 22Vdc**
DC indicator LOW	**20.5 – 22.5Vdc**

Transient recovery time	**300 ms**
Ripple and noise	**50mVpp**
Efficiency typ.	**86%**
Ouput Voltage accuracy	**+1% (factory adjusted)**
Temperature coefficient	**± 0.3%/°C**
Hold up Time Vi = 115Vac **Hold up time Vi = 230Vac**	**25ms** **30ms**
Minimum load	**5%**
Parallel Operation (only specific models)	**3 units max.**

* 12Vdc and 48Vdc available, see specific datasheets

1)N.A. on parallel model. Output voltage is fixed in house, cannot be trimmed by user.

Input data

Rated input voltage	**115/230 selectable**	**Frequency range**	**47- 63 Hz**
Voltage range AC in, 115 selected AC in, 230 selected DC in, only 230 selected	 **93 - 132 Vac** **186 - 264 Vac** **210 - 370 Vdc**	**Inrush current** Vi= 115Vac Vi= 230Vac	 **24A** **48A**
		P.F.C. (optional)	**0.7**

Controls and Protections

Input Fuse	**T4A/250Vac internal***	**Power ready** Threshold at start up Threshold after start up Contact rating at 60Vdc insulation	 **21.1-23.1** **19.0-20.6** **0.3A** **500Vdc**
Overvoltage Protection	**125 – 145%**		
Output Short Circuit	**Current limited**		
Rated Overload Protection	**105-125%**		

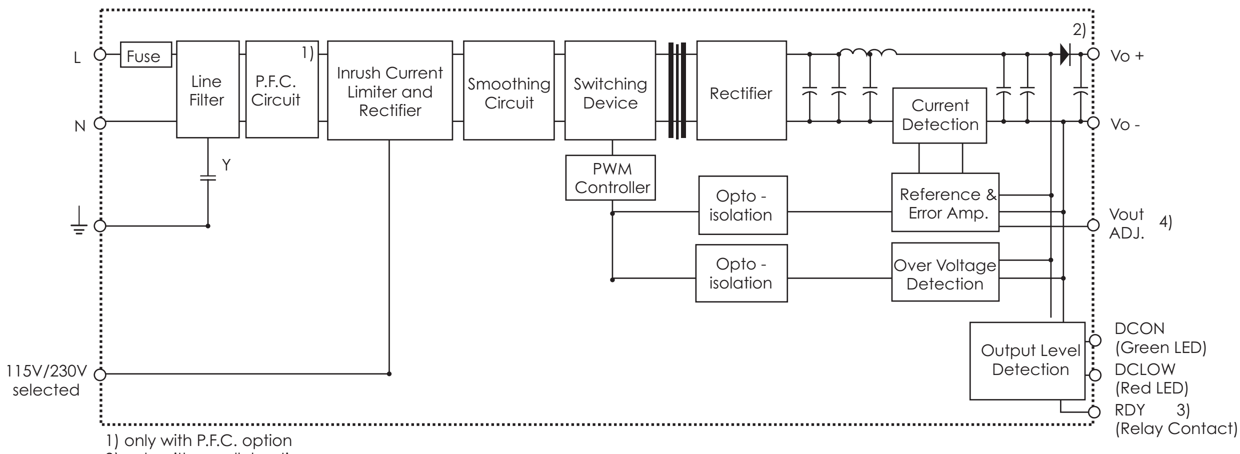
General data (@ nominal line, full load, 25°C)

Ambient temperature	**-10°C to 71°C**	**Cooling**	**Free air convection**
Case temperature V/I nom	**+90°C**	**Switching frequency**	**80kHz**
Derating (>60°C to +71°C)	**2.5%/°C**	**MTBF (MIL-HDBK-217F)**	**200.000h**
Ambient humidity	**<95%RH**	**Case material**	**Metal**
Storage	**-25°C to +85°C**	**Dimensions L x W x D**	**125 x 63.5 x 126**
Protection degree	**IP20**	Without P.F.C. With P.F.C.	**640g** **860g**

Approvals and EMC

Insulation voltage I / O	**3.000Vac**	**CE**	**EN50081-1** **EN55022 class B** **EN61000-3-2** **EN61000-3-3** **EN50082-1** **EN55024**
Insulation resistance	**100Mohm**		
UL / cUL	**UL508 listed, UL60950-1, Recognised**		
TUV	**EN60950**		

Block diagrams



1) only with P.F.C. option
2) only with parallel option
3) for 24VDC models
4) N.A. on parallel version

* Not replaceable by user.

CARLO GAVAZZI

Pin assignement and front controls

Pin No.	Designation	Description
1	**RDY**	DC OK, relay normally open contact
2	**RDY**	DC OK, relay normally open contact
3	**+**	Positive output terminal
4	**+**	Positive output terminal
5	**-**	Negative output terminal
6	**-**	Negative output terminal
7	**GND**	Ground terminal to minimise High frequency emissions
8	**L**	Phase input (no polarity with DC input)
9	**N**	Neutral input (no polarity with DC input)
	DC ON	DC output ready LED
	DC LO	DC low indicator LED
	Vout ADJ.	Trimmer for fine output voltage adjustment
	115/230	Input voltage selection switch

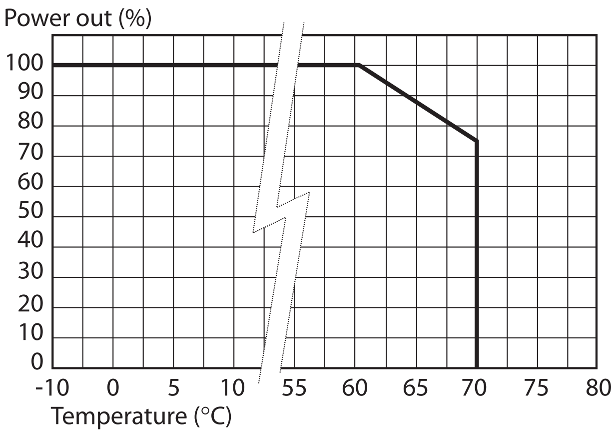
Installation

VENTILATION / COOLING:
- **Normal air convection**
- **25mm of free space along all sides to allow good cooling**

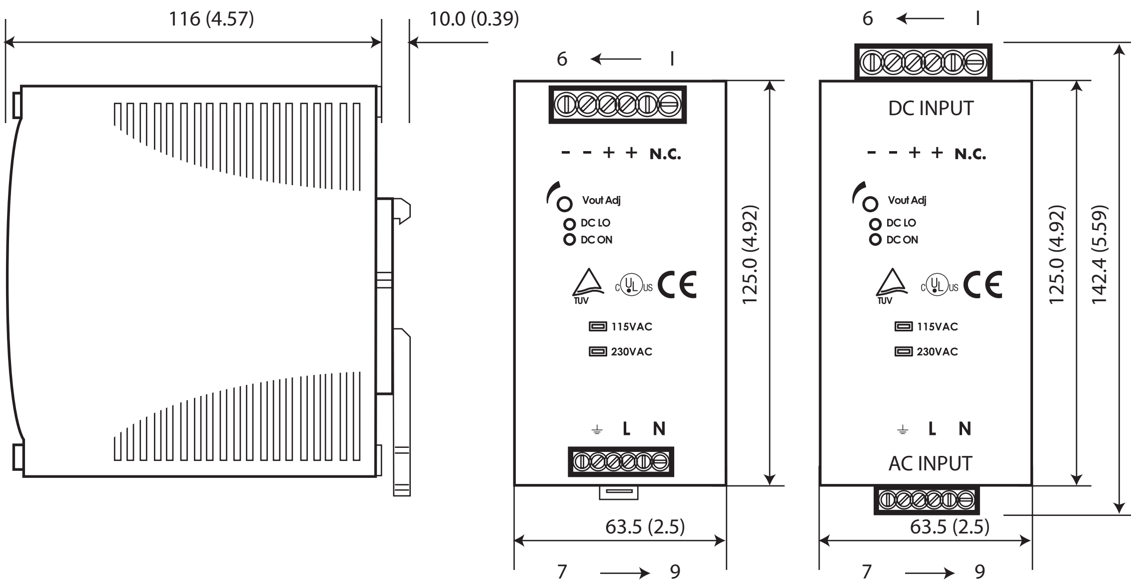
SCREW CONNECTIONS:
- **10-24AWG Flexible or solid cable. 8mm stripping recommended**

PLUG IN CONNECTORS:
- **10-24AWG Flexible or solid cable. 7mm stripping recommended**

Derating Diagram



Mechanical Drawings



TRANSFORMERS FOR HARSH LOCATIONS

Hammond encapsulated transformers are designed specifically for installation in harsh environments where dust, moisture and corrosive contaminants are present. In these applications, standard dry type distribution transformers would not be acceptable as the windings and connection joints are exposed to the undesirable environment.

Encapsulated transformers are standard dry type general purpose distribution transformers encased in a electrical grade silica and epoxy, and totally enclosed in a heavy duty NEMA 3R style enclosure. All leads are brought out to a separate, front accessible termination compartment. All units are copper wound.

Typical applications of Hammond Encapsulated Transformers are: pulp and paper plants, steel mills, food processing plants, breweries, mines, marine and shipboard installations etc.

COPPER WOUND SINGLE PHASE FEATURES

FEATURE	.05 kVA to 1 kVA	1.5 to 37.5 kVA
UL Listed	File: E50394	File: E50394
CSA Certified	File: LR3902	File: LR3902
Frequency	60 Hz (50/60 Hz on uints with 380V primary)	60 Hz (50/60 Hz on uints with 380V primary)
Insulation System	130°C (80°C rise) standard on all units	180°C (115°C rise) standard on all units. Optional 130°C (80°C rise) available.
Electrostatic Shield	Optional on units up to .500 kVA. Standard on .750 kVA and 1 kVA units.	Standard on all units.
Encapsulation	All units are encapsulated with electrical grade silica sand and resin compounds.	All units are encapsulated with electrical grade silica sand and resin compounds.
Enclosure Type	Heavy Duty Encapsulated NEMA Type 3R (optional NEMA 4, 4X and 12 available)	Heavy Duty Encapsulated NEMA Type 3R (optional NEMA 4, 4X and 12 available)
Enclosure Finish	ANSI 61 Grey, UL50	ANSI 61 Grey, UL50
Termination	Front accessible separate high and low voltage lead wires or copper tabs.	Front accessible separate high and low voltage lead wires or copper tabs.
Conduit Knock-Outs	Standard side and rear knock-outs on all units.	Standard side and rear knock-outs on all units.
Impedance	Typically 2 to 5%.	Typically 2 to 5%.
Mounting	Standard Wall Mounting.	Standard Wall Mounting. Lifting ears provided on all units 5 kVA and up.

Other voltages not listed in this section are available upon request. Please contact customer service for details, price and availability.

FOR TERMINATION DETAILS SEE PAGE 253.

FOR ACCESSORIES SEE PAGES 254 TO 256.

COPPER WOUND, SINGLE PHASE, NEMA 3R STYLE ENCLOSURE

240 X 480 Primary Volts 120/240 Secondary Volts 60 Hz

kVA	Catalog Number	Case Style (Page 238)	Approx. Dimensions (Inches) Width	Depth	Height	Approx. Weight (Lbs.)	Mtg Type W - Wall	Wiring Diagram (Pages 239-252)
0.05	**QC05LECB**	NQ0	3.75	5.25	7.25	6	W	SCD 1
0.10	**QC10LECB**	NQ0	3.75	5.25	7.25	7	W	SCD 1
0.15	**QC15LECB**	NQ0	3.75	5.25	7.25	8	W	SCD 1
0.20	**QC20LECB**	NQ1	4.50	5.75	7.25	11	W	SCD 1
0.25	**QC25LECB**	NQ1	4.50	5.75	7.25	13	W	SCD 1
0.35	**QC35LECB**	NQ1	4.50	5.75	7.25	14	W	SCD 1
0.5	**QC50LECB**	NQ2	5.00	4.75	9.25	15	W	SCD 1
0.75	**QC75LEKB**	NQ2	5.00	4.75	9.25	18	W	SCD 1
1	**Q1C0LEKB**	NQ3	5.88	5.50	10.00	22	W	SCD 1
1.5	**Q1C5LEKF**	NQ3	5.88	5.50	10.00	25	W	SCD 1
2	**Q002LEKF**	NQ4	7.00	6.50	11.25	40	W	SCD 1
3	**Q003LEKF**	NQ4	7.00	6.50	11.25	55	W	SCD 1
5	**Q005LEKF**	NQ5	10.00	7.75	17.25	90	W	SCD 1
7.5	**Q007LEKF**	NQ5	10.00	7.75	17.25	115	W	SCD 19
10	**Q010LEKF**	NQ6	12.25	9.25	20.88	165	W	SCD 19
15	**Q015LEKF**	NQ6	12.25	9.25	20.88	225	W	SCD 19
25	**Q025LEKF**	NQ7	14.50	10.75	21.38	285	W	SCD 19
37.5	**Q037LEKF**	NQ8	14.50	10.75	27.38	410	W	SCD 19

For shielded units up to 0.50 kVA, replace the suffix "CB" with a "KB".

SECTION 11

600 Primary Volts 120/240 Secondary Volts 60 Hz

kVA	Catalog Number	Case Style (Page 238)	Approx. Dimensions (Inches) Width	Depth	Height	Approx. Weight (Lbs.)	Mtg Type W - Wall	Wiring Diagram (Pages 239-252)
0.05	**QC05PECB**	NQ0	3.75	5.25	7.25	6	W	SCD 4
0.10	**QC10PECB**	NQ0	3.75	5.25	7.25	7	W	SCD 4
0.15	**QC15PECB**	NQ0	3.75	5.25	7.25	8	W	SCD 4
0.20	**QC20PECB**	NQ1	4.50	5.75	7.25	11	W	SCD 4
0.25	**QC25PECB**	NQ1	4.50	5.75	7.25	13	W	SCD 4
0.35	**QC35PECB**	NQ1	4.50	5.75	7.25	14	W	SCD 4
0.50	**QC50PECB**	NQ2	5.00	4.75	9.25	15	W	SCD 4
0.75	**QC75PEKB**	NQ2	5.00	4.75	9.25	18	W	SCD 4
1	**Q1C0PEKB**	NQ3	5.88	5.50	10.00	22	W	SCD 4
1.5	**Q1C5PEKF**	NQ3	5.88	5.50	10.00	25	W	SCD 4
2	**Q002PEKF**	NQ4	7.00	6.50	11.25	40	W	SCD 4
3	**Q003PEKF**	NQ4	7.00	6.50	11.25	55	W	SCD 4
5	**Q005PEKF**	NQ5	10.00	7.75	17.25	90	W	SCD 4
7.5	**Q007PEKF**	NQ5	10.00	7.75	17.25	115	W	SCD 6
10	**Q010PEKF**	NQ6	12.25	9.25	20.88	165	W	SCD 6
15	**Q015PEKF**	NQ6	12.25	9.25	20.88	225	W	SCD 6
25	**Q025PEKF**	NQ7	14.50	10.75	21.38	285	W	SCD 6
37.5	**Q037PEKF**	NQ8	14.50	10.75	27.38	410	W	SCD 6

For shielded units up to 0.50 kVA, replace the suffix "CB" with a "KB".

For termination details see page 253.
For accessories see pages 254 to 256.

COPPER WOUND THREE PHASE FEATURES

FEATURE	2 to 45 kVA
UL Listed	File: E50394
CSA Certified	File: LR3902
Frequency	60 Hz
Insulation System	180°C (115°C rise) Optional 130°C (80°C rise) available.
Electrostatic Shield	Optional on all units.
Encapsulation	All units are encapsulated with electrical grade silica sand and resin compounds.
Enclosure Type	Heavy Duty Encapsulated NEMA Type 3R (optional NEMA 4, 4X and 12 available)
Enclosure Finish	ANSI 61 Grey, UL50
Termination	Front accessible separate high and low voltage lead wires or copper tabs.
Conduit Knock-Outs	Standard on all units.
Impedance	Typically 2 to 5%.
Mounting	Standard Wall Mounting Lifting ears provided on all units 5 kVA and up.

Other voltages not listed in this section are available upon request. Please contact customer service for details, price and availability.

For termination details see page 253.

For accessories see pages 254 to 256.

AC Line Reactors and Motor Guarding Transient Filters

Description

Pioneer Electric Line Reactors are Today's Solution to SCR Drive/Inverter Application Problems.

Inductors placed at the input and output of electrical equipment, can provide and improve performance. Line reactors absorb many power line disturbances which could damage or shut down your inverters, variable speed controllers, or other voltage sensitive equipment.

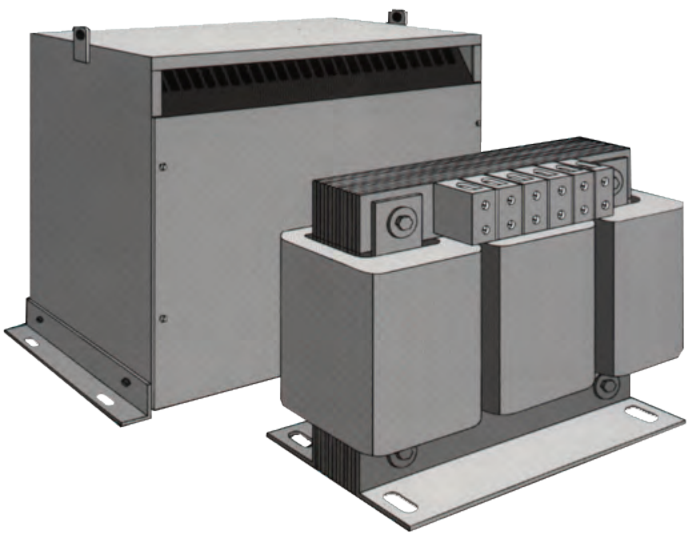
- Pioneer Electric reactor designs conform to UL, CSA, and IEC international standards
- Three phase AC line reactors when used as input or output filters on inverter electronic speed drive applications provide several significant benefits which are explained in this catalogue.
- Pioneer Electric motor guarding transient filters, incorporate reactors, resistors, and capacitors. When these devices are placed on the output of adjustable frequency drives they protect the motor windings from the damaging voltage spikes associated with the fast switching effects of IGBT's and long lines.

Features

- Easy to install
- Smaller and less expensive than isolation transformers
- Reduce harmful surge current.
- Available in open or NEMA 1 enclosed construction
- Conforms to CSA, UL, and IEC standards
- Available in a wide range of standard ratings
- ISO9001 registered quality system
- DIN rail mounting available in some ratings
- CE marking available

Benefit

- Reduce electrical line noise
- Extend the life and protect SCR's and transistors
- Filter power line disturbances
- Limit short circuit currents
- Important in achieving compliance to IEEE 519
- Reduce harmonic content
- Reduce nuisance tripping
- Reduce Telephone Influence Factor (TIF)



Construction

General

The construction of line reactors has presented a challenge for reactor manufacturers because by the nature of their application, reactors are regularly subjected to overload conditions, and severe power disturbances.

To control their impedance, line reactors are manufactured with gaps in their magnetic flux path. Maintaining the mechanical integrity and the consistency of these gaps, under punishing conditions over the life of the reactors, requires particular care during engineering, design, and construction.

Pioneer Electric through years of experience in reactor applications has developed a unique combination of design techniques, materials, and assembly practices that result in a product with reduced losses, low audible sound levels, and provides years of reliable service under adverse conditions.

Core

Manufactured from low loss, grain oriented silicon steel shunts, and assembled to reduce sound and minimize core losses.

Windings and Insulation

Class 220°C insulation is utilized throughout with a 115°C temperature rise. The windings are of all copper construction, the terminals are brazed, and the complete unit is impregnated with high temperature polyester baked varnish.

Gap

The impedance of the reactor is controlled and tuned by accurately maintaining the gap in the flux path. This is achieved using high temperature Nomex and fiberglass spacers which are reinforced by an epoxy baked compound to reduce sound levels.

Assembly and Brackets

The reactor windings are secured to the core by high temperature fiberglass pultrusions. The core is framed at the top and bottom by formed steel brackets and braced by non magnetic (stainless steel or bronze) tie bolts to minimize losses, reduce noise (hum), and to provide exceptional mechanical strength.

Enclosures

Reactor enclosures are manufactured from 14 gauge formed steel panels which are painted with ASA 61 grey powder paint suitable for most industrial and commercial applications.

Standard Technical Specification

- Max ambient temperature 40°C
- Insulation system 220°C
- Temperature rise 115°C
- CSA certified and UL listed
- Current overload capability: 150% for 1 minute
- Saturation rating: not less than 250% of rated current (50% rated inductance minimum at 350% rated current)
- Audible sound level:

0 - 15 amp.	60 dB. max.
16 - 100 amp.	65 dB. max.
101 - 350 amp.	70 dB. max.
351 - 600 amp.	75 dB. max.

- Harmonic compensation: suitable for operation with non-sinusoidal load currents with up to 50% total harmonic distortion

Test and Quality Inspection

- Dimensions (core, coil, and enclosure)
- Mechanical security of assembly, terminals, hardware
- Appearance (core, coil, enclosure, painting, and finishing)
- Electrical wiring, grounding, and markings
- Impulse: 4000 volts one minute winding to winding, winding to core ground
- Impedance measurement and tolerances
- Audible sound at rated current
- ISO9001 quality assurance

Applications and Benefits of Line Reactors as Input Reactor

General

Line reactors are placed in series with electrical equipment to introduce a specific controlled impedance to the circuit. This inserted impedance acts to reduce line harmonics, moderate line transients, or to isolate the harmonic sensitive elements (such as power factor correction capacitors, harmonic filters, etc.) from the rest of the system. In the case of particular equipment such as AC drives, the line reactors may be an integral and essential part of the drive acting primarily as an input filter. Other specialized roles for reactors with drives are described below.

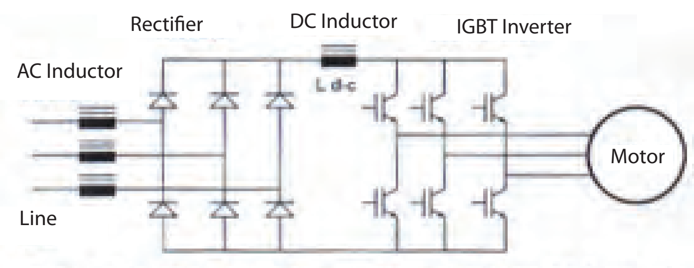


Figure 1: The IGBT Adjustable Frequency Drive (with AC and DC smoothing)

1. Line Harmonic Suppression

Figure 1 displays a typical AC drive topology demonstrating AC and DC line current smoothing. DC smoothing is optional and is obtained by a DC reactor built into the drive as shown. Frequently DC smoothing is eliminated for economy, relying only on the filtering effects of AC impedance. Regardless of what mix of DC and AC smoothing is used, inserting a specific amount of line reactance can reduce the line harmonics produced.

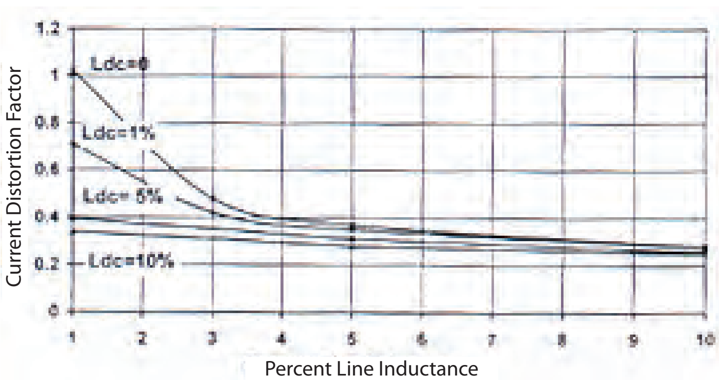


Figure 2: Current Distortion Factor versus Line and DC Link Inductance

Figure 2 demonstrates the effect of various amounts of line and DC inductance on line harmonics. The quality of the line current is measured on the basis of line current distortion factor (IDF) versus percent of inserted line inductance and different DC inductances.

2. Higher Frequency Line Harmonic Suppression, Telephone Influence Facto

In some instances higher frequency line harmonics must be suppressed to prevent possible interference with electrical equipment in proximity to the line. The most common examples of this are related to the interference standards in telephone communications as described in IEEE-519. Telephone interference is characterized by a quantity defined as TIF. A current distortion factor, TIF is calculated by applying specific weighting factors to each line harmonic, to emphasize the tendency of particular harmonics to cause interference in telephone audio band in the vicinity of 3KHz.

Series line reactors in combination with filter traps are effective in reducing such harmonics to the point that applicable standards can be met.

3. Line Transient Suppression

Frequently, severe transients are present on the line in the form of voltage spikes and over voltage excursions. Voltage spikes can produce different adverse effects. If the spike is of sufficient magnitude, it can cause the failure of the electrical components. In other circumstances, transients can cause the internal protective system to initiate nuisance trips making that equipment unreliable.

The introduction of series line reactors will reduce the effect of these transients to protect the equipment and improve reliability.

4. Specialized Applications

Line reactors are useful in other applications. For example, to assist in combining individual equipment as when paralleling rectifiers. In these roles, the reactors act to equalize the balancing of currents. For these and other applications consult Pioneer Electric engineering staff for detailed application assistance.

Applications and Benefits of Line Reactors as Output Reactor

The Benefits of Using Reactors in the Output of Adjustable Frequency Drives

Line reactors placed on the output of drives, are effective in alleviating high frequency effects of long cables. The two principal benefits:

1. Line reactors will slope the edges of PWM waveforms applied to long cables and conductors, thereby reducing the dv/dt and stress due to uneven voltage distribution. However, line reactors used alone are only partially effective in reducing the peak voltage appearing at the end of long lines, see Fig 4a-4c.

2. Long lines, particularly long cables, have capacitive effects producing charging currents in the order of 10 to 20 amperes which can cause spurious protective trips in small or low power drives. Reactors reduce cable charging current, producing higher reliability of operation and freedom from nuisance trips.

By using reactors alone on the output of PWM inverters, the potential spike of 200% of applied voltage due to reflections in long cables is reduced to typically less than 150% as shown in Figure 4c. This and the combination of low dv/dt translates to safe operation even at 575 volts input.

Combining line reactors with resistors and capacitors results in the formation of highly effective motor guarding filters which further reduce dv/dt and the voltage peaks (to less than 125%) appearing at the motor, see Fig. 4d. The voltage stresses are reduced to levels well within the design limits of motor insulation thereby restoring full insulation life expectancy. The incremental cost of adding the filter components to the reactor is minimal.

Note: Output reactors should be installed adjacent to the inverter output.

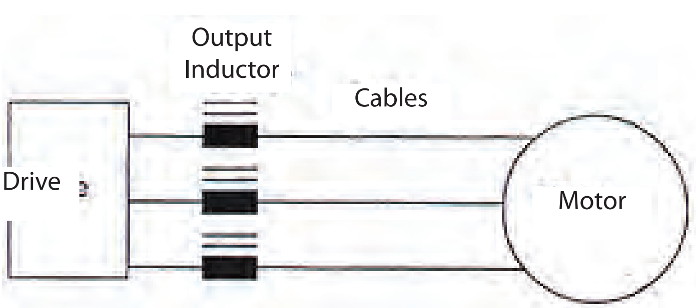


Figure 2: Typical Output Reactor Configuration

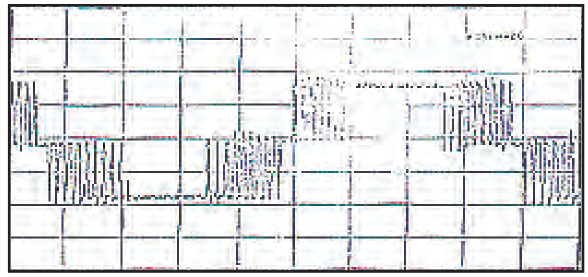


Figure 4a: Drive Output Voltage

Figure 4a. depicts the voltage output of PWM drive, measured directly at the drive terminals. Note the characteristic pattern of individual narrow pulses of fixed height and variable width. Note the steep leading and trailing edges representing high frequency content.

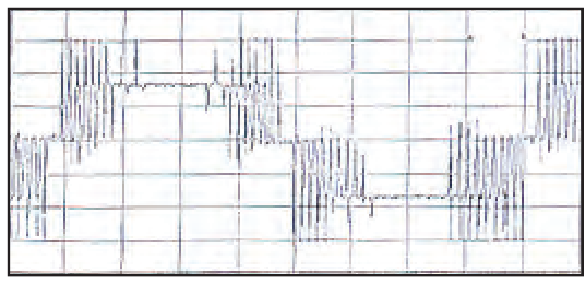


Figure 4b: Drive Output Voltage with no Filter

Figure 4b. shows the voltage measured at the end of a long cable feeding a motor. Note the spikes of double voltage (200%) at leading edges of the pulses.

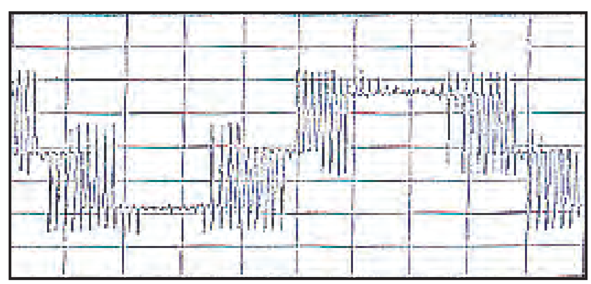


Figure 4c: Drive Output Voltage with Inductor Only

Figure 4c. depicts the result of using only a Pioneer Electric line reactor in the output. Note that the transients are reduced to approximately 150% of the applied voltage.

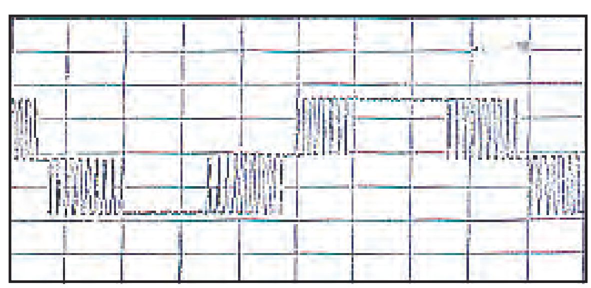


Figure 4d: Drive Output Voltage with Pioneer Electric Filter

Figure 4d. demonstrates the effectiveness of Pioneer Electric motor guarding output filters in reducing spikes and overshoots.

Selection Guide for Line Reactors

Easy Selection Guide

1. Determine the HP (horse power) rating or the current rating of the drive or motor.
2. Select the supply voltage (208, 240 , 480, or 600 volts).
3. Determine the percent impedance required for the application.
4. From the table below, select the Catalogue No. of the reactor corresponding to the current /HP, voltage, and the percent impedance.
5. For each Catalogue No. selected, the inductance, dimensions, and the weight are given in the following two pages.

Specifying Line Reactors

It is common to specify the quantity of impedance on the basis of a percentage (i.e. 5%) of the base impedance (at the rated line frequency i.e. 60Hz) of the load.

Standard reactors are offered in sizes of 3% and 5% in specific current and voltage ratings. Depending on the requirements, custom reactors of other sizes and ratings can be supplied by consulting the factory.

The impedance rating is determined by the ratio of the voltage drop across the reactor to the supply voltage when operated at rated current.

Line reactor applications typically require an impedance of 2% to 3%. In some more severe applications (higher transients or where improved line current quality is required, etc.) an impedance of 4% to 5% could be specified.

Ratings H.P.	Voltage = 208V			Voltage = 240V		
	Maximum Current (A)	Impedance		Maximum Current (A)	Impedance	
		3%	5%		3%	5%
1	4	3PR-0004C3L	3PR-0004C5L	4	3PR-0004C3L	3PR-0004C5L
1.5	8	3PR-0008C3L	3PR-0008C5L	8	3PR-0008C5L	3PR-0008C3H
2	8	3PR-0008C3L	3PR-0008C5L	8	3PR-0008C3L	3PR-0008C5L
3	11	3PR-0011C3L	3PR-0011C5L	11	3PR-0011C3L	3PR-0011C5L
5	17	3PR-0017C3L	3PR-0017C5L	17	3PR-0017C3L	3PR-0017C5L
7.5	27	3PR-0027C3L	3PR-0027C5L	27	3PR-0027C3L	3PR-0027C5L
10	34	3PR-0034C3L	3PR-0034C5L	27	3PR-0027C3L	3PR-0027C5L
15	45	3PR-0045C3L	3PR-0045C5L	45	3PR-0045C3L	3PR-0045C5L
20	60	3PR-0060C3L	3PR-0060C5L	60	3PR-0060C3L	3PR-0060C5L
25	80	3PR-0080C3L	3PR-0080C5L	80	3PR-0080C3L	3PR-0080C5L
30	100	3PR-0100C3L	3PR-0100C5L	80	3PR-0080C3L	3PR-0080C5L
40	130	3PR-0130C3L	3PR-0130C5L	100	3PR-0100C3L	3PR-0100C5L
50	160	3PR-0160C3L	3PR-0160C5L	130	3PR-0130C3L	3PR-0130C5L
60	160	3PR-0160C3L	3PR-0160C5L	160	3PR-0160C3L	3PR-0160C5L
75	200	3PR-0200C3L	3PR-0200C5L	200	3PR-0200C3L	3PR-0200C5L
100	255	3PR-0255C3L	3PR-0255C5L	255	3PR-0255C3L	3PR-0255C5L
125	320	3PR-0320C3L	3PR-0320C5L	320	3PR-0320C3L	3PR-0320C5L
150	410	3PR-0410C3L	3PR-0410C5L	410	3PR-0410C3L	3PR-0410C5L
200	500	3PR-0500C3L	3PR-0500C5L	500	3PR-0500C3L	3PR-0500C5L
250	750	3PR-0750C3	3PR-0750C5	600	3PR-0600C3	3PR-0600C5
300	750	3PR-0750C3	3PR-0750C5	750	3PR-0750C3	3PR-0750C5
350	1000	3PR-1000C3	3PR-1000C5	1000	3PR-1000C3	3PR-1000C5
400	1000	3PR-1000C3	3PR-1000C5	1000	3PR-1000C3	3PR-1000C5
500	1250	3PR-1250C3	3PR-1250C5	1250	3PR-1250C3	3PR-1250C5

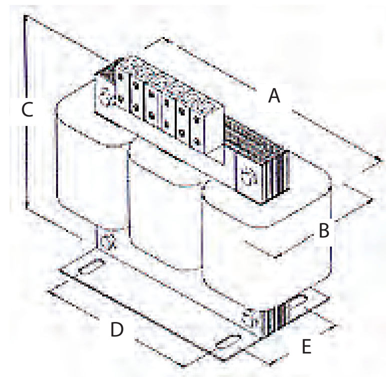
Selection Guide for Line Reactors

Ratings H.P.	Voltage = 480V			Voltage = 600V		
	Maximum Current (A)	Impedance		Maximum Current (A)	Impedance	
		3%	5%		3%	5%
1	2	3PR-0002C5L	3PR-0002C3H	2	3PR-0002C3H	3PR-0002C5H
1.5	4	3PR-0004C3H	3PR-0004C5H	2	3PR-0002C5L	3PR-0002C3H
2	4	3PR-0004C5L	3PR-0004C3H	4	3PR-0004C3H	3PR-0004C5H
3	8	3PR-0008C3H	3PR-0008C5H	4	3PR-0004C5L	3PR-0004C5H
5	8	3PR-0008C5L	3PR-0008C5H	8	3PR-0008C3H	3PR-0008C5H
7.5	11	3PR-0011C5L	3PR-0011C5H	11	3PR-0011C3H	3PR-0011C5H
10	17	3PR-0017C3H	3PR-0017C5H	11	3PR-0011C3H	3PR-0011C5H
15	27	3PR-0027C3H	3PR-0027C5H	17	3PR-0017C3H	3PR-0017C5H
20	27	3PR-0027C5L	3PR-0027C3H	27	3PR-0027C3H	3PR-0027C5H
25	34	3PR-0034C5L	3PR-0034C5H	27	3PR-0027C3H	3PR-0027C5H
30	45	3PR-0045C3H	3PR-0045C5H	34	3PR-0034C3H	3PR-0034C5H
40	60	3PR-0060C3H	3PR-0060C5H	45	3PR-0045C3H	3PR-0045C5H
50	80	3PR-0080C3H	3PR-0080C5H	60	3PR-0060C3H	3PR-0060C5H
60	80	3PR-0080C3H	3PR-0080C5H	60	3PR-0060C3H	3PR-0060C5H
75	100	3PR-0100C3H	3PR-0100C5H	80	3PR-0080C3H	3PR-0080C5H
100	130	3PR-0130C3H	3PR-0130C5H	100	3PR-0100C3H	3PR-0100C5H
125	160	3PR-0160C3H	3PR-0160C5H	130	3PR-0130C3H	3PR-0130C5H
150	200	3PR-0200C3H	3PR-0200C5H	160	3PR-0160C3H	3PR-0160C5H
200	255	3PR-0255C3H	3PR-0255C5H	200	3PR-0200C3H	3PR-0200C5H
250	320	3PR-0320C3H	3PR-0320C5H	255	3PR-0255C3H	3PR-0255C5H
300	410	3PR-0410C5L	3PR-0410C5H	320	3PR-0320C3H	3PR-0320C5H
350	410	3PR-0410C5L	3PR-0410C3H	320	3PR-0320C3H	3PR-0320C5H
400	500	3PR-0500C3H	3PR-0500C5H	410	3PR-0410C3H	3PR-0410C5H
500	600	3PR-0600C5L	3PR-0600C5H	500	3PR-0500C3H	3PR-0500C5H

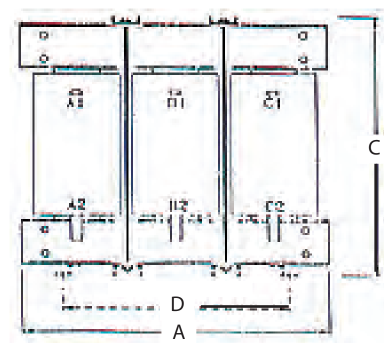
1400

Reactor Dimensions

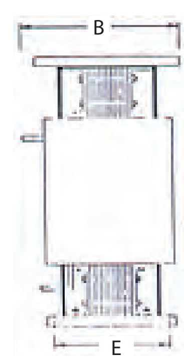
Open					Enclosed	
Catalogue No.	Maximum Amps	Inductance (mH)	Dimensions (Inches) A/B/C/D/E	Weight	Enclosure	Approximate Weight (Lbs)
3PR-0002C5L	2	14	4.25/2.375/4.375/2.875/2.25	4	#0	13
3PR-0002C3H	2	21	4.25/2.75/4.375/2.875/2.50	4.5	#0	13.5
3PR-0002C5H	2	32	4.25/3.00/4.375/2.875/2.625	5.5	#0	14.5
3PR-0004C3L	4	3	4.25/2.25/4.375/2.875/2.125	6	#0	15
3PR-0004C5L	4	6	4.25/2.625/4.375/2.875/2.375	6.5	#0	15.5
3PR-0004C3H	4	10	4.25/3.00/4.375/2.875/2.50	7	#0	16
3PR-0004C5H	4	15	4.25/3.125/4.375/2.875/2.75	8	#0	17
3PR-0008C3L	8	1.5	6.00/3.3754.875/2.00/2.375	6	#0	15
3PR-0008C5L	8	2.6	6.00/3.50/4.875/2.00/2.50	7	#0	16
3PR-0008C3H	8	4.2	6.00/4.00/4.875/2.00/2.75	9	#0	18
3PR-0008C5H	8	7.5	6.00/4.375/4.875/2.00/3.375	12	#0	21
3PR-0011C3L	11	1	6.00/3.375/4.875/2.00/2.625	7	#0	16
3PR-0011C5L	11	1.8	6.00/3.50/4.875/2.00/2.75	8.5	#0	17.5
3PR-0011C3H	11	2.6	6.00/3.75/4.875/2.00/2.875	10	#0	19
3PR-0011C5H	11	4.3	6.00/4.125/4.875/2.00/3.125	12	#0	21
3PR-0017C3L	17	0.65	6.00/3.875/4.875/2.00/3.00	10	#0	19
3PR-0017C5L	17	1	6.00/4.25/4.875/2.00/3.125	11.5	#0	20.5
3PR-0017C3H	17	1.46	6.00/4.375/4.875/2.00/3.25	13	#0	22
3PR-0017C5H	17	2.6	6.00/4.50/4.875/2.00/3.50	14	#0	23
3PR-0027C3L	27	0.44	7.00/4.00/6.00/3.25/2.75	15	#0	24
3PR-0027C5L	27	0.74	7.00/4.50/6.00/3.25/3.25	16	#0	25
3PR-0027C3H	27	1.14	7.00/4.75/6.00/3.25/3.375	18	#0	27
3PR-0027C5H	27	1.95	7.00/5.00/6.00/3.25/3.75	20	#0	29
3PR-0034C3L	34	0.33	7.00/4.625/6.00/3.25/3.00	17	#0	26
3PR-0034C5L	34	0.55	7.00/5.00/6.00/3.25/3.375	20	#0	29
3PR-0034C3H	34	0.83	7.00/5.25/6.00/3.25/3.625	22	#0	31
3PR-0034C5H	34	1.25	7.00/5.50/6.00/3.25/3.875	24	#0	33
3PR-0045C3L	45	0.24	9.00/4.25/7.00/3.00/2.625	26	#1	37
3PR-0045C5L	45	0.41	9.00/5.00/7.00/3.00/3.375	30	#1	41
3PR-0045C3H	45	0.61	9.00/5.25/7.00/3.00/3.625	35	#1	46
3PR-0045C5H	45	1.02	9.00/6.00/7.00/3.00/4.375	40	#1	51
3PR-0060C3L	60	0.19	9.00/4.75/7.00/3.00/3.125	25	#1	36
3PR-0060C5L	60	0.32	9.00/5.25/7.00/3.00/3.625	30	#1	41
3PR-0060C3H	60	0.48	9.00/6.00/7.00/3.00/4.375	40	#1	51
3PR-0060C5H	60	0.8	9.00/6.125/7.00/3.00/4.50	50	#1	61
3PR-0080C3L	80	0.14	9.00/6.00/7.00/3.00/3.125	30	#2	44
3PR-0080C5L	80	0.23	9.00/6.50/7.00/3.00/3.625	35	#2	49
3PR-0080C3H	80	0.34	9.00/7.00/7.00/3.00/4.50	40	#2	54
3PR-0080C5H	80	0.57	9.00/7.50/7.00/3.00/4.75	50	#2	64
3PR-0100C3L	100	0.11	12.00/4.50/8.50/3.50/3.25	40	#4	71
3PR-0100C5L	100	0.18	12.00/5.00/8.50/3.50/3.75	50	#4	81
3PR-0100C3H	100	0.26	12.00/7.00/8.50/3.50/4.50	60	#4	91
3PR-0100C5H	100	0.43	12.00/8.00/8.50/3.50/5.50	65	#4	96
3PR-0130C3L	130	0.085	12.00/6.00/8.50/3.50/3.75	45	#4	76
3PR-0130C5L	130	0.142	12.00/7.00/8.50/3.50/4.50	50	#4	81
3PR-0130C3H	130	0.21	12.00/7.50/8.50/3.50/4.75	65	#4	96
3PR-0130C5H	130	0.35	12.00/8.50/8.50/3.50/5.75	75	#4	106



Up to 45 Amps



60 Amps and Above

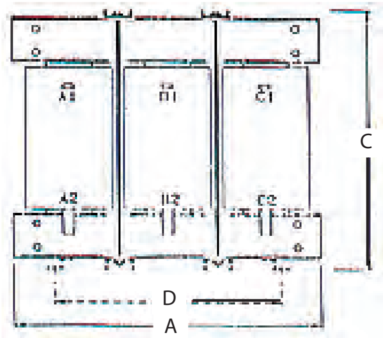


60 Amps and Above

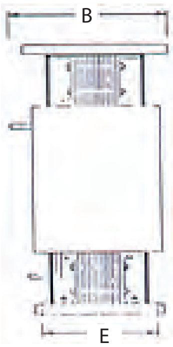
Note: Add the suffix /E at the end of the above catalogue numbers to denote enclosed.

Reactor Dimensions

Open					Enclosed	
Catalogue No.	Maximum Amps	Inductance (mH)	Dimensions (Inches) A/B/C/D/E	Weight	Enclosure	Approximate Weight (Lbs)
3PR-0160C3L	160	0.069	12.00/7.50/8.50/3.50/4.00	70	#4	101
3PR-0160C5L	160	0.115	12.00/8.20/8.50/3.50/4.75	75	#4	106
3PR-0160C3H	160	0.172	12.00/9.25/8.50/3.50/5.75	80	#4	111
3PR-0160C5H	160	0.28	12.00/10.00/8.50/3.50/6.50	85	#4	116
3PR-0200C3L	200	0.056	12.00/7.50/8.50/3.50/4.50	80	#4	111
3PR-0200C5L	200	0.09	12.00/8.25/8.50/3.50/5.00	85	#4	116
3PR-0200C3H	200	0.14	12.00/9.25/8.50/3.50/6.25	90	#4	121
3PR-0200C5H	200	0.23	12.00/10.00/8.50/3.50/6.50	100	#4	131
3PR-0255C3L	255	0.04	12.00/8.00/8.50/3.50/5.50	100	#4	131
3PR-0255C5L	255	0.068	12.00/8.75/8.50/3.50/5.50	110	#4	141
3PR-0255C3H	255	0.11	12.00/9.25/8.50/3.50/6.50	120	#4	151
3PR-0255C5H	255	0.143	12.00/10.00/8.50/3.50/6.50	130	#4	161
3PR-0320C3L	320	0.034	12.00/8.00/14.00/4.60/4.00	85	#6	170
3PR-0320C3H	320	0.086	12.00/9.00/14.00/4.60/4.50	130	#6	200
3PR-0320C5H	320	0.143	12.00/10.00/14.00/4.60/5.25	165	#6	235
3PR-0410C3L	410	0.028	12.00/8.50/14.00/4.60/4.25	90	#6	160
3PR-0410C5L	410	0.048	12.00/9.00/14.00/4.60/4.75	120	#6	190
3PR-0410C3H	410	0.071	18.00/9.50/14.00/4.60/4.75	165	#6	235
3PR-0410C5H	410	0.119	18.00/10.50/14.00/4.60/5.50	240	#6	310
3PR-0500C3L	500	0.022	18.00/9.00/18.00/9.75/15.50	135	#6	205
3PR-0500C5L	500	0.036	18.00/9.50/18.00/9.75/15.50	170	#6	240
3PR-0500C3H	500	0.055	18.00/10.50/18.00/9.75/15.50	210	#6	280
3PR-0500C5H	500	0.086	18.00/11.00/18.00/9.75/15.50	250	#6	320
3PR-0600C3L	600	0.018	18.00/10.50/18.00/9.75/15.50	155	#6	225
3PR-0600C5L	600	0.033	18.00/11.50/18.00/9.75/15.50	190	#6	260
3PR-0600C5H	600	0.061	18.00/12.50/18.00/9.75/15.50	245	#6	315
3PR-0750C3	750	0.013	18.00/11.00/19.00/7.25/6.50	160	#6	230
3PR-0750C5	750	0.024	18.00/11.50/19.00/7.25/7.00	180	#6	250
3PR-1000C3	1000	0.01	22.00/10.50/21.00/7.50/9.00	230	#7	310
3PR-1000C5	1000	0.017	22.00/11.50/21.00/7.50/9.00	265	#7	345
3PR-1250C3	1250	0.008	22.00/12.00/23.00/7.50/9.00	270	#7	350
3PR-1250C5	1250	0.014	22.00/13.50/23.00/7.50/9.00	295	#7	375



60 Amps and Above



60 Amps and Above

Note: Add the suffix /E at the end of the above catalogue numbers to denote enclosed.

Enclosure Dimensions

Size No.	Length	Depth	Height
0	9.50	7.00	8.00
1	12.00	9.00	10.00
2	11.00	11.00	14.25
3	15.50	11.00	14.25
4	15.75	16.00	21.00
5	20.50	16.00	21.00
6	20.50	20.75	26.25
7	24.50	22.00	31.50

1402

Motor Guarding Transient Filters

The Problem

The steep voltage wave fronts of the Pulse Width Modulated (PWM) output of the Adjustable Frequency Drives (AFD) produce high frequency effects which may damage the insulation of motors operated by the equipment. The problems result from two distinct effects:

1. High DV/DT Effects

The rapid rate of voltage rise (dv/dt) at the leading edges of each output pulse of the PWM inverter, produces an uneven distribution of voltage within the motor windings. The result is a concentration of the voltage at the particular points of the winding causing abnormal stress leading to breakdown of the insulation. This phenomena has been described as "first coil breakdown" and is well documented.

2. Reflections in Long Lines & Cables

A long cable, in addition to resistance, has distributed inductance and capacitance, producing effects similar to a transmission line as shown below.

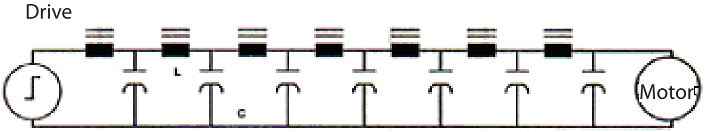


Figure 5: Delay Line Equivalent Circuit of Long Cable

The high frequencies present in the output of PWM waveforms cause reflections in long conductors connecting the motors to the drives (see image below). Harmful effects with conductors as short as 10 meters have been observed. However, the effects are most severe with cables of lengths greater than 50 meters leading to the doubling of the applied voltage. This translates to voltage peaks approaching 1600 volts in 575 volt systems.

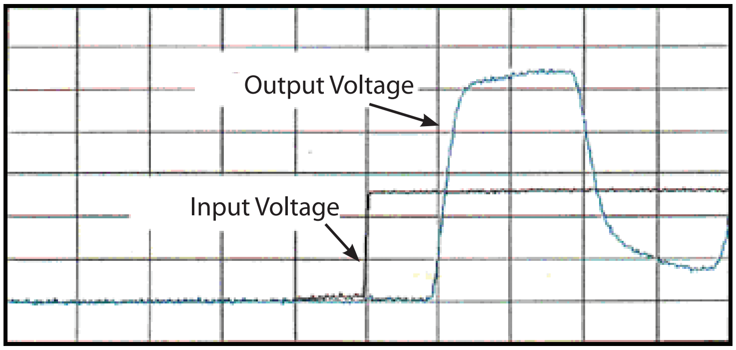


Figure 6a: Cable Input and Output Voltage - Using No Filter

On the output of PWM inverters the voltage peak due to reflections in long cable lines can be 200% (as shown in the image above).

The combination of these two effects stresses the winding insulation considerably beyond design limits and has been known to shorten the insulation life and in some instances leads to early catastrophic failure of motors.

The Solution

It has been demonstrated that these transient effects can be reduced by using filters placed at the AFD's thereby allowing safe operation of the motors and an expectation of full insulation life (see figure below). The filters are constructed using optimized combinations of inductors, capacitors, and resistors.

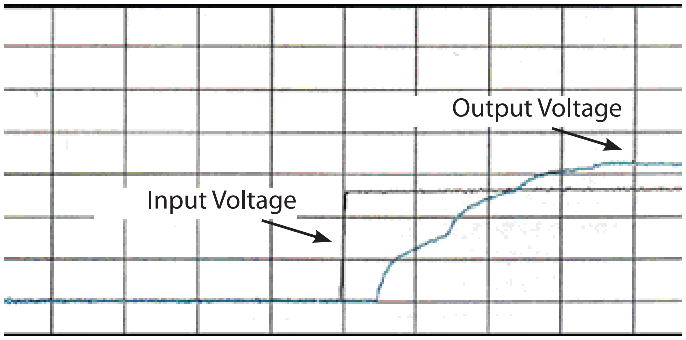
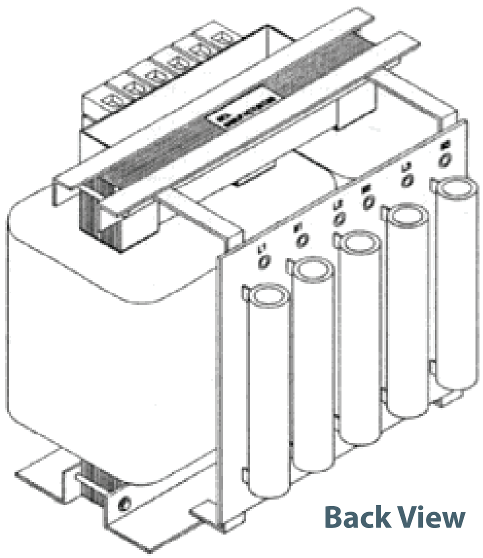


Figure 6a: Cable Input and Output Voltage - Using No Filter

By adding a Pioneer Electric motor guarding filter to the output of PWM inverters the voltage peak is reduced to less than 125% appearing at the motor as shown above.



Back View

1403

PowerFlex 40 Adjustable Frequency AC Drive

FRN 5.xx - 6.xx

This Quick Start guide summarizes the basic steps needed to install, start-up and program the PowerFlex 40 Adjustable Frequency AC Drive. **The information provided Does Not replace the User Manual and is intended for qualified drive service personnel only.**
For detailed PowerFlex 40 information including EMC instructions, application considerations and related precautions, refer to the PowerFlex 40 *User Manual*, Publication 22B-UM001… at **www.rockwellautomation.com/literature.**

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: Equipment damage and/or personal injury may result if parameter A092 [Auto Rstrt Tries] or A094 [Start At PowerUp] is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

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.

Mounting Considerations

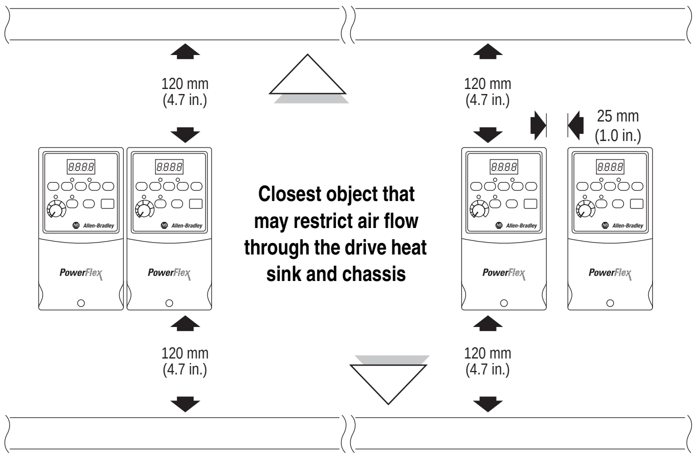
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque	DIN Rail
B	M4 (#8-32)	1.56-1.96 N-m (14-17 lb.-in.)	35 mm
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)	–
B (IP66, Type 4X)	M6 (#12-24)	3.95-4.75 N-m (35-42 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 Page 21 for mounting dimensions.



Mounting Option A
No clearance required between drives.

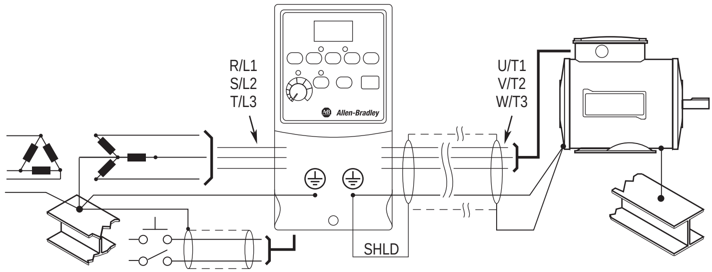
Mounting Option B

Ambient Operating Temperatures

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances
Minimum	Maximum		
-10°C (14°F)	40°C (104°F)	IP20, NEMA/UL Type Open	Use Mounting Option A
		IP66, NEMA/UL Type 4X	Use Mounting Option A
		IP30, NEMA/UL Type 1[1]	Use Mounting Option B
	50°C (122°F)	IP20, NEMA/UL Type Open	Use Mounting Option B

(1) Rating requires installation of the PowerFlex 40 IP 30, NEMA/UL Type 1 option kit.

Typical Grounding

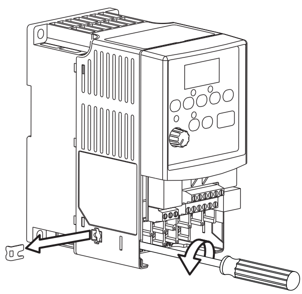


Disconnecting MOVs

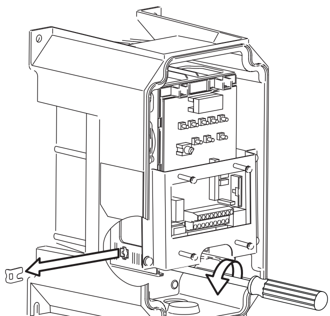
To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the figures 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



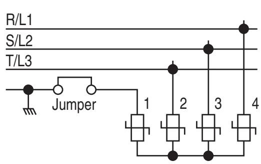
IP20, NEMA/UL Type Open



IP66, NEMA/UL Type 4X

Important: Tighten screw after jumper removal.

Phase to Ground MOV Removal



CE Conformity

Refer to the PowerFlex 40 *User Manual* for details on how to comply with the Low Voltage (LV) and Electromagnetic Compatibility (EMC) Directives.

Specifications, Fuses and Circuit Breakers

Drive Ratings

Catalog Number(1)	Output Ratings		Input Ratings			Branch Circuit Protection				Power Dissipation
	kW (HP)	*Amps*	*Voltage Range*	*kVA*	*Amps*	*Fuses*	*140M Motor Protectors(3) (4)*	*Contactors*	*Min. Enclosure Volume(5) (in.^{3})*	*IP20 Open Watts*
100 - 120V AC (±10%) – 1-Phase Input, 0 - 230V 3-Phase Output										
22B-V2P3x104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12	1655	40
22B-V5P0x104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23	1655	60
22B-V6P0x104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37	1655	80
200 - 240V AC (±10%) – 1-Phase(2) Input, 0 - 230V 3-Phase Output										
22B-A2P3x104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09	1655	40
22B-A5P0x104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12	1655	60
22B-A8P0x104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23	1655	85
22B-A012x104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37	2069	125
200 - 240V AC (±10%) – 3-Phase Input, 0 - 230V 3-Phase Output										
22B-B2P3x104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07	1655	40
22B-B5P0x104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09	1655	60
22B-B8P0x104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12	1655	85
22B-B012x104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23	1655	125
22B-B017x104	3.7 (5.0)	17.5	180-264	8.6	21.0	30	140M-F8E-C25	100-C23	1655	180
22B-B024x104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37	2069	235
22B-B033x104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-G8E-C45	100-C60	2069	305
380 - 480V AC (±10%) – 3-Phase Input, 0 - 460V 3-Phase Output										
22B-D1P4x104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07	1655	35
22B-D2P3x104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07	1655	50
22B-D4P0x104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09	1655	70
22B-D6P0x104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09	1655	100
22B-D010x104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23	1655	160
22B-D012x104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23	2069	175
22B-D017x104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23	2069	210
22B-D024x104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43	2069	300
460 - 600V AC (±10%) – 3-Phase Input, 0 - 575V 3-Phase Output										
22B-E1P7x104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09	1655	50
22B-E3P0x104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09	1655	70
22B-E4P2x104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-D8E-B63	100-C09	1655	100
22B-E6P6x104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-D8E-C10	100-C09	1655	160
22B-E9P9x104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-D8E-C16	100-C16	2069	175
22B-E012x104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-D8E-C16	100-C23	2069	210
22B-E019x104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-F8E-C25	100-C30	2069	300

(1) In the Catalog Numbers listed "x" represents enclosure type. Specifications are valid for all enclosure types. IP66, NEMA/UL Type 4X drive ratings are only available as Frame B drives.

(2) 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114. Filter option is not available for IP66, NEMA/UL Type 4X rated drives.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(5) When using a Manual Self-Protected (Type E) Combination Motor Controller, 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.

Input/Output Ratings	Approvals
Output Frequency: 0-400 Hz (Programmable) *Efficiency:* 97.5% (Typical)	UL508C CSA 22.2 EMC Directive 89/336 LV: EN 50178, EN 60204 EMC: EN 61800-3, EN 50081-1, EN 50082-2

Digital Control Inputs (Input Current = 6mA)		Analog Control Inputs
SRC (Source) Mode: 18-24V = ON 0-6V = OFF	SNK (Sink) Mode: 0-6V = ON 18-24V = OFF	*4-20mA Analog:* 250 ohm input impedance *0-10V DC Analog:* 100k ohm input impedance *External Pot:* 1-10k ohms, 2 Watt minimum

Control Output

Programmable Output (form C relay)	*Opto Outputs*	*Analog Outputs (10 bit)*
Resistive Rating: 3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC	30V DC, 50mA	0-10V, 1k ohm Min.
Inductive Rating: 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC	Non-inductive	4-20mA, 525 ohm Max.

Fuses and Circuit Breakers

Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.
Recommended Circuit Breakers: HMCP circuit breakers or equivalent.

Protective Features

Motor Protection: I^2t overload protection - 150% for 60 Secs, 200% for 3 Secs (Provides Class 10 protection)

Overcurrent: 200% hardware limit, 300% instantaneous fault

Over Voltage:
100-120V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 150V AC incoming line)
200-240V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 290V AC incoming line)
380-460V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)
460-600V AC Input – Trip occurs at 1005V DC bus voltage (equivalent to 711V AC incoming line)

Under Voltage:
100-120V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 75V AC incoming line)
200-240V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 150V AC incoming line)
380-480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)
460-600V AC Input – If P042 = 3 “High Voltage” trip occurs at 487V DC bus voltage (344V AC incoming line);
If P042 = 2 “Low Voltage” trip occurs at 390V DC bus voltage (275V AC incoming line)

Control Ride Through: Minimum ride through is 0.5 Secs - typical value 2 Secs

Faultless Power Ride Through: 100 milliseconds

Dynamic Braking

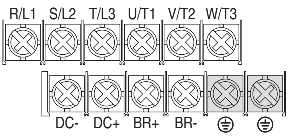
Internal brake IGBT included with all ratings except No Brake versions. Refer to Appendix B of the PowerFlex 40 *User Manual* for DB resistor ordering information.

Power Wiring

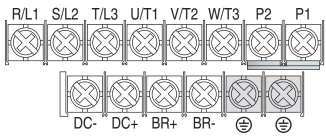
Power Wire Rating	Recommended Copper Wire
Unshielded 600V, 75°C (167°F) THHN/THWN	15 Mils insulated, dry location
Shielded 600V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	Anixter OLF-7xxxxx, Belden 29501-29507 or equivalent
Shielded Tray rated 600V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	Anixter 7V-7xxxx-3G Shawflex 2ACD/3ACD or equivalent

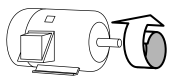
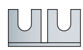
Power Terminal Block

B Frame



C Frame



Terminal [1]	Description
R/L1, S/L2	1-Phase Input
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1
V/T2	To Motor V/T2 =  Switch any two motor leads to change forward direction.
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection (C Frame drives only.) The C Frame drive is shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected. 
DC+, DC-	DC Bus Connection
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground - PE

(1) **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 Specifications

Frame	Maximum Wire Size [2]	Minimum Wire Size [2]	Torque
B	5.3 mm^2 (10 AWG)	1.3 mm^2 (16 AWG)	1.7-2.2 N-m (16-19 lb.-in.)
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9-3.7 N-m (26-33 lb.-in.)

(2) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance) Greater than 120 kVA supply transformer	• Install Line Reactor[2] • or Isolation Transformer • or Bus Inductor – 5.5-11 kW (7.5-15 HP) drives only
Line has power factor correction capacitors Line has frequent power interruptions Line has intermittent noise spikes in excess of 6000V (lightning)	• Install Line Reactor • or Isolation Transformer
Phase to ground voltage exceeds 125% of normal line to line voltage Ungrounded distribution system	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
240V open delta configuration (stinger leg)[1]	• Install Line Reactor

(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. Refer to the PowerFlex 40 *User Manual* for specific line reactor part numbers.

(2) Refer to Appendix B of the PowerFlex 40 User Manual for accessory ordering information.

I/O Wiring Recommendations [3]

Wire Type(s)[4]	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18 AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18 AWG), 3 conductor, shielded for remote pot only.	

(3) 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.

(4) Stranded or solid wire.

I/O Terminal Block Specifications

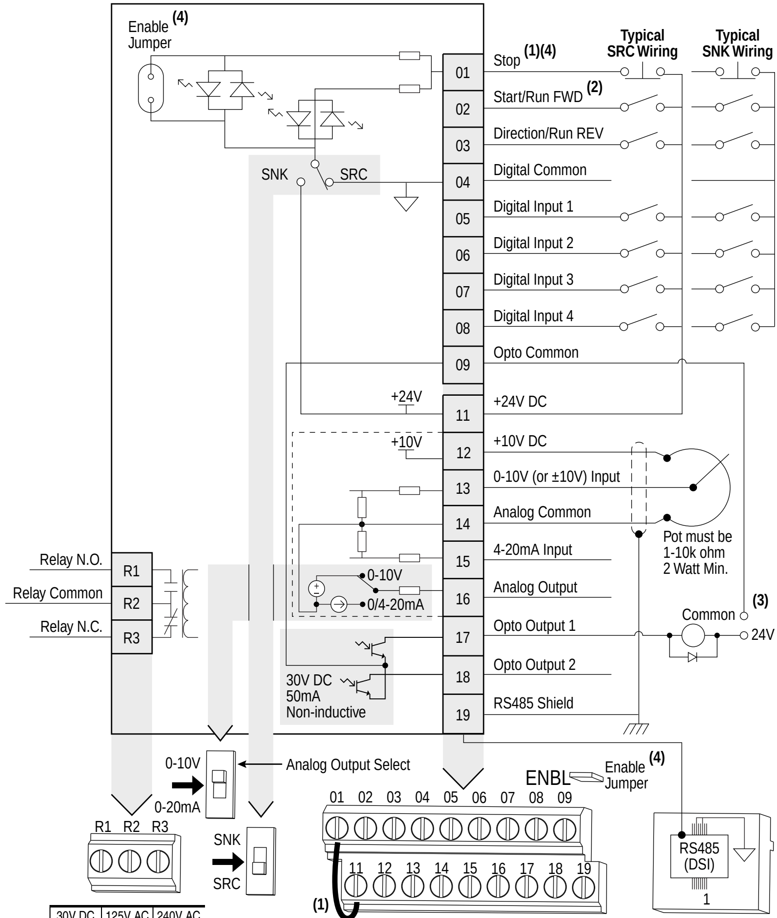
Frame	Maximum Wire Size [5]	Minimum Wire Size [5]	Torque
B & C	1.3 mm^2 (16 AWG)	0.2 mm^2 (24 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(5) Maximum / minimum that the terminal block will accept - these are not recommendations.

Refer to the PowerFlex 40 *User Manual* for recommendations on maximum power and control cable length.

Control Terminal Block

Control Wiring Block Diagram



	30V DC	125V AC	240V AC
Resistive	3.0A	3.0A	3.0A
Inductive	0.5A	0.5A	0.5A

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037
2-Wire	Per P037	Coast
RS485 Port	Per P037	Coast

(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to "3-Wire" or "Momt FWD/REV" control. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [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.

(4) When the ENBL jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation. Refer to the PowerFlex 40 User Manual for more information.

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Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
R1	Relay N.O.	Fault	Normally open contact for output relay.	A055
R2	Relay Common	–	Common for output relay.	
R3	Relay N.C.	Fault	Normally closed contact for output relay.	A055

Analog Output Select DIP Switch	0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].
Sink/Source DIP Switch	Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

01	Stop [1]	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.	P036 [1]
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default. To disable reverse operation, see A095 [Reverse Disable].	P036, P037
03	Direction/Run REV	Not Active		P036, P037, A095
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.	
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].	A051
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].	A052
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].	A053
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].	A054
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.	
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.	
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.	P038
13	±10V In [2]	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.	P038, A051-A054, A123, A132
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.	
15	4-20mA In [2]	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).	P038, A051-A054, A132
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To covert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	A065, A066
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]	A058, A059, A064
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]	A061, A062, A064
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.	

(1) See Footnotes (1) and (4) on page 8.

(2) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously. Inputs may be used independently for speed control or jointly when operating in PID mode.

Prepare For Drive Start-Up

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.

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See page 8 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. 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.

❑ **5.** 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.

Applying Power to the Drive

❑ **6.** Apply AC power and control voltages to the drive.

❑ **7.** Familiarize yourself with the integral keypad features (see next page) before setting any Program Group parameters.

If a fault appears on power up, refer to page 20 for an explanation of the fault code. For complete troubleshooting information, refer to the PowerFlex 40 *User Manual*.

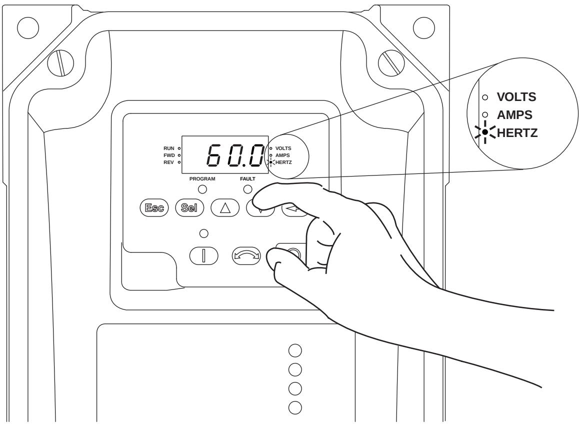
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, change direction and control speed directly from the integral keypad.

Important: To disable reverse operation, see A095 [Reverse Disable].

Changing the Speed Reference of an IP66, NEMA/UL Type 4X rated drive

When a Display Group parameter, for example, d001 [Output Freq] is displayed, and P038 [Speed Ref] is set to A069 [Internal Freq], you can change the internal frequency using the Up Arrow and Down Arrow keys.



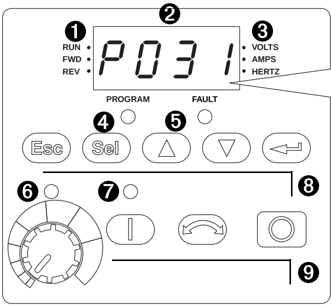
When the internal frequency is being adjusted, its value is displayed and the Hertz LED flashes. Any changes are saved immediately. The display then returns to the Display Group parameter previously shown.

TIP: By default, the speed reference of an IP66, NEMA/UL Type 4X rated drive is set to the internal frequency, A069 [Internal Freq].

TIP: You can also change the speed reference by editing the parameter A069 [Internal Freq] in program mode. For details on how to enter the program mode, see the section, “Viewing and Editing Parameters.”

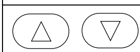
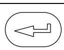
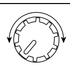
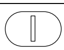
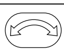
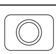
The default value of A069 [Internal Freq] is 0 Hz. For IP20 rated PowerFlex 40 drives, the default value of this parameter is 60 Hz.

Integral Keypad



Menu	Description
d	**Display Group (View Only)** Consists of commonly viewed drive operating conditions.
P	**Basic Program Group** Consists of most commonly used programmable functions.
A	**Advanced Program Group** Consists of remaining programmable functions.
F	**Fault Designator** Consists of list of codes for specific fault conditions. Displayed only when fault is present.

No.	LED	LED State	Description
❶	Run/Direction Status	Steady Red	Indicates drive is running and commanded motor direction.
		Flashing Red	Drive has been commanded to change direction. Indicates actual motor direction while decelerating to zero.
❷	Alphanumeric Display	Steady Red	Indicates parameter number, parameter value, or fault code.
		Flashing Red	Single digit flashing indicates that digit can be edited. All digits flashing indicates a fault condition.
❸	Displayed Units	Steady Red	Indicates the units of the parameter value being displayed.
❹	Program Status	Steady Red	Indicates parameter value can be changed.
❺	Fault Status	Flashing Red	Indicates drive is faulted.
❻	Pot Status	Steady Green	Indicates potentiometer on Integral Keypad is active.(1)
❼	Start Key Status	Steady Green	Indicates Start key on Integral Keypad is active. The Reverse key is also active unless disabled by A095 [Reverse Disable].

No.	Key	Name	Description
❽	Esc	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Sel	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
		Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit. Used to adjust internal frequency of IP66, NEMA/UL Type 4X rated drives *only* when a Display Group parameter is shown and P038 [Speed Reference] is set to internal frequency, A069 [Internal Freq].
		Enter	Advance one step in programming menu. Save a change to a parameter value.
❾		Potentiometer(1)	Used to control speed of drive. Default is active. Controlled by parameter P038 [Speed Reference].
		Start	Used to start the drive. Default is active. Controlled by parameter P036 [Start Source].
		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P036 [Start Source] and A095 [Reverse Disable].
		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) IP66, NEMA/UL Type 4X rated drives are not equipped with a potentiometer.

Viewing and Editing Parameters

The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Program Group parameter.

Step	Key(s)	Example Displays
1. When power is applied, the last user-selected 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 d001 [Output Freq] with the drive stopped.)		0.0 (HERTZ)
2. Press Esc once to display the Display Group parameter number shown on power-up. The parameter number will flash.	Esc	d001
3. Press Esc again to enter the group menu. The group menu letter will flash.	Esc	d001
4. Press the Up Arrow or Down Arrow to scroll through the group menu (d, P and A).	△ or ▽	
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or Sel	P031
6. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	△ or ▽	
7. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or Sel	230 (VOLTS)
8. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or Sel	230 (VOLTS, PROGRAM)
9. Press the Up Arrow or Down Arrow to change the parameter value. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	△ or ▽	
10. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off.	Esc	
Or		
Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	↵	220 (VOLTS)
11. 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 d001 [Output Frequency] is displayed. Press Enter or Sel to enter the group menu.	Esc	P031

The Basic Program Group contains the most commonly changed parameters.

Display Group Parameters

No.	Parameter	Min/Max	Display/Options
d001	[Output Freq]	0.0/[Maximum Freq]	0.1 Hz
d002	[Commanded Freq]	0.0/[Maximum Freq]	0.1 Hz
d003	[Output Current]	0.00/(Drive Amps × 2)	0.01 Amps
d004	[Output Voltage]	0/Drive Rated Volts	1 VAC
d005	[DC Bus Voltage]	Based on Drive Rating	1 VDC
d006	[Drive Status]	0/1 (1 = Condition True)	Bit 3 Decelerating; Bit 2 Accelerating; Bit 1 Forward; Bit 0 Running
d007-d009	[Fault x Code]	F2/F122	F1
d010	[Process Display]	0.00/9999	0.01 – 1
d012	[Control Source]	0/9	Digit 1 = Speed Command (See P038; 9 = "Jog Freq") Digit 0 = Start Command (See P036; 9 = "Jog")
d013	[Contrl In Status]	0/1 (1 = Input Present)	Bit 3 DB Trans On; Bit 2 Stop Input; Bit 1 Dir/REV In; Bit 0 Start/FWD In
d014	[Dig In Status]	0/1 (1 = Input Present)	Bit 3 Digital In 4; Bit 2 Digital In 3; Bit 1 Digital In 2; Bit 0 Digital In 1
d015	[Comm Status]	0/1 (1 = Condition True)	Bit 3 Comm Error; Bit 2 DSI Option; Bit 1 Transmitting; Bit 0 Receiving
d016	[Control SW Ver]	1.00/99.99	0.01
d017	[Drive Type]	1001/9999	1
d018	[Elapsed Run Time]	0/9999 Hrs	1 = 10 Hrs
d019	[Testpoint Data]	0/FFFF	1 Hex
d020	[Analog In 0-10V]	0.0/100.0%	0.1%
d021	[Analog In 4-20mA]	0.0/100.0%	0.1%
d022	[Output Power]	0.00/(Drive Power × 2)	0.01 kW
d023	[Output Powr Fctr]	0.0/180.0 deg	0.1 deg
d024	[Drive Temp]	0/120 degC	1 degC
d025	[Counter Status]	0/9999	1
d026	[Timer Status]	0.0/9999 Secs	0.1 Secs
d028	[Stp Logic Status]	0/7	1
d029	[Torque Current]	0.00/(Drive Amps × 2)	0.01 Amps

Smart Start-Up with Basic Program Group Parameters

The PowerFlex 40 is designed so that start up is simple and efficient. The Program Group contains the most commonly used parameters.

= Stop drive before changing this parameter.

No.	Parameter	Min/Max	Display/Options	Default
P031	[Motor NP Volts] Set to the motor nameplate rated volts.	20/Drive Rated Volts	1 VAC	Based on Drive Rating
P032	[Motor NP Hertz] Set to the motor nameplate rated frequency.	15/400 Hz	1 Hz	60 Hz
P033	[Motor OL Current] Set to the maximum allowable motor current.	0.0/(Drive Rated Amps×2)	0.1 Amps	Based on Drive Rating
P034	[Minimum Freq] Sets the lowest frequency the drive will output continuously.	0.0/400.0 Hz	0.1 Hz	0.0 Hz
P035	[Maximum Freq] Sets the highest frequency the drive will output.	0/400 Hz	1 Hz	60 Hz
P036	[Start Source] Sets the control scheme used to start the drive. (1) When active, the Reverse key is also active unless disabled by A095 [Reverse Disable].	0/6	0 = "Keypad"(1) 1 = "3-Wire" 2 = "2-Wire" 3 = "2-W Lvl Sens" 4 = "2-W Hi Speed" 5 = "Comm Port" 6 = "Momt FWD/REV"	0

= Stop drive before changing this parameter.

No.	Parameter	Min/Max	Display/Options	Default
P037	[Stop Mode] Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below. **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].	0/9	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" 9 = "Ramp+EM Brk" [1] Stop input also clears active fault.	0
P038	[Speed Reference] Sets the source of the speed reference to the drive. **Important:** When A051 or A052 [Digital Inx Sel] is set to option 2, 4, 5, 6, 13 or 14 and the digital input is active, A051, A052, A053 or A054 will override the speed reference commanded by this parameter. Refer to Chapter 1 of the PowerFlex 40 *User Manual* for details.	0/7	0 = "Drive Pot" 1 = "InternalFreq" 2 = "0-10V Input" 3 = "4-20mA Input" 4 = "Preset Freq" 5 = "Comm Port" 6 = "Stp Logic" 7 = "Anlg In Mult"	0 1 (IP66, Type 4X)
P039	[Accel Time 1] Sets the rate of accel for all speed increases.	0.0/600.0 Secs	0.1 Secs	10.0 Secs
P040	[Decel Time 1] Sets the rate of decel for all speed decreases.	0.1/600.0 Secs	0.1 Secs	10.0 Secs
P041	[Reset To Defalts] Resets all parameter values to factory defaults.	0/1	0 = "Ready/Idle" 1 = "Factory Rset"	0
P042	[Voltage Class] Sets the voltage class of 600V drives.	2/3	2 = "Low Voltage" (480V) 3 = "High Voltage" (600V)	3
P043	[Motor OL Ret] Enables/disables the Motor Overload Retention function.	0/1	0 = "Disabled" 1 = "Enabled"	0

Advanced Group Parameters

No.	Parameter	Min/Max	Display/Options		Default
A051 A052 A053 A054	[Digital In1 Sel] *I/O Terminal 05* [Digital In2 Sel] *I/O Terminal 06* [Digital In3 Sel] *I/O Terminal 07* [Digital In4 Sel] *I/O Terminal 08* (1) **Important:** Speed source for IP66, NEMA/UL Type 4X rated drives comes from A069 [Internal Freq].	0/27	0 = "Not Used" 1 = "Acc & Dec 2" 2 = "Jog" 3 = "Aux Fault" 4 = "Preset Freq" 5 = "Local"(1) 6 = "Comm Port" 7 = "Clear Fault" 8 = "RampStop,CF" 9 = "CoastStop,CF" 10 = "DCInjStop,CF" 11 = "Jog Forward" 12 = "Jog Reverse" 13 = "10V In Ctrl"	14 = "20mA In Ctrl" 15 = "PID Disable" 16 = "MOP Up" 17 = "MOP Down" 18 = "Timer Start" 19 = "Counter In" 20 = "Reset Timer" 21 = "Reset Countr" 22 = "Rset Tim&Cnt" 23 = "Logic In1" 24 = "Logic In2" 25 = "Current Lmt2" 26 = "Anlg Invert" 27 = "EM Brk Rlse"	4 4 5 11
A055	[Relay Out Sel]	0/24	0 = "Ready/Fault" 1 = "At Frequency" 2 = "MotorRunning" 3 = "Reverse" 4 = "Motor Overld" 5 = "Ramp Reg" 6 = "Above Freq" 7 = "Above Cur" 8 = "Above DCVolt" 9 = "Retries Exst" 10 = "Above Anlg V" 11 = "Logic In 1" 12 = "Logic In 2"	13 = "Logic 1 & 2" 14 = "Logic 1 or 2" 15 = "StpLogic Out" 16 = "Timer Out" 17 = "Counter Out" 18 = "Above PF Ang" 19 = "Anlg In Loss" 20 = "ParamControl" 21 = "NonRec Fault" 22 = "EM Brk Cntrl" 23 = "Above Fcmd" 24 = "MsgControl" (for FRN 6.01 and later)	0
A056	[Relay Out Level]	0.0/9999	0.1		0.0
A058 A061	[Opto Out1 Sel] [Opto Out2 Sel]	0/24	See A055 for Options.		2 1
A059 A062	[Opto Out1 Level] [Opto Out2 Level]	0.0/9999	0.1		0.0

A055, A058 & A061 Setting	A056, A059 & A062 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

No.	Parameter	Min/Max	Display/Options	Default
A064	[Opto Out Logic]	0/3	1	0

A064 Option	Opto Out1 Logic	Opto Out2 Logic
0	NO (Normally Open)	NO (Normally Open)
1	NC (Normally Closed)	NO (Normally Open)
2	NO (Normally Open)	NC (Normally Closed)
3	NC (Normally Closed)	NC (Normally Closed)

No.	Parameter	Min/Max	Display/Options	Default
A065	[Analog Out Sel]	0/23	1	0

Option	Output Range	Minimum Output Value	Maximum Output Value [Analog Out High]	DIP Switch Position
0 “OutFreq 0-10”	0-10V	0V = 0 Hz	P035 [Maximum Freq]	0-10V
1 “OutCurr 0-10”	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V
2 “OutVolt 0-10”	0-10V	0V = 0 Volts	120% Drive Rated Output Volts	0-10V
3 “OutPowr 0-10”	0-10V	0V = 0 kW	200% Drive Rated Power	0-10V
4 “TstData 0-10”	0-10V	0V = 0000	65535 (Hex FFFF)	0-10V
5 “OutFreq 0-20”	0-20 mA	0 mA = 0 Hz	P035 [Maximum Freq]	0-20 mA
6 “OutCurr 0-20”	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA
7 “OutVolt 0-20”	0-20 mA	0 mA = 0 Volts	120% Drive Rated Output Volts	0-20 mA
8 “OutPowr 0-20”	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	0-20 mA
9 “TstData 0-20”	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	0-20 mA
10 “OutFreq 4-20”	4-20 mA	4 mA = 0 Hz	P035 [Maximum Freq]	0-20 mA
11 “OutCurr 4-20”	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA
12 “OutVolt 4-20”	4-20 mA	4 mA = 0 Volts	120% Drive Rated Output Volts	0-20 mA
13 “OutPowr 4-20”	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	0-20 mA
14 “TstData 4-20”	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	0-20 mA
15 “OutTorq 0-10”	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V
16 “OutTorq 0-20”	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA
17 “OutTorq 4-20”	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA
18 “Setpnt 0-10”	0-10V	0V = 0%	100.0% Setpoint Setting	0-10V
19 “Setpnt 0-20”	0-20 mA	0 mA = 0%	100.0% Setpoint Setting	0-20 mA
20 “Setpnt 4-20”	4-20 mA	4 mA = 0%	100.0% Setpoint Setting	0-20 mA
21 “MinFreq 0-10”	0-10V	0V = Min. Freq	P035 [Maximum Freq]	0-10V
22 “MinFreq 0-20”	0-20 mA	0 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA
23 “MinFreq 4-20”	4-20 mA	4 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA

No.	Parameter	Min/Max	Display/Options	Default
A066	[Analog Out High]	0/800%	1%	100%
A067	[Accel Time 2]	0.0/600.0 Secs	0.1 Secs	20.0 Secs
A068	[Decel Time 2]	0.1/600.0 Secs	0.1 Secs	20.0 Secs
A069	[Internal Freq]	0.0/400.0 Hz	0.1 Hz	0.0 Hz (for IP66, NEMA/UL Type 4X drives) 60.0 Hz (for IP20 drives)
A070 A071 A072 A073 A074 A075 A076 A077	[Preset Freq 0][1] [Preset Freq 1] [Preset Freq 2] [Preset Freq 3] [Preset Freq 4] [Preset Freq 5] [Preset Freq 6] [Preset Freq 7]	0.0/400.0 Hz	0.1 Hz	0.0 Hz 5.0 Hz 10.0 Hz 20.0 Hz 30.0 Hz 40.0 Hz 50.0 Hz 60.0 Hz

[1] To activate [Preset Freq 0] set P038 [Speed Reference] to option 4.

Input State of Digital In 1 (I/O Terminal 05)	Input State of Digital In 2 (I/O Terminal 06)	Input State of Digital In 3 (I/O Terminal 07)	Frequency Source	Accel / Decel Parameter Used [2]
0	0	0	[Preset Freq 0]	[Accel Time 1] / [Decel Time 1]
1	0	0	[Preset Freq 1]	[Accel Time 1] / [Decel Time 1]
0	1	0	[Preset Freq 2]	[Accel Time 2] / [Decel Time 2]
1	1	0	[Preset Freq 3]	[Accel Time 2] / [Decel Time 2]
0	0	1	[Preset Freq 4]	[Accel Time 1] / [Decel Time 1]
1	0	1	[Preset Freq 5]	[Accel Time 1] / [Decel Time 1]
0	1	1	[Preset Freq 6]	[Accel Time 2] / [Decel Time 2]
1	1	1	[Preset Freq 7]	[Accel Time 2] / [Decel Time 2]

[2] When a Digital Input is set to “Accel 2 & Decel 2”, and the input is active, that input overrides the settings in this table.

No.	Parameter	Min/Max	Display/Options	Default
A078	[Jog Frequency]	0.0/[Maximum Freq]	0.1 Hz	10.0 Hz
A079	[Jog Accel/Decel]	0.1/600.0 Secs	0.1 Secs	10.0 Secs
A080	[DC Brake Time] A setting of 99.9 Secs = Continuous	0.0/99.9 Secs	0.1 Secs	0.0 Secs
A081	[DC Brake Level]	0.0/(Drive Amps × 1.8)	0.1 Amps	Amps × 0.05
A082	[DB Resistor Sel]	0/99	0 = “Disabled” 1 = “Normal RA Res” 2 = “NoProtection” 3-99 = % of Duty Cycle	0
A083	[S Curve %]	0/100%	1%	0% (Disabled)

No.	Parameter	Min/Max	Display/Options	Default
A084	[Boost Select] Only active when A125 [Torque Perf Mode] is set to 0 "V/Hz".	0/14	Settings in % of base voltage. 0 = "Custom V/Hz" Variable Torque: 1 = "30.0, VT", 2 = "35.0, VT", 3 = "40.0, VT", 4 = "45.0, VT" Constant Torque: 5 = "0.0, no IR", 6 = "0.0", 7 = "2.5, CT", 8 = "5.0, CT", 9 = "7.5, CT", 10 = "10.0, CT", 11 = "12.5, CT", 12 = "15.0, CT", 13 = "17.5, CT", 14 = "20.0, CT"	8 7 4-11 kW (5-15 HP)
A085	[Start Boost] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/25.0%	0.1%	2.5%
A086	[Break Voltage] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/100.0%	0.1%	25.0%
A087	[Break Frequency] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to "0".	0.0/400.0 Hz	0.1 Hz	15.0 Hz
A088	[Maximum Voltage]	20/Rated Volts	1 VAC	Rated Volts
A089	[Current Limit 1]	0.1/(Drive Amps × 1.8)	0.1 Amps	Amps × 1.5
A090	[Motor OL Select]	0/2	0 = "No Derate" 1 = "Min Derate" 2 = "Max Derate"	0
A091	[PWM Frequency]	2.0/16.0 kHz	0.1 kHz	4.0 kHz
A092	[Auto Rstrt Tries]	0/9	1	0
A093	[Auto Rstrt Delay]	0.0/300.0 Secs	0.1 Secs	1.0 Secs
A094	[Start At PowerUp]	0/1	0 = "Disabled" 1 = "Enabled"	0
A095	[Reverse Disable]	0/1	0 = "Rev Enabled" 1 = "Rev Disabled"	0
A096	[Flying Start En]	0/1	0 = "Disabled" 1 = "Enabled"	0
A097	[Compensation]	0/3	0 = "Disabled" 1 = "Electrical" 2 = "Mechanical" 3 = "Both"	1
A098	[SW Current Trip]	0.0/(Drive Amps × 2)	0.1 Amps	0.0 (Disabled)
A099	[Process Factor]	0.1/999.9	0.1	30.0
A100	[Fault Clear]	0/2	0 = "Ready/Idle" 1 = "Reset Fault" 2 = "Clear Buffer"	0
A101	[Program Lock]	0/9999	0 = "Unlocked" 1 = "Locked"	0
A102	[Testpoint Sel]	400/FFFF	1 Hex	400
A103	[Comm Data Rate] Power to drive must be cycled before any changes will affect drive operation.	0/5	0 = "1200" 1 = "2400" 2 = "4800" 3 = "9600" 4 = "19.2K" 5 = "38.4K"	3
A104	[Comm Node Addr] Power to drive must be cycled before any changes will affect drive operation.	1/247	1	100
A105	[Comm Loss Action]	0/3	0 = "Fault" 1 = "Coast Stop" 2 = "Stop" 3 = "Continu Last"	0
A106	[Comm Loss Time]	0.1/60.0 Secs	0.1 Secs	5.0 Secs
A107	[Comm Format] Power to drive must be cycled before any changes will affect drive operation.	0/5	0 = "RTU 8-N-1" 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"	0
A108	[Language]	1/10	1 = "English" 2 = "Français" 3 = "Español" 4 = "Italiano" 5 = "Deutsch" 6 = "Reserved" 7 = "Português" 8 = "Reserved" 9 = "Reserved" 10 = "Nederlands"	1
A109	[Anlg Out Setpt]	0.0/100.0%	0.1%	0.0%
A110	[Anlg In 0-10V Lo]	0.0/100.0%	0.1%	0.0%
A111	[Anlg In 0-10V Hi]	0.0/100.0%	0.1%	100.0%
A112	[Anlg In4-20mA Lo]	0.0/100.0%	0.1%	0.0%
A113	[Anlg In4-20mA Hi]	0.0/100.0%	0.1%	100.0%
A114	[Slip Hertz @ FLA]	0.0/10.0 Hz	0.1 Hz	2.0 Hz
A115	[Process Time Lo]	0.00/99.99	0.01	0.00

No.	Parameter	Min/Max	Display/Options	Default
A116	[Process Time Hi]	0.00/99.99	0.01	0.00
A117	[Bus Reg Mode]	0/1	0 = "Disabled" 1 = "Enabled"	1
A118	[Current Limit 2]	0.1/(Drive Amps × 1.8)	0.1 Amps	Amps × 1.5
A119	[Skip Frequency]	0/400 Hz	1 Hz	0 Hz
A120	[Skip Freq Band]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
A121	[Stall Fault Time]	0/5	0 = "60 Seconds" 1 = "120 Seconds" 2 = "240 Seconds" 3 = "360 Seconds" 4 = "480 Seconds" 5 = "Flt Disabled"	0
A122	[Analog In Loss]	0/6	0 = "Disabled" 1 = "Fault (F29)" 2 = "Stop" 3 = "Zero Ref" 4 = "Min Freq Ref" 5 = "Max Freq Ref" 6 = "Int Freq Ref"	0
A123	[10V Bipolar Enbl]	0/1	0 = "Uni-Polar In" 1 = "Bi-Polar In"	0
A124	[Var PWM Disable]	0/1	0 = "Enabled" 1 = "Disabled"	0
A125	[Torque Perf Mode]	0/1	0 = "V/Hz" 1 = "Sensrls Vect"	1
A126	[Motor NP FLA]	0.1/(Drive Amps × 2)	0.1 Amps	Rated Amps
A127	[Autotune]	0/2	0 = "Ready/Idle" 1 = "Static Tune" 2 = "Rotate Tune"	0
A128	[IR Voltage Drop]	0.0/230.0 VAC	0.1 VAC	Rated Volts
A129	[Flux Current Ref]	0.00/[Motor NP FLA]	0.01 Amps	Rated Amps
A130	[PID Trim Hi]	0.0/400.0	0.1	60.0
A131	[PID Trim Lo]	0.0/400.0	0.1	0.0
A132	[PID Ref Sel]	0/8	0 = "PID Disabled" 1 = "PID Setpoint" 2 = "0-10V Input" 3 = "4-20mA Input" 4 = "Comm Port" 5 = "Setpnt, Trim" 6 = "0-10V, Trim" 7 = "4-20mA, Trim" 8 = "Comm, Trim"	0
A133	[PID Feedback Sel]	0/2	0 = "0-10V Input" 1 = "4-20mA Input" 2 = "Comm Port"	0
A134	[PID Prop Gain]	0.00/99.99	0.01	0.01
A135	[PID Integ Time]	0.0/999.9 Secs	0.1 Secs	0.1 Secs
A136	[PID Diff Rate]	0.00/99.99 (1/Secs)	0.01 (1/Secs)	0.01 (1/Secs)
A137	[PID Setpoint]	0.0/100.0%	0.1%	0.0%
A138	[PID Deadband]	0.0/10.0%	0.1%	0.0%
A139	[PID Preload]	0.0/400.0 Hz	0.1 Hz	0.0 Hz
A140-A147	[Stp Logic 0-7]	0001/bAFF	4 Digits For a list of digit options, refer to the PowerFlex 40 *User Manual*.	00F1
A150-A157	[Stp Logic Time 0-7]	0.0/999.9 Secs	0.1 Secs	30.0 Secs
A160	[EM Brk Off Delay]	0.01/10.00 Secs	0.01 Secs	2.00 Secs
A161	[EM Brk On Delay]	0.01/10.00 Secs	0.01 Secs	2.00 Secs
A162	[MOP Reset Sel]	0/1	0 = "Zero MOP Ref" 1 = "Save MOP Ref"	1
A163	[DB Threshold]	0.0/110.0%	0.0%	100.0%
A164	[Comm Write Mode]	0/1	0 = "Save" 1 = "RAM Only"	0
A165	[Anlg Loss Delay]	0.0/20.0 Secs	0.1 Secs	0.0 Secs
A166	[Analog In Filter]	0/14	1	0
A167	[PID Invert Error]	0/1	0 = "Not Inverted" 1 = "Inverted"	0

Fault Codes

To clear a fault, press the Stop key, cycle power or set A100 [Fault Clear] to 1 or 2.

No.	Fault	Description
F2	Auxiliary Input[1]	Check remote wiring.
F3	Excessive DC Bus voltage ripple	Monitor the incoming line for phase loss or line imbalance. Then, check input line fuse.
F4	UnderVoltage[1]	Monitor the incoming AC line for low voltage or line power interruption.
F5	OverVoltage[1]	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.
F6	Motor Stalled[1]	Increase [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit].
F7	Motor Overload[1]	An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current].
F8	Heatsink OvrTmp[1]	Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40°C (104°F) for IP 30/NEMA 1/UL Type 1 installations or 50°C (122°F) for Open type installations. Check fan.
F12	HW OverCurrent	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	Check the motor and external wiring to the drive output terminals for a grounded condition.
F29	Analog Input Loss[1]	An analog input is configured to fault on signal loss. A signal loss has occurred.
F33	Auto Rstrt Tries	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	Check the wiring between the drive and motor. Check motor for grounded phase. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd	
F40	Phase W to Gnd	
F41	Phase UV Short	Check the motor and drive output terminal wiring for a shorted condition. Replace drive if fault cannot be cleared.
F42	Phase UW Short	
F43	Phase VW Short	
F48	Params Defaulted	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.
F63	SW OverCurrent[1]	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	Reduce load or extend Accel Time.
F70	Power Unit	Cycle power. Replace drive if fault cannot be cleared.
F71	Net Loss	The communication network has faulted.
F80	SVC Autotune	The autotune function was either cancelled by the user of failed.
F81	Comm Loss	If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. Check connection. An adapter was intentionally disconnected. Turn off using A105 [Comm Loss Action].
F100	Parameter Checksum	Restore factory defaults.
F122	I/O Board Fail	Cycle power. Replace drive if fault cannot be cleared.

(1) Auto-Reset/Run type fault. Configure with parameters A092 and A093.

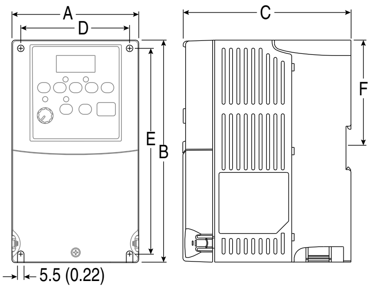
Drive Dimensions

PowerFlex 40 Frames – Ratings are in kW and (HP)

Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase		480V AC – 3-Phase		600V AC – 3-Phase	
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	2.2 (3.0) 3.7 (5.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	2.2 (3.0) 4.0 (5.0)	0.75 (1.0) 1.5 (2.0) 2.2 (3.0)	4.0 (5.0)
C(1)		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)		5.5 (7.5) 7.5 (10.0)	11.0 (15.0)	5.5 (7.5) 7.5 (10.0)	11.0 (15.0)

(1) IP66, NEMA/UL Type 4X rated drives are not availble in Frame C drive ratings.

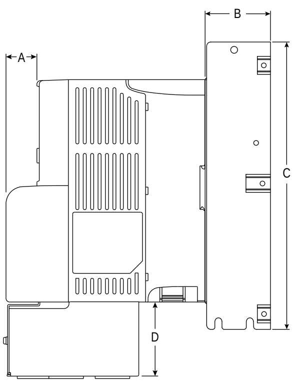
IP20, NEMA/UL Type Open

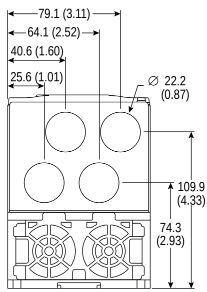


Dimensions are in millimeters and (inches).
Weights are in kilograms and (pounds).

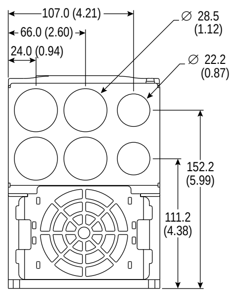
Frame	A	B	C	D	E	F	Ship Weight
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	–	4.3 (9.5)

Communication, RFI Filter, IP 30/NEMA 1/UL Type 1 Option Kits



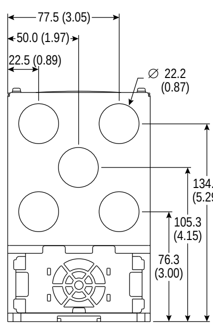


B Frame - 22-JBAB

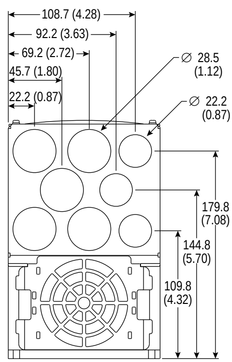


C Frame - 22-JBAC

Dimension	Option	B Frame Drive	C Frame Drive
A	Comm Cover	25 (0.98)	25 (0.98)
B	EMC Line Filter	50 (1.97)	60 (2.36)
C	EMC Line Filter	229 (9.02)	309 (12.17)
D	IP30/NEMA 1/UL Type 1	33 (1.30)	60 (2.36)
	IP30/NEMA 1/UL Type 1 for Comm Cover	64 (2.52)	60 (2.36)

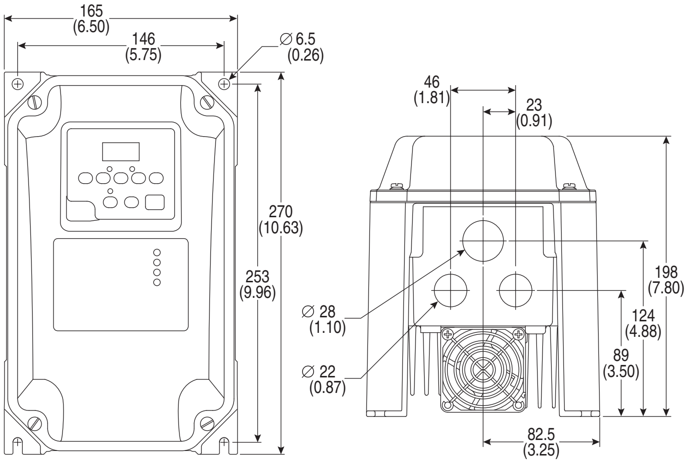


B Frame - 22-JBCB
(used with Comm Cover)



C Frame - 22-JBCC
(used with Comm Cover)

IP66, NEMA Type/UL Type 4X – Dimensions are in millimeters and (inches) Weights are in kilograms and (pounds).



Weight
5.2 (11.5)

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Allen-Bradley

PowerFlex® 40

Adjustable Frequency AC Drive

FRN 1.xx - 6.xx

User Manual

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.

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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.

Important: Identifies information that is critical for successful application and understanding of the product.

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 the hazard
- recognize the consequences

Shock Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

Burn Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be at dangerous temperatures.

Summary of Changes

The information below summarizes the changes to the PowerFlex 40 *User Manual* since the August 2008 release.

Manual Updates

Description of New or Updated Information	Page(s)
Minimum Enclosure Volume column and new footnotes added.	1-9, A-2
Drive, Fuse & Circuit Breaker Ratings topic updated.	A-1
Electronic Motor Overload Protection description updated.	A-4

The information below summarizes the changes to the PowerFlex 40 *User Manual* since the April 2008 release.

Manual Updates

Description of New or Updated Information	Page(s)
Description of A056 revised.	3-17
Description of A059/A062 revised.	3-19
Fault description for F3 revised.	4-3
A table row for electrical specifications added.	A-4
Graphic for the “Network Wiring” section revised.	C-1
Second last paragraph in the “Network Wiring” section revised.	C-2
Text in the “Writing (06) Logic Command Data” section revised.	C-4
Frequency source for logic command 001 of bits 14, 13, and 12 corrected.	C-4
Text in the “Writing (06) Reference” section revised.	C-5

Parameter Updates

The following parameters have been updated with firmware version 6.xx.

Parameter	Number	Description	Page
[Relay Out Sel]	A055	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-16
[Relay Out Sel]	A058, A061	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-18

The information below summarizes the changes to the PowerFlex 40 *User Manual* since the January 2007 release.

Manual Updates

Description of New or Updated Information	Page(s)
Input description and attention text for Multiple Digital Input Connection example corrected.	1-22
New method of changing speed reference for IP66, NEMA/UL Type 4X rated drives described.	2-2
Description for Up Arrow and Down Arrow keys revised.	2-4
Fault description for F3 revised.	4-3
Graphic for the "Network Wiring" section revised.	C-1
Descriptions for bits 6, 7, and 15 of register address 8192 (Logic Command) updated.	C-4
New information on reading register address 8192 added.	C-4
New information on reading register address 8193 added.	C-5
Graphic for the "Connecting an RS-485 Network" section corrected.	D-4
New method for inverting sign of PID error added.	F-6

New Parameter

The following parameter has been added with firmware version 5.xx.

Parameter	Number	Description	Page
[PID Invert Error]	A167	New	3-44

Parameter Updates

The following parameters have been updated with firmware version 5.xx.

Parameter	Number	Description	Page
[Control Source]	d012	Options 7 and 8 added.	3-5
[Start Source]	P036	Description revised for option 6.	3-10
[Relay Out Sel]	A055	Description revised for option 20.	3-16
[Relay Out Level]	A056	Description revised.	3-17
[Opto Outx Sel]	A058, A061	Description revised for option 20.	3-18
[Opto Outx Level]	A059, A062	Description revised.	3-19
[Internal Freq]	A069	Default value for IP66, NEMA/ UL Type 4X drives is 0.0 Hz. Default value for IP20 rated drives is 60.0 Hz.	3-22
[PID Trim Hi]	A130	Description revised.	3-38
[PID Trim Lo]	A131	Description revised.	3-38

Table of Contents

Appendix C RS485 (DSI) Protocol

Appendix D RJ45 DSI Splitter Cable

Appendix E StepLogic™, Basic Logic and Timer/Counter Functions

Appendix F PID Set Up

Index

Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex 40 Adjustable Frequency AC Drive.

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.

Reference Materials

The following manuals are recommended for general drive information:

Title	Publication	Available Online at ...
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001…	**www.rockwellautomation.com/literature**
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	

Manual Conventions

- In this manual we refer to the PowerFlex 40 Adjustable Frequency AC Drive as; drive, PowerFlex 40 or PowerFlex 40 Drive.
- Parameter numbers and names are shown in this format:

P031 [Motor NP Volts]

Name

Number

Group

d = Display Group
P = Basic Program Group
A = Advanced Program Group

- The following words are used throughout the manual to describe an action:

Word	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

Drive Frame Sizes

Similar PowerFlex 40 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 A117). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases.

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12 (1)	13-14
22B	**-**	**A**	**1P5**	**N**	**1**	**1**	**4**	**AA**
Drive	Dash	Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type	Optional

Code	
22B	PowerFlex 40

Code	Voltage	Ph.
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Version
3	No Brake IGBT
4	Standard

Code	Rating
0	Not Filtered
1	Filtered

Code	Interface Module
1	Fixed Keypad

Code	Purpose
AA thru ZZ	Reserved for custom firmware

Code	Enclosure
N	Panel Mount - IP20, NEMA/UL Type Open
C	Panel Mount - IP66, NEMA/UL Type 4X
F	Flange Mount - IP20, NEMA/UL Type Open
H	Replacement Plate Drive - IP20, NEMA/UL Type Open *- Contact factory for ordering information.*

Output Current
@ 100-120V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
6P0	6.0	1.1 (1.5)

Output Current
@ 200-240V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
8P0	8.0	1.5 (2.0)
012	12	2.2 (3.0)
017	17.5	3.7 (5.0)
024	24	5.5 (7.5)
033	33	7.5 (10)

Output Current
@ 380-480V 50/60 Hz Input

Code	Amps	kW (HP)
1P4	1.4	0.4 (0.5)
2P3	2.3	0.75 (1.0)
4P0	4.0	1.5 (2.0)
6P0	6.0	2.2 (3.0)
010	10.5	4.0 (5.0)
012	12	5.5 (7.5)
017	17	7.5 (10)
024	24	11 (15)

Output Current
@ 500-600V 50/60 Hz Input

Code	Amps	kW (HP)
1P7	1.7	0.75 (1.0)
3P0	3.0	1.5 (2.0)
4P2	4.2	2.2 (3.0)
6P6	6.6	4.0 (5.0)
9P9	9.9	5.5 (7.5)
012	12.2	7.5 (10)
019	19	11 (15)

(1) Position 12 of the Catalog Number now indicates drive type. All PowerFlex 40 drives are equipped with RS485 communication.

Additional accessories, options and adapters are available. See Appendix B for details.

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 40 Drive.

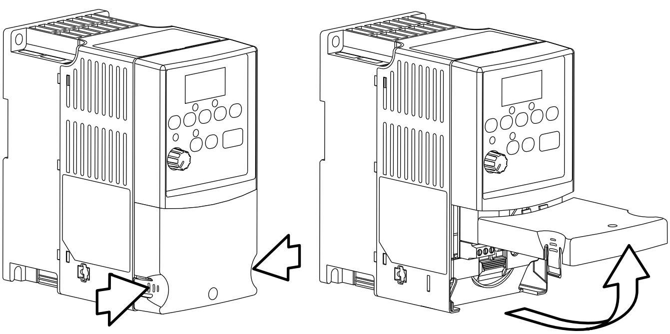
Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. 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.

Opening the Cover

IP20, NEMA/UL Type Open

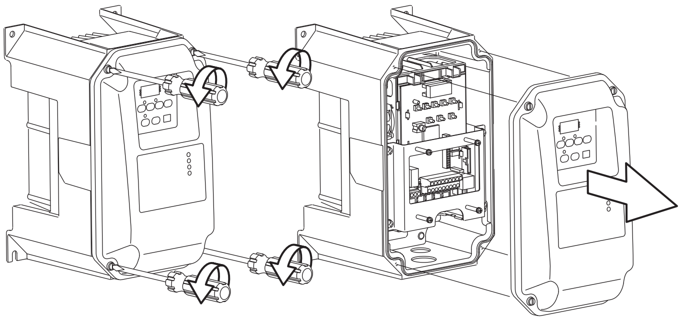
1. Press and hold in the tabs on each side of the cover.
2. Pull the cover out and up to release.



IP66, NEMA/UL Type 4X

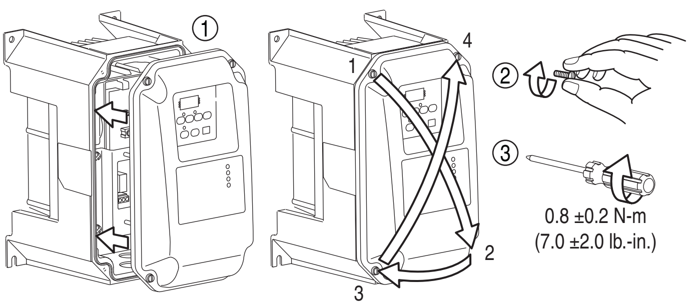
ATTENTION: To avoid an electric shock hazard, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)] and wait three minutes for capacitors to discharge before removing the external cover. Once the cover is removed, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the DC– and DC+ terminals on the Power Terminal Block (refer to page 1-13 for Power Terminal descriptions). The voltage must be zero.

1. Loosen the four captive cover screws.
2. Pull cover straight off chassis.



IP66, NEMA/UL Type 4X Cover Installation

1. Squarely align the cover on the chassis.
2. Lightly tighten the four captive cover screws.
3. Torque the cover screws using an alternating pattern.



Mounting Considerations

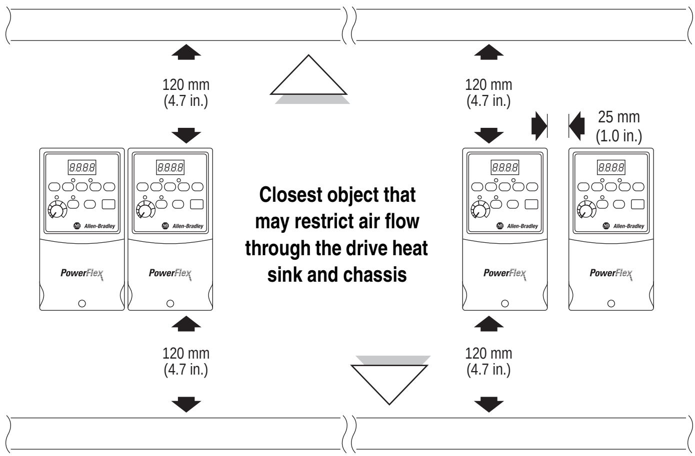
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque	DIN Rail
B	M4 (#8-32)	1.56-1.96 N-m (14-17 lb.-in.)	35 mm
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)	–
B (IP66, Type 4X)	M6 (#12-24)	3.95-4.75 N-m (35-42 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

Refer to Appendix B for mounting dimensions.



Mounting Option A
No clearance required between drives.

Mounting Option B

Ambient Operating Temperatures

Table 1.A Enclosure and Clearance Requirements

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances
Minimum	Maximum		
-10°C (14°F)	40°C (104°F)	IP20, NEMA/UL Type Open	Use Mounting Option A
		IP66, NEMA/UL Type 4X	Use Mounting Option A
		IP30, NEMA/UL Type 1(1)	Use Mounting Option B
	50°C (122°F)	IP20, NEMA/UL Type Open	Use Mounting Option B

(1) Rating requires installation of the PowerFlex 40 IP30, NEMA/UL Type 1 option kit.

Debris Protection

A plastic top panel is included with the drive. Install the panel to prevent debris from falling through the vents of the drive housing during installation. Remove the panel for IP20, NEMA/UL Type Open applications.

Storage

- Store within an ambient temperature range of -40° to +85°C.
- Store within a relative humidity range of 0% to 95%, non-condensing.
- Do not expose to a corrosive atmosphere.

AC Supply Source Considerations

Ungrounded Distribution Systems

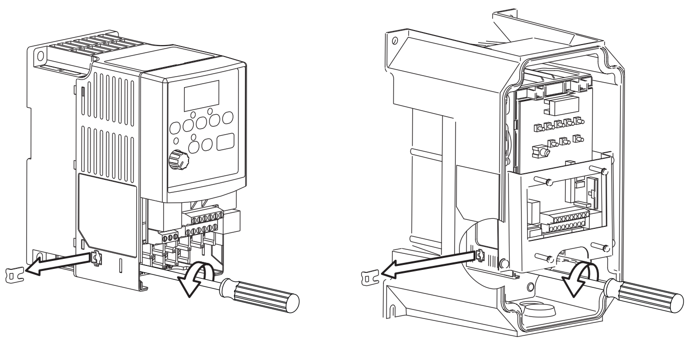
ATTENTION: PowerFlex 40 drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system 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 Figures 1.1 and 1.2.

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.

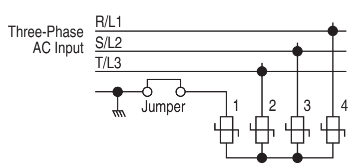
Figure 1.1 Jumper Location (Typical)



IP20, NEMA/UL Type Open   IP66, NEMA/UL Type 4X

Important: Tighten screw after jumper removal.

Figure 1.2 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 Appendix A). Listed in Table 1.B are certain input power conditions which may cause component damage or reduction in product life. If any of the conditions exist, as described in Table 1.B, 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.

Table 1.B Input Power Conditions

<table>
<tr><th>Input Power Condition</th><th>Corrective Action</th></tr>
<tr><td>Low Line Impedance (less than 1% line reactance)</td><td rowspan="2">• Install Line Reactor[2]
• or Isolation Transformer
• or Bus Inductor – 5.5 & 11 kW (7.5 & 15 HP) drives only</td></tr>
<tr><td>Greater than 120 kVA supply transformer</td></tr>
<tr><td>Line has power factor correction capacitors</td><td rowspan="3">• Install Line Reactor
• or Isolation Transformer</td></tr>
<tr><td>Line has frequent power interruptions</td></tr>
<tr><td>Line has intermittent noise spikes in excess of 6000V (lightning)</td></tr>
<tr><td>Phase to ground voltage exceeds 125% of normal line to line voltage</td><td rowspan="2">• Remove MOV jumper to ground.
• or Install Isolation Transformer with grounded secondary if necessary.</td></tr>
<tr><td>Ungrounded distribution system</td></tr>
<tr><td>240V open delta configuration (stinger leg)[1]</td><td>• Install Line Reactor</td></tr>
</table>

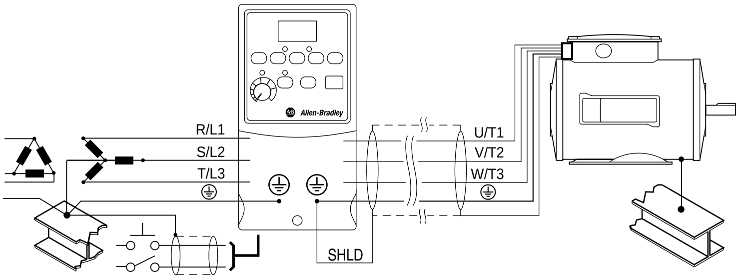
(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the “stinger leg,” “high leg,” “red leg,” etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. Refer to Table B.D for specific line reactor part numbers.

(2) Refer to 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.

Figure 1.3 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 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 single phase drives with integral filter, or an external filter with any drive rating, 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 40 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.

ATTENTION: To guard against personal injury and/or equipment damage caused by improper fusing or circuit breaker selection, use only the recommended line fuses/circuit breakers specified in this section.

Fusing

The PowerFlex 40 has been UL tested and approved for use with input fuses. The ratings in the table that follows are the minimum recommended values for use with each drive rating. The devices listed in this table are provided to serve as a guide.

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 and group motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

Table 1.C Minimum Recommended Branch Circuit Protective Devices

Voltage Rating	**Drive Rating** *kW (HP)*	**Fuse Rating**[1] *Amps*	**140M Motor Protectors**[2] [3] *Catalog No.*	**Recommended MCS Contactors** *Catalog No.*	**Min. Enclosure Volume**[4] *Inches*^{3}
120V AC – 1-Phase	0.4 (0.5)	15	140M-C2E-C16	100-C12	1655
	0.75 (1.0)	35	140M-D8E-C20	100-C23	1655
	1.1 (1.5)	40	140M-F8E-C32	100-C37	1655
240V AC – 1-Phase	0.4 (0.5)	10	140M-C2E-B63	100-C09	1655
	0.75 (1.0)	20	140M-C2E-C16	100-C12	1655
	1.5 (2.0)	30	140M-D8E-C20	100-C23	1655
	2.2 (3.0)	40	140M-F8E-C32	100-C37	2069
240V AC – 3-Phase	0.4 (0.5)	6	140M-C2E-B40	100-C07	1655
	0.75 (1.0)	10	140M-C2E-C10	100-C09	1655
	1.5 (2.0)	15	140M-C2E-C16	100-C12	1655
	2.2 (3.0)	25	140M-C2E-C16	100-C23	1655
	3.7 (5.0)	30	140M-F8E-C25	100-C23	1655
	5.5 (7.5)	40	140M-F8E-C32	100-C37	2069
	7.5 (10.0)	60	140M-G8E-C45	100-C60	2069
480V AC – 3-Phase	0.4 (0.5)	3	140M-C2E-B25	100-C07	1655
	0.75 (1.0)	6	140M-C2E-B40	100-C07	1655
	1.5 (2.0)	10	140M-C2E-B63	100-C09	1655
	2.2 (3.0)	15	140M-C2E-C10	100-C09	1655
	4.0 (5.0)	20	140M-C2E-C16	100-C23	1655
	5.5 (7.5)	25	140M-D8E-C20	100-C23	2069
	7.5 (10.0)	30	140M-D8E-C20	100-C23	2069
	11 (15)	50	140M-F8E-C32	100-C43	2069
600V AC – 3-Phase	0.75 (1.0)	6	140M-C2E-B25	100-C09	1655
	1.5 (2.0)	6	140M-C2E-B40	100-C09	1655
	2.2 (3.0)	10	140M-D8E-B63	100-C09	1655
	4.0 (5.0)	15	140M-D8E-C10	100-C09	1655
	5.5 (7.5)	20	140M-D8E-C16	100-C16	2069
	7.5 (10.0)	25	140M-D8E-C16	100-C23	2069
	11 (15)	40	140M-F8E-C25	100-C30	2069

(1) Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

(2) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(3) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(4) When using a Manual Self-Protected (Type E) Combination Motor Controller, 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 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 200-600 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 meters (1 foot) for every 10 meters (32.8 feet) 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 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 degree 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. **Do not use THHN or similarly coated wire in wet areas**. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

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 Guidelines for PWM AC Drives," publication DRIVES-IN001A-EN-P.

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). See Table 1.D for recommendations.

The reflected wave data applies to all frequencies 2 to 16 kHz.

For 240V ratings, reflected wave effects do not need to be considered.

Table 1.D Maximum Cable Length Recommendations

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only**[(1)]
	1000 Vp-p	15 meters (49 feet)
	1200 Vp-p	40 meters (131 feet)
	1600 Vp-p	170 meters (558 feet)

(1) Longer cable lengths can be achieved by installing devices on the output of the drive. Consult factory for recommendations.

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 control run commands.

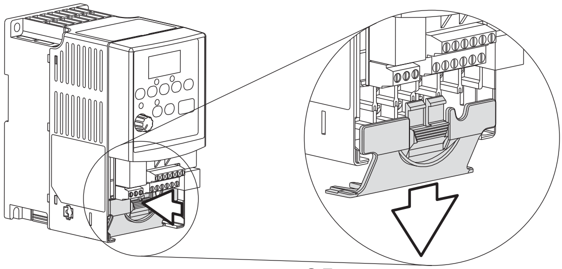
Power Terminal Block

The power terminal block is covered by a finger guard. To remove:

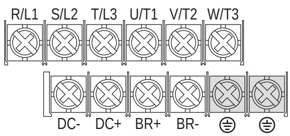
1. Press in and hold the locking tab.
2. Slide finger guard down and out.

Replace the finger guard when wiring is complete.

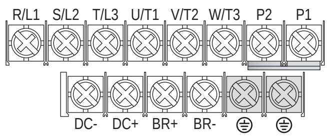
Figure 1.4 Power Terminal Block (Typical)

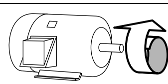
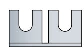


B Frame



C Frame



Terminal [1]	Description		
R/L1, S/L2	1-Phase Input		
R/L1, S/L2, T/L3	3-Phase Input		
U/T1	To Motor U/T1	= 	Switch any two motor leads to change forward direction.
V/T2	To Motor V/T2		
W/T3	To Motor W/T3		
P2, P1	DC Bus Inductor Connection (C Frame drives only.) The C Frame drive is shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected.		
DC+, DC-	DC Bus Connection		
BR+, BR-	Dynamic Brake Resistor Connection		
⏚	Safety Ground - PE		

(1) **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.

Table 1.E Power Terminal Block Specifications

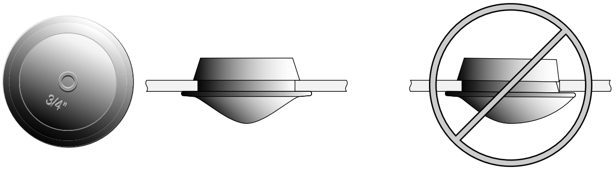
Frame	Maximum Wire Size [1]	Minimum Wire Size [1]	Torque
B	5.3 mm^2 (10 AWG)	1.3 mm^2 (16 AWG)	1.7-2.2 N-m (16-19 lb.-in.)
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9-3.7 N-m (26-33 lb.-in.)

(1) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

IP66, NEMA/UL Type 4X Installations

Use the plugs supplied with IP66, NEMA/UL Type 4X rated drives to seal unused holes in the conduit entry plate.

Important: Completely seat the plug inner rim for the best seal.



I/O Wiring Recommendations

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.

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 meters (1 foot).

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 4-20mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Control Wire Types

Table 1.F Recommended Control and Signal Wire[1]

Wire Type(s)[2]	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18 AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18 AWG), 3 conductor, shielded for remote pot only.	

(1) 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.

(2) Stranded or solid wire.

I/O Terminal Block

Table 1.G I/O Terminal Block Specifications

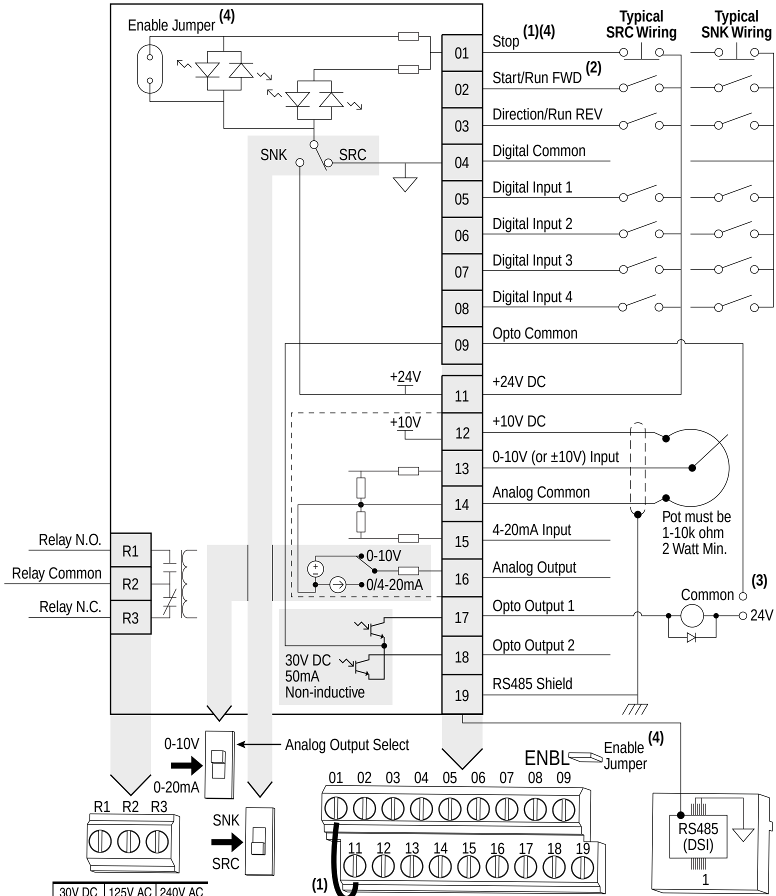
Frame	Maximum Wire Size [3]	Minimum Wire Size [3]	Torque
B & C	1.3 mm^2 (16 AWG)	0.2 mm^2 (24 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(3) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 meters (100 feet). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common must be connected to ground terminal/protective earth. If using the RS485 (DSI) port, I/O Terminal 16 should also be connected to ground terminal/protective earth.

Figure 1.5 Control Wiring Block Diagram



	30V DC	125V AC	240V AC
Resistive	3.0A	3.0A	3.0A
Inductive	0.5A	0.5A	0.5A

(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to “3-Wire” or “Momt FWD/REV” control. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [Stop Mode].

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037(4)
2-Wire	Per P037	Coast
Momt FWD/REV	Per P037	Per P037(4)
RS485 Port	Per P037	Coast

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.

(4) When the ENBL enable jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation.

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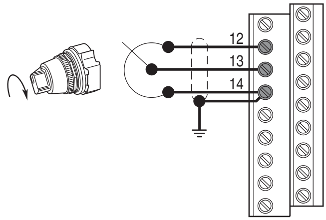
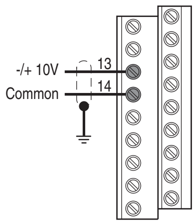
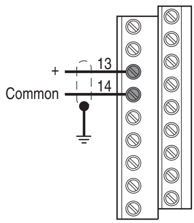
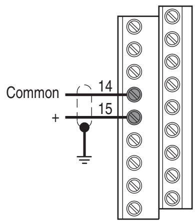
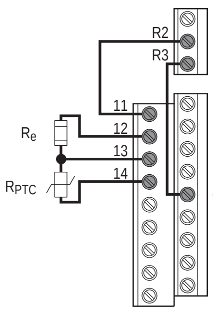
Table 1.H Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
R1	Relay N.O.	Fault	Normally open contact for output relay.	A055
R2	Relay Common	–	Common for output relay.	
R3	Relay N.C.	Fault	Normally closed contact for output relay.	A055
Analog Output Select DIP Switch		0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].	
Sink/Source DIP Switch		Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.	
01	Stop (1)	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.	P036 (1)
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default. To disable reverse operation, see A095 [Reverse Disable].	P036, P037
03	Direction/Run REV	Not Active		P036, P037, A095
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.	
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].	A051
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].	A052
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].	A053
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].	A054
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.	
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.	
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.	P038
13	±10V In (2)	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.	P038, A051-A054, A123, A132
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.	
15	4-20mA In (2)	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).	P038, A051-A054, A132
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To covert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	A065, A066
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]	A058, A059, A064
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]	A061, A062, A064
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.	

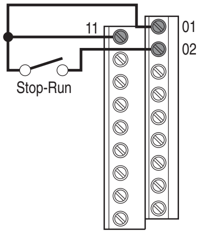
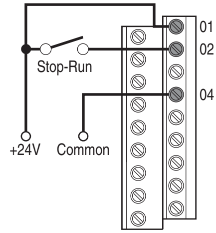
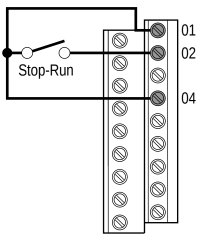
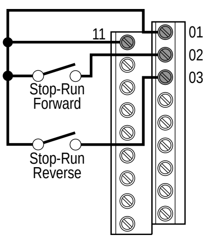
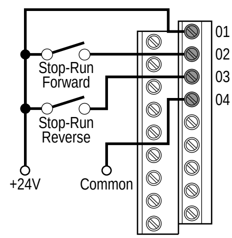
(1) See Footnotes (1) and (4) on page 1-16.

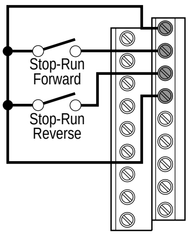
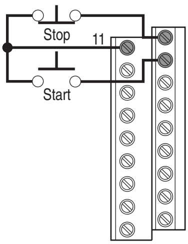
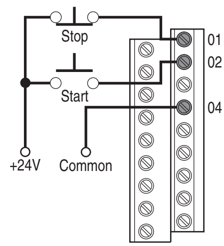
(2) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously. Inputs may be used independently for speed control or jointly when operating in PID mode.

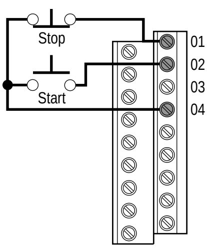
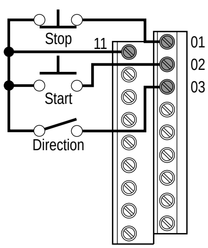
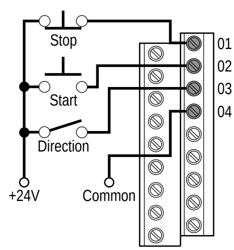
I/O Wiring Examples

<table>
<tr><th>Input/Output</th><th colspan="3">Connection Example</th></tr>
<tr><td rowspan="2">Potentiometer
1-10k Ohm Pot. Recommended (2 Watt minimum)</td><td colspan="3">P038 [Speed Reference] = 2 “0-10V Input”</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td rowspan="2">Analog Input
0 to +10V, 100k ohm impedance
4-20 mA, 250 ohm impedance</td><td>Bipolar
P038 [Speed Reference] = 2 “0-10V Input” and A123 [10V Bipolar Enbl] = 1 “Bi-Polar In”</td><td>Unipolar (Voltage)
P038 [Speed Reference] = 2 “0-10V Input”</td><td>Unipolar (Current)
P038 [Speed Reference] = 3 “4-20mA Input”</td></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td rowspan="2">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.
A051 [Digital In1 Sel] = 3 “Aux Fault”
A055 [Relay Out Sel] = 10 “Above Anlg V”
A056 [Relay Out Level] = % Voltage Trip</td></tr>
<tr><td colspan="3">

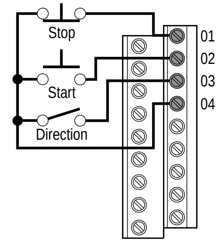
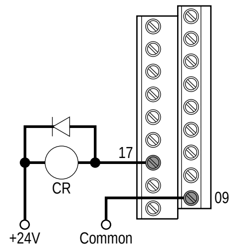
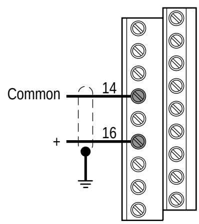
$$V_{Trip} = \frac{R_{PTC\ (hot)}}{R_{PTC\ (hot)} + R_e} \times 100$$</td></tr>
</table>

Input/Output	Connection Example	
2 Wire SRC Control - Non-Reversing	Internal Supply (SRC)	External Supply (SRC)
P036 [Start Source] = 2, 3 or 4 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode]. If desired, a User Supplied 24V DC power source can be used. Refer to the “External Supply (SRC)” example.		 Each digital input draws 6 mA.
2 Wire SNK Control - Non-Reversing	Internal Supply (SNK)	
		
2 Wire SRC Control - Run FWD/Run REV	Internal Supply (SRC)	External Supply (SRC)
P036 [Start Source] = 2, 3 or 4 Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode]. If both Run Forward and Run Reverse inputs are closed at the same time, an undetermined state could occur.		 Each digital input draws 6 mA.

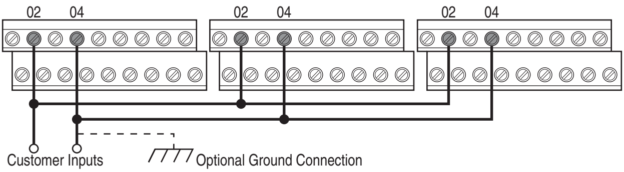
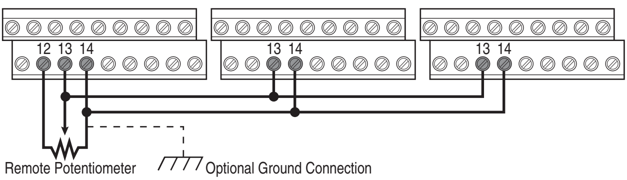
<table>
<tr><th>Input/Output</th><th colspan="2">Connection Example</th></tr>
<tr><td rowspan="2">2 Wire SNK Control - Run FWD/Run REV</td><td colspan="2">Internal Supply (SNK)</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td rowspan="2">3 Wire SRC Control - Non-Reversing
P036 [Start Source] = 1
A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode].</td><td>Internal Supply (SRC)</td><td>External Supply (SRC)</td></tr>
<tr><td>
</td><td>

Each digital input draws 6 mA.</td></tr>
<tr><td rowspan="2">3 Wire SNK Control - Non-Reversing</td><td colspan="2">Internal Supply (SNK)</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td rowspan="2">3 Wire SRC Control - Reversing
P036 [Start Source] = 1
A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode]. I/O Terminal 03 determines direction.</td><td>Internal Supply (SRC)</td><td>External Supply (SRC)</td></tr>
<tr><td>
</td><td>

Each digital input draws 6 mA.</td></tr>
</table>

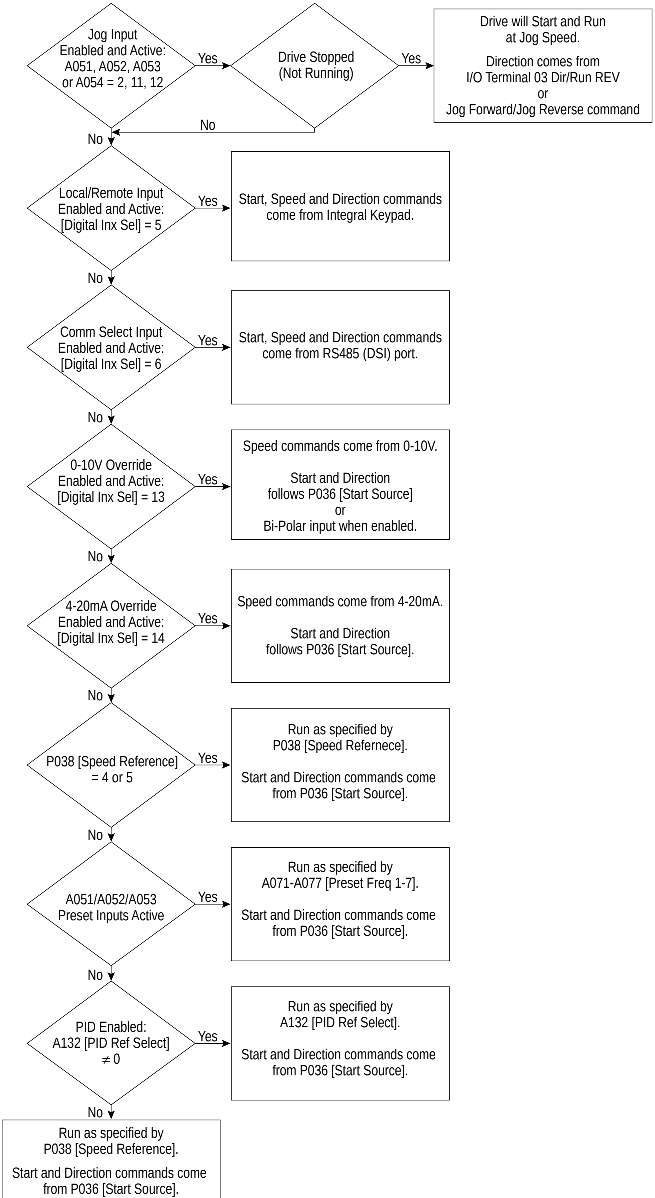
Input/Output	Connection Example
3 Wire SNK Control - Reversing	Internal Supply (SNK) 
Opto Output (1 & 2) A058 [Opto Out1 Sel] determines Opto-Output 1 (I/O Terminal 17) operation. A061 [Opto Out2 Sel] determines Opto-Output 2 (I/O Terminal 18) operation. When using Opto-Output with an inductive load 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 A065 [Analog Out Sel] determines analog output type and drive conditions. 0-10V, 1k ohm minimum 0-20mA/4-20mA, 525 ohm maximum	A065 [Analog Out Sel] = 0 through 14 The Analog Output Select DIP Switch must be set to match the analog output signal mode set in A065 [Analog Out Sel]. 

Typical Multiple Drive Connection Examples

Input/Output	Connection Example
Multiple Digital Input Connections Customer Inputs can be wired per External Supply (SRC) examples on 1-19 and 1-20.	 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:** Digital inputs on multiple drives 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.

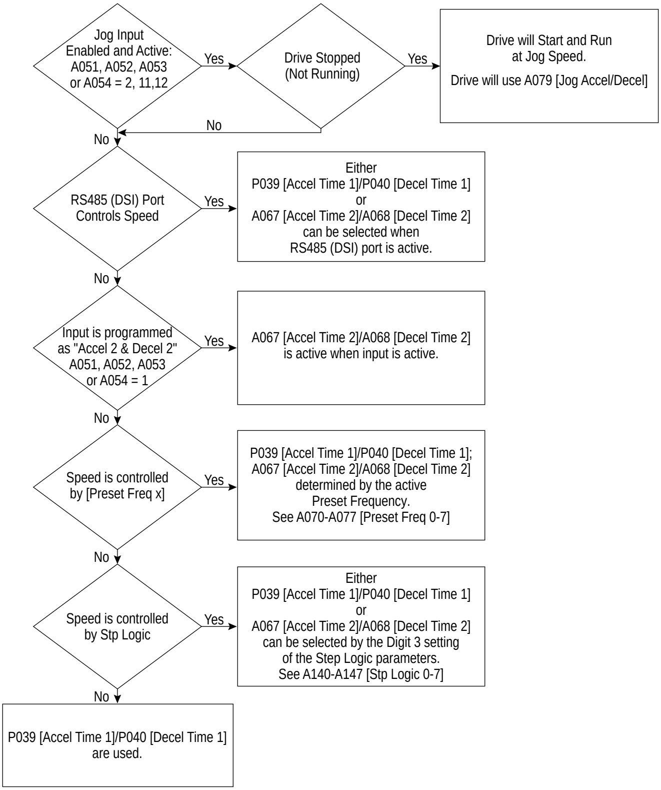
Start and Speed Reference Control

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. See the chart below for the override priority.



Accel/Decel Selection

The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P039 [Accel Time 1] and P040 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, RS485 (DSI) communications and/or parameters. See the chart below for the override priority.



EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User Manual.

CE Declarations of Conformity are available online at:
http://www.ab.com/certification/ce/docs.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

General Notes

- If the plastic top panel is removed or the optional conduit box 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.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Essential Requirements for CE Compliance

Conditions 1-3 listed below **must be** satisfied for PowerFlex drives to meet the requirements of **EN61800-3**.

1. Grounding as described in Figure 1.6. Refer to page 1-8 for additional grounding recommendations.

2. Output power, control (I/O) and signal wiring must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.

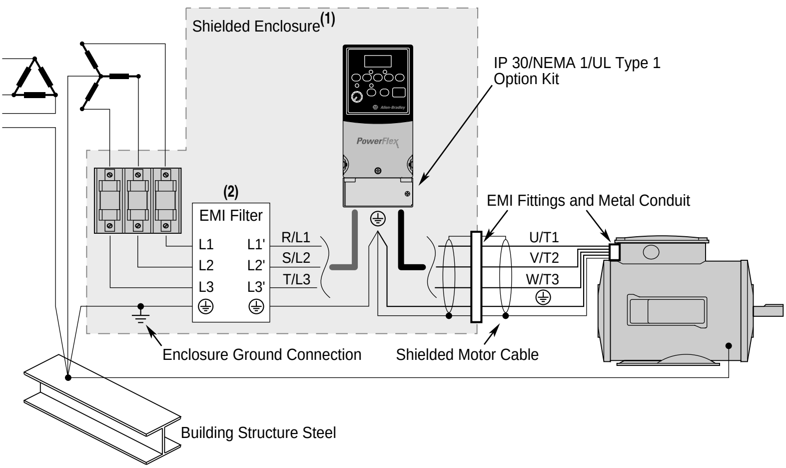
3. Allowable cable length in Table 1.I is not exceeded.

Table 1.I Allowable Cable Length

Filter Type	EN61800-3 First Environment Restricted Distribution or Second Environment (2)	EN61800-3 First Environment Unrestricted Distribution (3)
Integral	10 meters (33 feet)	1 meter (3 feet)
External - S Type(1)	10 meters (33 feet)	1 meter (3 feet)
External - L Type(1)	100 meters (328 feet)	5 meters (16 feet)

(1) Refer to Appendix B for details on optional external filters.
(2) Equivalent to EN55011 Class A.
(3) Equivalent to EN55011 Class B.

Figure 1.6 Connections and Grounding



(1) First Environment Unrestricted Distribution installations require a shielded enclosure. Keep wire length as short as possible between the enclosure entry point and the EMI filter.

(2) Integral EMI filters are available on 240V, 1-Phase drives.

EN61000-3-2

- 0.75 kW (1 HP) 240V 1-Phase and 3-Phase drives and 0.37 kW (0.5 HP) 240V 1-Phase drives are suitable for installation on a private low voltage power network. Installations on a public low voltage power network may require additional external harmonic mitigation.
- Other drive ratings meet the current harmonic requirements of EN61000-3-2 without additional external mitigation.

Notes:

Start Up

This chapter describes how to start up the PowerFlex 40 Drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

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

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See Figure 1.5 on page 1-16 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. 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.

❑ **5.** 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.

Applying Power to the Drive

❑ **6.** Apply AC power and control voltages to the drive.

❑ **7.** Familiarize yourself with the integral keypad features (see page 2-4) before setting any Program Group parameters.

If a fault appears on power up, refer to Fault Descriptions on page 4-3 for an explanation of the fault code.

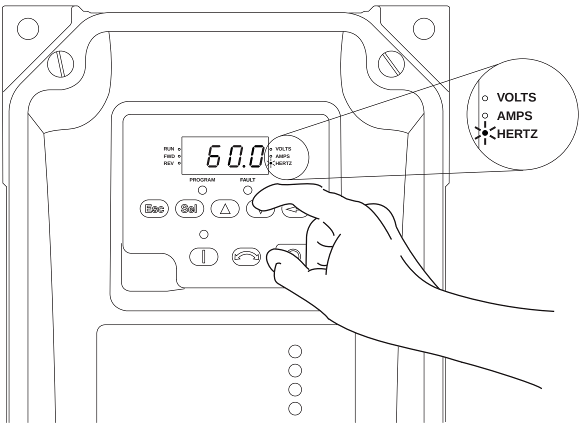
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, change direction and control speed directly from the integral keypad.

Important: To disable reverse operation, see A095 [Reverse Disable].

Changing the Speed Reference of an IP66, NEMA/UL Type 4X rated drive

When a Display Group parameter, for example, d001 [Output Freq] is displayed, and P038 [Speed Ref] is set to A069 [Internal Freq], you can change the internal frequency using the Up Arrow and Down Arrow keys.



When the internal frequency is being adjusted, its value is displayed and the Hertz LED flashes. Any changes are saved immediately. The display then returns to the Display Group parameter previously shown.

TIP: By default, the speed reference of an IP66, NEMA/UL Type 4X rated drive is set to the internal frequency, A069 [Internal Freq].

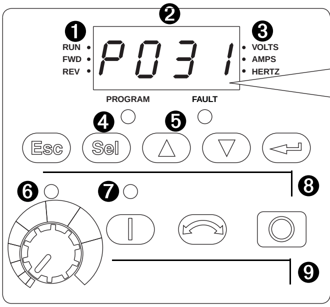
TIP: You can also change the speed reference by editing the parameter A069 [Internal Freq] in program mode. For details on how to enter the program mode, see Viewing and Editing Parameters on page 2-5.

Note: The default value of A069 [Internal Freq] is 0 Hz. For IP20 rated PowerFlex 40 drives, the default value of this parameter is 60 Hz.

Variable Torque Fan/Pump Applications

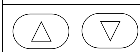
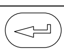
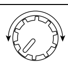
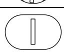
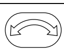
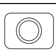
For improved motor tuning performance when using a premium efficient motor on a variable torque load, set A084 [Boost Select] to option 2 “35.0, VT”.

Integral Keypad



Menu	Description
d	**Display Group (View Only)** Consists of commonly viewed drive operating conditions.
P	**Basic Program Group** Consists of most commonly used programmable functions.
A	**Advanced Program Group** Consists of remaining programmable functions.
F	**Fault Designator** Consists of list of codes for specific fault conditions. Displayed only when fault is present.

No.	LED	LED State	Description
❶	Run/Direction Status	Steady Red	Indicates drive is running and commanded motor direction.
		Flashing Red	Drive has been commanded to change direction. Indicates actual motor direction while decelerating to zero.
❷	Alphanumeric Display	Steady Red	Indicates parameter number, parameter value, or fault code.
		Flashing Red	Single digit flashing indicates that digit can be edited. All digits flashing indicates a fault condition.
❸	Displayed Units	Steady Red	Indicates the units of the parameter value being displayed.
❹	Program Status	Steady Red	Indicates parameter value can be changed.
❺	Fault Status	Flashing Red	Indicates drive is faulted.
❻	Pot Status	Steady Green	Indicates potentiometer on Integral Keypad is active.(1)
❼	Start Key Status	Steady Green	Indicates Start key on Integral Keypad is active. The Reverse key is also active unless disabled by A095 [Reverse Disable].

No.	Key	Name	Description
❽	Esc	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Sel	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
		Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit. Used to adjust internal frequency of IP66, NEMA/UL Type 4X rated drives *only* when a Display Group parameter is shown and P038 [Speed Reference] is set to internal frequency, A069 [Internal Freq].
		Enter	Advance one step in programming menu. Save a change to a parameter value.
❾		Potentiometer(1)	Used to control speed of drive. Default is active. Controlled by parameter P038 [Speed Reference].
		Start	Used to start the drive. Default is active. Controlled by parameter P036 [Start Source].
		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P036 [Start Source] and A095 [Reverse Disable].
		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) IP66, NEMA/UL Type 4X rated drives are not equipped with a potentiometer.

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Viewing and Editing Parameters

The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Program Group parameter.

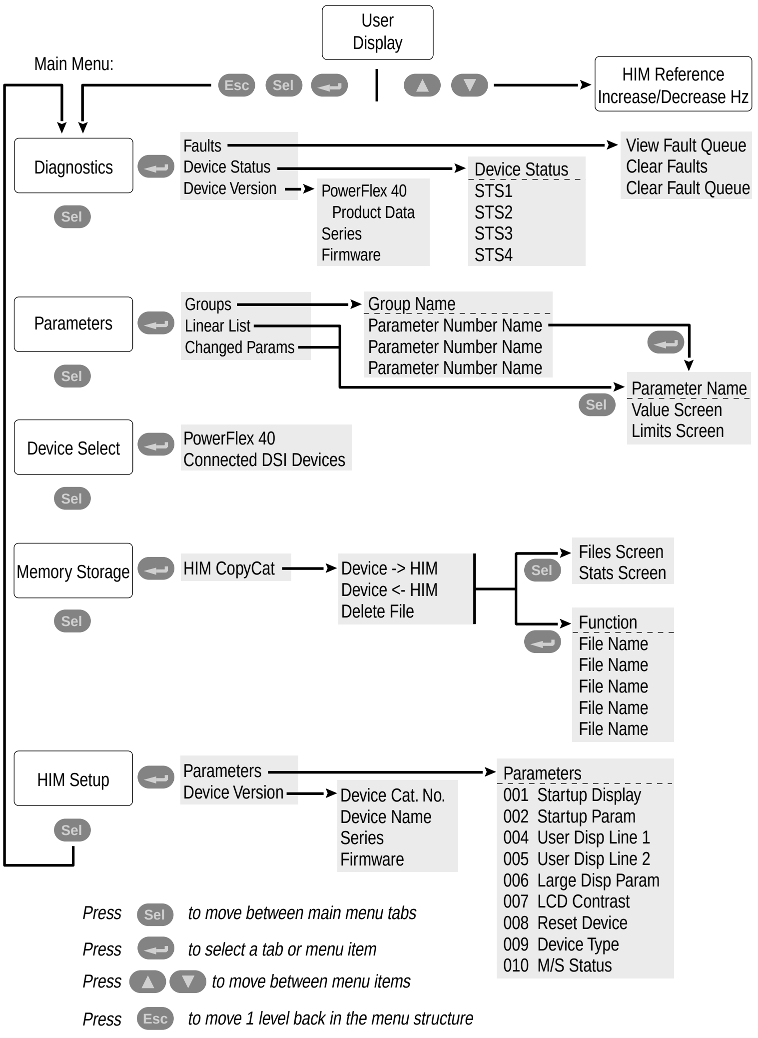
Step	Key(s)	Example Displays
1. When power is applied, the last user-selected Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of d001 [Output Freq] with the drive stopped.)		0.0 (VOLTS ○ AMPS ○ HERTZ ●; PROGRAM ○ FAULT ○)
2. Press Esc once to display the Display Group parameter number shown on power-up. The parameter number will flash.	Esc	d001 (VOLTS ○ AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)
3. Press Esc again to enter the group menu. The group menu letter will flash.	Esc	d001 (VOLTS ○ AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)
4. Press the Up Arrow or Down Arrow to scroll through the group menu (d, P and A).	△ or ▽	
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or Sel	P031 (VOLTS ○ AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)
6. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	△ or ▽	
7. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or Sel	230 (VOLTS ● AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)
8. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or Sel	230 (VOLTS ● AMPS ○ HERTZ ○; PROGRAM ● FAULT ○)
9. Press the Up Arrow or Down Arrow to change the parameter value. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	△ or ▽	
10. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off. Or Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	Esc ↵	220 (VOLTS ● AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)
11. 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 d001 [Output Frequency] is displayed. Press Enter or Sel to enter the group menu.	Esc	P031 (VOLTS ○ AMPS ○ HERTZ ○; PROGRAM ○ FAULT ○)

The Basic Program Group (page 3-9) contains the most commonly changed parameters.

Remote HIM Menu Structure

The Menu Structure below can be accessed through the following Human Interface Module options:

HIM Option	Catalog Number
Remote Panel Mount Small, LCD Display	22-HIM-C2S
Remote Handheld, LCD Display	22-HIM-A3



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Diagnostics Menu

When a fault trips the drive, use this menu to access detailed data about the drive.

Option	Description
Faults	View fault queue or fault information, clear faults or clear fault queue.
Device Status	View status information about the drive or peripheral.
Device Version	View the firmware version and hardware series of components.

Parameters Menu

Use this menu to access drive parameters. Parameters can be displayed in groups, in a linear list, or only those changed from their defaults.

Device Select Menu

Use this menu to access the drive or peripheral that the drive is to access.

Memory Storage Menu

Drive data can be saved to, or recalled from HIM sets.
HIM sets are files stored in permanent nonvolatile HIM memory.

Option	Description
HIM Copycat Device -> HIM Device <- HIM	Save data to a HIM set or load data from a HIM set to active drive memory. A maximum of 5 HIM set can be stored.
Delete File	Delete a HIM set.

HIM Setup Menu

The HIM and drive have features that you can customize.

Option	Description
Parameters	Access parameters in HIM to set display options.
Device Version	View HIM version, hardware series and firmware version

Notes:

Programming and Parameters

Chapter 3 provides a complete listing and description of the PowerFlex 40 parameters. Parameters are programmed (viewed/edited) using the integral keypad. As an alternative, programming can also be performed using DriveExplorer™ or DriveExecutive™ software, a personal computer and a serial converter module. Refer to Appendix B for catalog numbers.

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 (i.e. 0.1 Volts).
- **Bit Parameters**
  Bit parameters have four individual bits associated with features or conditions. If the bit is 0, the feature is off or the condition is false. If the bit is 1, the feature is on or the condition is true.

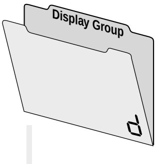
Some parameters are marked as follows.

= Stop drive before changing this parameter.

32 = 32 bit parameter. Parameters marked 32 bit will have two parameter numbers when using RS485 communications and programming software.

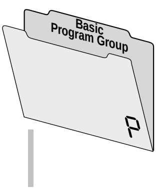
Parameter Organization

Refer to page 3-45 for an alphabetical listing of parameters.



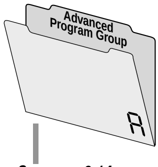
See page 3-3

Output Freq	d001
Commanded Freq	d002
Output Current	d003
Output Voltage	d004
DC Bus Voltage	d005
Drive Status	d006
Fault 1 Code	d007
Fault 2 Code	d008
Fault 3 Code	d009
Process Display	d010
Control Source	d012
Contrl In Status	d013
Dig In Status	d014
Comm Status	d015
Control SW Ver	d016
Drive Type	d017
Elapsed Run Time	d018
Testpoint Data	d019
Analog In 0-10V	d020
Analog In 4-20mA	d021
Output Power	d022
Output Power Fctr	d023
Drive Temp	d024
Counter Status	d025
Timer Status	d026
Stp Logic Status	d028
Torque Current	d029



See page 3-9

Motor NP Volts	P031
Motor NP Hertz	P032
Motor OL Current	P033
Minimum Freq	P034
Maximum Freq	P035
Start Source	P036
Stop Mode	P037
Speed Reference	P038
Accel Time 1	P039
Decel Time 1	P040
Reset To Defalts	P041
Voltage Class	P042
Motor OL Ret	P043



See page 3-14

Digital In1 Sel	A051
Digital In2 Sel	A052
Digital In3 Sel	A053
Digital In4 Sel	A054
Relay Out Sel	A055
Relay Out Level	A056
Opto Out1 Sel	A058
Opto Out1 Level	A059
Opto Out2 Sel	A061
Opto Out2 Level	A062
Opto Out Logic	A064
Analog Out Sel	A065
Analog Out High	A066
Accel Time 2	A067
Decel Time 2	A068
Internal Freq	A069
Preset Freq 0	A070
Preset Freq 1	A071
Preset Freq 2	A072
Preset Freq 3	A073
Preset Freq 4	A074
Preset Freq 5	A075
Preset Freq 6	A076
Preset Freq 7	A077
Jog Frequency	A078
Jog Accel/Decel	A079
DC Brake Time	A080
DC Brake Level	A081
DB Resistor Sel	A082
S Curve %	A083
Boost Select	A084
Start Boost	A085
Break Voltage	A086
Break Frequency	A087
Maximum Voltage	A088
Current Limit 1	A089
Motor OL Select	A090
PWM Frequency	A091
Auto Rstrt Tries	A092
Auto Rstrt Delay	A093
Start At PowerUp	A094
Reverse Disable	A095
Flying Start En	A096
Compensation	A097
SW Current Trip	A098
Process Factor	A099
Fault Clear	A100
Program Lock	A101
Testpoint Sel	A102
Comm Data Rate	A103
Comm Node Addr	A104
Comm Loss Action	A105

See page 3-14

Comm Loss Time	A106
Comm Format	A107
Language	A108
Anlg Out Setpt	A109
Anlg In 0-10V Lo	A110
Anlg In 0-10V Hi	A111
Anlg In4-20mA Lo	A112
Anlg In4-20mA Hi	A113
Slip Hertz @ FLA	A114
Process Time Lo	A115
Process Time Hi	A116
Bus Reg Mode	A117
Current Limit 2	A118
Skip Frequency	A119
Skip Freq Band	A120
Stall Fault Time	A121
Analog In Loss	A122
10V Bipolar Enbl	A123
Var PWM Disable	A124
Torque Perf Mode	A125
Motor NP FLA	A126
Autotune	A127
IR Voltage Drop	A128
Flux Current Ref	A129
PID Trim Hi	A130
PID Trim Lo	A131
PID Ref Sel	A132
PID Feedback Sel	A133
PID Prop Gain	A134
PID Integ Time	A135
PID Diff Rate	A136
PID Setpoint	A137
PID Deadband	A138
PID Preload	A139
Stp Logic 0	A140
Stp Logic 1	A141
Stp Logic 2	A142
Stp Logic 3	A143
Stp Logic 4	A144
Stp Logic 5	A145
Stp Logic 6	A146
Stp Logic 7	A147
Stp Logic Time 0	A150
Stp Logic Time 1	A151
Stp Logic Time 2	A152
Stp Logic Time 3	A153
Stp Logic Time 4	A154
Stp Logic Time 5	A155
Stp Logic Time 6	A156
Stp Logic Time 7	A157
EM Brk Off Delay	A160
EM Brk On Delay	A161
MOP Reset Sel	A162
DB Threshold	A163
Comm Write Mode	A164
Anlg Loss Delay	A165
Analog In Filter	A166
PID Invert Error	A167

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Display Group

d001 [Output Freq]

Related Parameter(s): d002, d010, P034, P035, P038

Output frequency present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d002 [Commanded Freq]

Related Parameter(s): d001, d013, P034, P035, P038

Value of the active frequency command. Displays the commanded frequency even if the drive is not running.

Important: The frequency command can come from a number of sources. Refer to Start and Speed Reference Control on page 1-23 for details.

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d003 [Output Current]

The output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

d004 [Output Voltage]

Related Parameter(s): P031, A084, A088

Output voltage present at terminals T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0/Drive Rated Volts
	Display:	1 VAC

d005 [DC Bus Voltage]

Present DC bus voltage level.

Values	Default:	Read Only
	Min/Max:	Based on Drive Rating
	Display:	1 VDC

Display Group *(continued)*

d006 [Drive Status]

Related Parameter(s): A095

Present operating condition of the drive.

0000

1 = Condition True, 0 = Condition False	
Running	Bit 0
Forward	Bit 1
Accelerating	Bit 2
Decelerating	Bit 3

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d007 [Fault 1 Code]
d008 [Fault 2 Code]
d009 [Fault 3 Code]

A code that represents a drive fault. The codes will appear in these parameters in the order they occur (d007 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once.

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	F2/F122
	Display:	F1

d010 [Process Display]

Related Parameter(s): d001, A099

32 32 bit parameter.

The output frequency scaled by A099 [Process Factor].

Output Freq x Process Factor = Process Display

Values	Default:	Read Only
	Min/Max:	0.00/9999
	Display:	0.01 – 1

Display Group *(continued)*

d012 [Control Source]

Related Parameter(s): P036, P038, A051-A054

Displays the active source of the Start Command and Speed Command which are normally defined by the settings of P036 [Start Source] and P038 [Speed Reference] but may be overridden by digital inputs. Refer to the flowcharts on pages 1-23 and 1-24 for details.

0000

Start Command 0 = Keypad 1 = 3-Wire 2 = 2-Wire 3 = 2-Wire Level Sensitive 4 = 2-Wire High Speed 5 = RS485 (DSI) Port 9 = Jog	Digit 0
Speed Command 0 = Drive Potentiometer 1 = A069 [Internal Freq] 2 = 0-10V Input/Remote Potentiometer 3 = 4-20mA Input 4 = A070-A077 [Preset Freq x] (A051 - A053 [Digital Inx Sel] must be set to 4) 5 = RS485 (DSI) Port 6 = StepLogic Control (Parameters A140 - A147) 7 = Anlg In Mult 8 = PID 9 = Jog Freq	Digit 1
Reserved	Digit 2
Reserved	Digit 3

Values	Default:	Read Only
	Min/Max:	0/9
	Display:	1

d013 [Contrl In Status]

Related Parameter(s): d002, P034, P035

Status of the control terminal block control inputs.

Important: Actual control commands may come from a source other than the control terminal block.

0000

1 = Input Present, 0 = Input Not Present

Start / Run FWD Input (I/O Terminal 02)	Bit 0
Direction / Run REV Input (I/O Terminal 03)	Bit 1
Stop Input(1) (I/O Terminal 01)	Bit 2
Dynamic Brake Transistor On	Bit 3

(1) The stop input must be present in order to start the drive.
When this bit is a 1 the drive can be started.
When this bit is a 0 the drive will stop.

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

Display Group *(continued)*

d014 [Dig In Status]

Related Parameter(s): A051-A054

Status of the control terminal block digital inputs.

0000

1 = Input Present, 0 = Input Not Present	
Digital In1 Sel (I/O Terminal 05)	Bit 0
Digital In2 Sel (I/O Terminal 06)	Bit 1
Digital In3 Sel (I/O Terminal 07)	Bit 2
Digital In4 Sel (I/O Terminal 08)	Bit 3

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d015 [Comm Status]

Related Parameter(s): A103-A107

Status of the communications ports.

0000

1 = Condition True, 0 = Condition False	
Receiving Data	Bit 0
Transmitting Data	Bit 1
RS485 (DSI) Based Option Connected (Allen-Bradley devices only.)	Bit 2
Communication Error Occurred	Bit 3

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d016 [Control SW Ver]

Main Control Board software version.

Values	Default:	Read Only
	Min/Max:	1.00/99.99
	Display:	0.01

d017 [Drive Type]

Used by Rockwell Automation field service personnel.

Values	Default:	Read Only
	Min/Max:	1001/9999
	Display:	1

Display Group *(continued)*

d018 [Elapsed Run Time]

Accumulated time drive is outputting power. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/9999 Hrs
	Display:	1 = 10 Hrs

d019 [Testpoint Data]

Related Parameter(s): A102

The present value of the function selected in A102 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1 Hex

d020 [Analog In 0-10V]

Related Parameter(s): A110, A111

The present value of the voltage at I/O Terminal 13 (100.0% = 10 volts).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d021 [Analog In 4-20mA]

Related Parameter(s): A112, A113

The present value of the current at I/O Terminal 15 (0.0% = 4mA, 100.0% = 20mA).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d022 [Output Power]

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power × 2)
	Display:	0.01 kW

d023 [Output Powr Fctr]

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

Display Group *(continued)*

d024 [Drive Temp]

Present operating temperature of the drive power section.

Values	Default:	Read Only
	Min/Max:	0/120 degC
	Display:	1 degC

d025 [Counter Status]

The current value of the counter when counter is enabled.

Values	Default:	Read only
	Min/Max:	0/9999
	Display:	1

d026 [Timer Status]

32 32 bit parameter.

The current value of the timer when timer is enabled.

Values	Default:	Read Only
	Min/Max:	0.0/9999 Secs
	Display:	0.1 Secs

d028 [Stp Logic Status]

When P038 [Speed Reference] is set to 6 “Stp Logic”, this parameter will display the current step of the StepLogic profile as defined by parameters A140-A147 [Stp Logic x].

Values	Default:	Read Only
	Min/Max:	0/7
	Display:	1

d029 [Torque Current]

The current value of the motor torque current.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

Basic Program Group

P031 [Motor NP Volts]

Related Parameter(s): d004, A084, A085, A086, A087

Stop drive before changing this parameter.

Set to the motor nameplate rated volts.

Values	Default:	Based on Drive Rating
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

P032 [Motor NP Hertz]

Related Parameter(s): A084, A085, A086, A087, A090

Stop drive before changing this parameter.

Set to the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/400 Hz
	Display:	1 Hz

P033 [Motor OL Current]

Related Parameter(s): A055, A058, A061, A089, A090, A098, A114, A118

Set to the maximum allowable motor current.

The drive will fault on an F7 Motor Overload if the value of this parameter is exceeded by 150% for 60 seconds.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

P034 [Minimum Freq]

Related Parameter(s): d001, d002, d013, P035, A085, A086, A087, A110, A112

Sets the lowest frequency the drive will output continuously.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

P035 [Maximum Freq]

Related Parameter(s): d001, d002, d013, P034, A065, A078, A085, A086, A087, A111, A113

Stop drive before changing this parameter.

Sets the highest frequency the drive will output.

Values	Default:	60 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

Basic Program Group *(continued)*

P036 [Start Source]

Related Parameter(s): d012, P037

Stop drive before changing this parameter.

Sets the control scheme used to start the drive.

Refer to Start and Speed Reference Control on page 1-23 for details about how other drive settings can override the setting of this parameter.

Important: For all settings except option 3, the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power or fault condition.

Options	**0**	"Keypad" (Default)	• Integral keypad controls drive operation. • I/O Terminal 1 "Stop" = coast to stop. • When active, the Reverse key is also active unless disabled by A095 [Reverse Disable].
	1	"3-Wire"	I/O Terminal 1 "Stop" = stop according to the value set in P037 [Stop Mode].
	2	"2-Wire"	I/O Terminal 1 "Stop" = coast to stop.
	3	"2-W Lvl Sens"	Drive will restart after a "Stop" command when: • Stop is removed and • Start is held active

ATTENTION: Hazard of injury exists due to unintended operation. When P036 [Start Source] is set to option 3, 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).

	4	"2-W Hi Speed"	**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 1 "Stop" = coast to stop.
	5	"Comm Port"	• Remote communications. Refer to Appendix C for details. • I/O Terminal 1 "Stop" = coast to stop.
	6	"Momt FWD/REV"	• 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 1 "Stop" = coast to stop.

Basic Program Group *(continued)*

P037 [Stop Mode]

Related Parameter(s): P036, A080, A081, A082, A105, A160

Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below.

Important: I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].

Hardware Enable Circuitry

By default, I/O Terminal 01 is a coast to stop input. The status of the input is interpreted by drive software. If the application requires the drive to be disabled without software interpretation, a "dedicated" hardware enable configuration can be utilized. This is accomplished by removing the ENBL enable jumper on the control board. In this case, the drive will always coast to a stop regardless of the settings of P036 [Start Source] and P037 [Stop Mode].

Options	**0**	"Ramp, CF"(1) (Default)	Ramp to Stop. "Stop" command clears active fault.
	1	"Coast, CF"(1)	Coast to Stop. "Stop" command clears active fault.
	2	"DC Brake, CF"(1)	DC Injection Braking Stop. "Stop" command clears active fault.
	3	"DCBrkAuto,CF"(1)	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A080 [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 A080 [DC Brake Time]. OR • Drive shuts off if current limit is exceeded.
	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.

(1) Stop input also clears active fault.

Basic Program Group *(continued)*

P038 [Speed Reference]

Related Parameter(s): d001, d002, d012, d020, d021, P039, P040, A051-A054, A069, A070-A077, A110-A113, A123, A132, A140-A147, A150-A157

Sets the source of the speed reference to the drive.

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 [PID Ref Sel] is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

Options	**0**	"Drive Pot" (Default)	Frequency command from the potentiometer on the integral keypad. **Important:** This option is not available with IP66, NEMA/UL Type 4X rated drives. Internal frequency command comes from A069 [Internal Freq].
	1	"InternalFreq" (IP66, NEMA/UL Type 4X Default)	Internal frequency command from A069 [Internal Freq]. Must be set when using MOP function.
	2	"0-10V Input"	External frequency command from the 0-10V or ±10V analog input or remote potentiometer.
	3	"4-20mA Input"	External frequency command from the 4-20mA analog input.
	4	"Preset Freq"	External frequency command as defined by A070 - A077 [Preset Freq x] when A051 - A054 [Digital Inx Sel] are programmed as "Preset Frequencies" and the digital inputs are active.
	5	"Comm Port"	External frequency command from the communications port. Refer to Appendix C for details.
	6	"Stp Logic"	External frequency command as defined by A070 - A077 [Preset Freq x] and A140 - A147 [Stp Logic x].
	7	"Anlg In Mult"	External frequency command as defined by the product of the analog inputs (shown in d020 [Analog In 0-10V] and d021 [Analog In 4-20mA]). [Analog In 0-10V] $\times$ [Analog In 4-20mA] = Speed Command Example: 100% $\times$ 50% = 50%

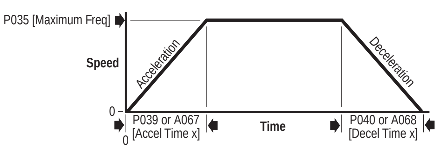
P039 [Accel Time 1]

Related Parameter(s): P038, P040, A051-A054, A067, A070-A077, A140-A147

Sets the rate of acceleration for all speed increases.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



Basic Program Group *(continued)*

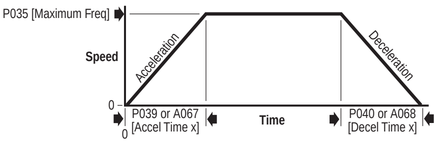
P040 [Decel Time 1]

Related Parameter(s): P038, P039, A051-A054, A068, A070-A077, A140-A147

Sets the rate of deceleration for all speed decreases.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



P041 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameter values to factory defaults.

Options	**0**	"Ready/Idle" (Default)	
	1	"Factory Rset"	• After the reset function is complete, this parameter will set itself back to "0". • Causes an F48 Params Defaulted fault.

P042 [Voltage Class]

Stop drive before changing this parameter.

Sets the voltage class of 600V drives.

Options	**2**	"Low Voltage"	480V
	3	"High Voltage" (Default)	600V

P043 [Motor OL Ret]

Related Parameter(s): P033

Enables/disables the Motor Overload Retention function. When Enabled, the value held in the motor overload counter is saved at power-down and restored at power-up. A change to this parameter setting resets the counter.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group

A051 [Digital In1 Sel]
(I/O Terminal 05)
A052 [Digital In2 Sel]
(I/O Terminal 06)
A053 [Digital In3 Sel]
(I/O Terminal 07)
A054 [Digital In4 Sel]
(I/O Terminal 08)

Related Parameter(s): d012, d014, P038, P039, P040, A067, A068, A070-A077, A078, A079, A118, A140-A147

Stop drive before changing this parameter.

Selects the function for the digital inputs. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

Options	**0**	"Not Used"	Terminal has no function but can be read over network communications via d014 [Dig In Status].
	1	"Acc & Dec 2"	• When active, A067 [Accel Time 2] and A068 [Decel Time 2] are used for all ramp rates except Jog. • Can only be tied to one input. Refer to the flowchart on page 1-24 for more information on Accel/Decel selection.
	2	"Jog"	• When input is present, drive accelerates according to the value set in A079 [Jog Accel/Decel] and ramps to the value set in A078 [Jog Frequency]. • When input is removed, drive ramps to a stop according to the value set in A079 [Jog Accel/Decel]. • A valid "Start" command will override this input.
	3	"Aux Fault"	When enabled, an F2 Auxiliary Input fault will occur when the input is removed.
	4	"Preset Freq" (A051 & A052 Default)	Refer to A070 - A077 [Preset Freq x]. **Important:** Digital Inputs have priority for frequency control when programmed as Preset Speed and are active. Refer to the flowchart on page 1-23 for more information on speed reference control priority.
	5	"Local" (A053 Default)	When active, sets integral keypad as start source and potentiometer on the integral keypad as speed source. **Important:** Speed source for IP66, NEMA/UL Type 4X rated drives comes from A069 [Internal Freq].
	6	"Comm Port"	• When active, sets communications device as default start/speed command source. • Can only be tied to one input.
	7	"Clear Fault"	When active, clears an active fault.
	8	"RampStop,CF"	Causes drive to immediately ramp to a stop regardless of how P037 [Stop Mode] is set.
	9	"CoastStop,CF"	Causes drive to immediately coast to a stop regardless of how P037 [Stop Mode] is set.
	10	"DCInjStop,CF"	Causes drive to immediately begin a DC Injection stop regardless of how P037 [Stop Mode] is set.
	11	"Jog Forward" (A054 Default)	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.
	12	"Jog Reverse"	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.

A051 - A054 Options (Cont.)	**13** “10V In Ctrl”	Selects 0-10V or ±10V control as the frequency reference. Start source is not changed.
	14 “20mA In Ctrl”	Selects 4-20mA control as the frequency reference. Start source is not changed.
	15 “PID Disable”	Disables PID function. Drive uses the next valid non-PID speed reference.
	16 “MOP Up”	Increases the value of A069 [Internal Freq] at the current Accel rate if P038 [Speed Reference] is set to 1 “InternalFreq”. For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	17 “MOP Down”	Decreases the value of A069 [Internal Freq] at the current Decel rate if P038 [Speed Reference] is set to 1 “InternalFreq”. For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	18 “Timer Start”	Clears and starts the timer function. May be used to control the relay or opto outputs.
	19 “Counter In”	Starts the counter function. May be used to control the relay or opto outputs.
	20 “Reset Timer”	Clears the active timer.
	21 “Reset Countr”	Clears the active counter.
	22 “Rset Tim&Cnt”	Clears the active timer and counter.
	23 “Logic In1”	Logic function input number 1. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	24 “Logic In2”	Logic function input number 2. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	25 “Current Lmt2”	When active, A118 [Current Limit 2] determines the drive current limit level.
	26 “Anlg Invert”	Inverts the scaling of the analog input levels set in A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] or A112 [Anlg In4-20mA Lo] and A113 [Anlg In4-20mA Hi].
	27 “EM Brk Rlse”	If EM brake function is enabled, this input releases the brake.

ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

Advanced Program Group *(continued)*

A055 [Relay Out Sel]

Related Parameter(s): P033, A056, A092, A140-A147, A150-A157, A160, A161

Sets the condition that changes the state of the output relay contacts.

Options	**0**	"Ready/Fault" (Default)	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A056 [Relay Out Level]. • Use A056 to set threshold. **Important:** Value for A056 [Relay Out Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A056 [Relay Out Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A056 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	18	"Above PF Ang"	• Power Factor angle has exceeded the value set in A056 [Relay Out Level]. • Use A056 to set threshold.

A055 Options (Cont.)	**19** "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.) With FRN 4.01 and later, the logic command word bit 15 has full control of A056. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A056 [Relay Out Level].
	24 "MsgControl"	With FRN 4.01 and later, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.)

A056 [Relay Out Level]

Related Parameter(s): A055

32 32 bit parameter.

Sets the trip point for the digital output relay if the value of A055 [Relay Out Sel] is 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A055 is set to 20, the logic command word bit 15 has full control of A056.

A055 Setting	A056 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A058 [Opto Out1 Sel]
A061 [Opto Out2 Sel]

Related Parameter(s): P033, A059, A062, A092, A122, A123, A160, A161, A140-A147, A150-A157

Determines the operation of the programmable opto outputs.

Options	**0**	"Ready/Fault"	Opto outputs are active when power is applied. This indicates that the drive is ready for operation. Opto outputs are inactive when power is removed or a fault occurs.
	1	"At Frequency" (A061 Default)	Drive reaches commanded frequency.
	2	"MotorRunning" (A058 Default)	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold. **Important:** Value for A059 or A062 [Opto Outx Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A059 or A062 [Opto Outx Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A059 or A062 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.

A058, A061 Options (Cont.)	**18** "Above PF Ang"	• Power Factor angle has exceeded the value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	19 "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.) With FRN 4.01 and later: Setting this option for A058 means the logic command word bit 6 has full control of A059. Setting this option for A059 means the logic command word bit 7 has full control of A062. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A059 or A062 [Opto Outx Level].
	24 "MsgControl"	With FRN 4.01 and later: Enables the output to be controlled over the network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.)

A059 [Opto Out1 Level]
A062 [Opto Out2 Level]

Related Parameter(s): A058, A061

32 32 bit parameter.

Determines the on/off point for the opto outputs when A058 or A061 [Opto Outx Sel] is set to option 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A058 is set to 20, the logic command word bit 6 has full control of A059 and when the value of A061 is set to 20, bit 7 has full control of A062.

A058 & A061 Setting	A059 & A062 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A064 [Opto Out Logic]

Determines the logic (Normally Open/NO or Normally Closed/NC) of the opto outputs.

A064 Option	Opto Out1 Logic	Opto Out2 Logic
0	NO (Normally Open)	NO (Normally Open)
1	NC (Normally Closed)	NO (Normally Open)
2	NO (Normally Open)	NC (Normally Closed)
3	NC (Normally Closed)	NC (Normally Closed)

Values	Default:	0
	Min/Max:	0/3
	Display:	1

A065 [Analog Out Sel]

Related Parameter(s): P035, A066

Sets the analog output signal mode (0-10V, 0-20mA, or 4-20mA). The output is used to provide a signal that is proportional to several drive conditions.

Option	Output Range	Minimum Output Value	Maximum Output Value A066 [Analog Out High]	DIP Switch Position	Related Parameter
0 "OutFreq 0-10"	0-10V	0V = 0 Hz	P035 [Maximum Freq]	0-10V	d001
1 "OutCurr 0-10"	0-10V	0V = 0 Amps	200% Drive Rated Output Current	0-10V	d003
2 "OutVolt 0-10"	0-10V	0V = 0 Volts	120% Drive Rated Output Volts	0-10V	d004
3 "OutPowr 0-10"	0-10V	0V = 0 kW	200% Drive Rated Power	0-10V	d022
4 "TstData 0-10"	0-10V	0V = 0000	65535 (Hex FFFF)	0-10V	d019
5 "OutFreq 0-20"	0-20mA	0 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
6 "OutCurr 0-20"	0-20mA	0 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
7 "OutVolt 0-20"	0-20mA	0 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
8 "OutPowr 0-20"	0-20mA	0 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
9 "TstData 0-20"	0-20mA	0 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
10 "OutFreq 4-20"	4-20mA	4 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
11 "OutCurr 4-20"	4-20mA	4 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
12 "OutVolt 4-20"	4-20mA	4 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
13 "OutPowr 4-20"	4-20mA	4 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
14 "TstData 4-20"	4-20mA	4 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
15 "OutTorq 0-10"	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V	d029
16 "OutTorq 0-20"	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
17 "OutTorq 4-20"	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
18 "Setpnt 0-10"	0-10V	0V = 0%	100.0% Setpoint Setting	0-10V	A109
19 "Setpnt 0-20"	0-20 mA	0 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
20 "Setpnt 4-20"	4-20 mA	4 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
21 "MinFreq 0-10"	0-10V	0V = Min. Freq	P035 [Maximum Freq]	0-10V	d001
22 "MinFreq 0-20"	0-20 mA	0 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001
23 "MinFreq 4-20"	4-20 mA	4 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001

Values	Default:	0
	Min/Max:	0/23
	Display:	1

Advanced Program Group *(continued)*

A066 [Analog Out High]

Related Parameter(s): A065

Scales the Maximum Output Value for the A065 [Analog Out Sel] source setting.

Examples:

A066 Setting	A065 Setting	A065 Max. Output Value
50%	1 "OutCurr 0-10"	5V for 200% Drive Rated Output Current
90%	8 "OutPowr 0-20"	18mA for 200% Drive Rated Power

Values		
	Default:	100%
	Min/Max:	0/800%
	Display:	1%

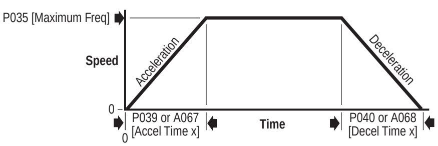
A067 [Accel Time 2]

Related Parameter(s): P039, A051-A054, A070-A077, A140-A147

When active, sets the rate of acceleration for all speed increases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values		
	Default:	20.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



Advanced Program Group *(continued)*

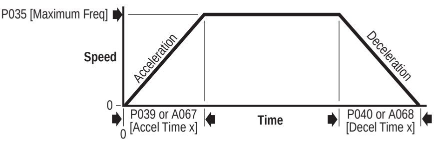
A068 [Decel Time 2]

Related Parameter(s): P040, A051-A054, A070-A077, A140-A147

When active, sets the rate of deceleration for all speed decreases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	20.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



A069 [Internal Freq]

Related Parameter(s): P038, A162

Provides the frequency command to the drive when P038 [Speed Reference] is set to 1 “Internal Freq”. When enabled, this parameter will change the frequency command in “real time” using the integral keypad Up Arrow or Down Arrow when in program mode.

Important: Once the desired command frequency is reached, the Enter key must be pressed to store this value to EEPROM memory. If the ESC key is used before the Enter key, the frequency will return to the original value following the normal accel/decel curve.

If A051 - A054 [Digital Inx Sel] is set to 16 “MOP Up” or 17 “MOP Down” this parameter acts as the MOP frequency reference.

Values	Default:	60.0 Hz for IP20 rated drives 0.0 Hz for IP66, NEMA/UL Type 4X drives
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A070 [Preset Freq 0][1]
A071 [Preset Freq 1]
A072 [Preset Freq 2]
A073 [Preset Freq 3]
A074 [Preset Freq 4]
A075 [Preset Freq 5]
A076 [Preset Freq 6]
A077 [Preset Freq 7]

Related Parameter(s): P038, P039, P040, A051-A053, A067, A068, A140-A147, A150-A157

Values	A070 Default:[1]	0.0 Hz
	A071 Default:	5.0 Hz
	A072 Default:	10.0 Hz
	A073 Default:	20.0 Hz
	A074 Default:	30.0 Hz
	A075 Default:	40.0 Hz
	A076 Default:	50.0 Hz
	A077 Default:	60.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Provides a fixed frequency command value when A051 - A053 [Digital Inx Sel] is set to 4 “Preset Frequencies”.

An active preset input will override speed command as shown in the flowchart on page 1-23.

(1) To activate A070 [Preset Freq 0] set P038 [Speed Reference] to option 4 “Preset Freq 0-3”.

Input State of Digital In 1 (I/O Terminal 05 when A051 = 4)	Input State of Digital In 2 (I/O Terminal 06 when A052 = 4)	Input State of Digital In 3 (I/O Terminal 07 when A053 = 4)	Frequency Source	Accel / Decel Parameter Used[2]
0	0	0	A070 [Preset Freq 0]	[Accel Time 1] / [Decel Time 1]
1	0	0	A071 [Preset Freq 1]	[Accel Time 1] / [Decel Time 1]
0	1	0	A072 [Preset Freq 2]	[Accel Time 2] / [Decel Time 2]
1	1	0	A073 [Preset Freq 3]	[Accel Time 2] / [Decel Time 2]
0	0	1	A074 [Preset Freq 4]	[Accel Time 1] / [Decel Time 1]
1	0	1	A075 [Preset Freq 5]	[Accel Time 1] / [Decel Time 1]
0	1	1	A076 [Preset Freq 6]	[Accel Time 2] / [Decel Time 2]
1	1	1	A077 [Preset Freq 7]	[Accel Time 2] / [Decel Time 2]

(2) When a Digital Input is set to “Accel 2 & Decel 2”, and the input is active, that input overrides the settings in this table.

A078 [Jog Frequency]

Related Parameter(s): P035, A051-A054, A079

Sets the output frequency when a jog command is issued.

Values	Default:	10.0 Hz
	Min/Max:	0.0/[Maximum Freq]
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A079 [Jog Accel/Decel]

Related Parameter(s): A078, A051-A054

Sets the acceleration and deceleration time when a jog command is issued.

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs

A080 [DC Brake Time]

Related Parameter(s): P037, A081

Sets the length of time that DC brake current is "injected" into the motor. Refer to parameter A081 [DC Brake Level].

Values	Default:	0.0 Secs
	Min/Max:	0.0/99.9 Secs (A setting of 99.9 = Continuous)
	Display:	0.1 Secs

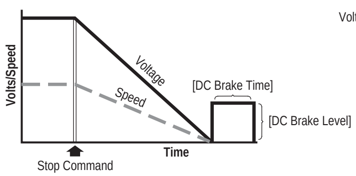
A081 [DC Brake Level]

Related Parameter(s): P037, A080

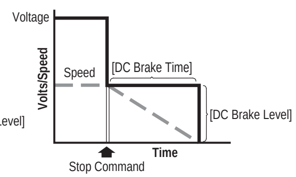
Defines the maximum DC brake current, in amps, applied to the motor when P037 [Stop Mode] is set to either "Ramp" or "DC Brake".

Values	Default:	Drive Rated Amps × 0.05
	Min/Max:	0.0/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps

P037 Ramp-to-Stop Mode



P037 DC Injection Braking Mode



ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

ATTENTION: This feature should not be used with synchronous or permanent magnet motors. Motors may be demagnetized during braking.

Advanced Program Group *(continued)*

A082 [DB Resistor Sel]

Related Parameter(s): P037

Stop drive before changing this parameter.

Enables/disables external dynamic braking.

Setting	Min/Max
0	"Disabled"
1	"Normal RA Res" (5% Duty Cycle) – Refer to Table B.C on page B-2.
2	"NoProtection" (100% Duty Cycle)
3-99	"x%Duty Cycle" Limited (3% – 99% of Duty Cycle)

The drive is able to provide full braking indefinitely. Braking power is limited by the external DB resistor. When this parameter is set to 1 "Normal RA Res" and an appropriate resistor is used (see selection Table B.C), the drive provides calculated resistor overload protection. However, the drive cannot protect against a brake IGBT failure.

ATTENTION: A risk of fire exists if external braking resistors are not protected. The external resistor package must be self-protected from over temperature or the protective circuit shown in Figure B.9 on page B-13, or equivalent, must be supplied.

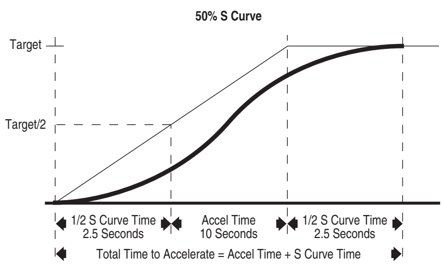
Values		
	Default:	0
	Min/Max:	0/99
	Display:	1

A083 [S Curve %]

Sets the percentage of acceleration or deceleration time that is applied to the ramp as S Curve. Time is added, 1/2 at the beginning and 1/2 at the end of the ramp.

Values		
	Default:	0% (Disabled)
	Min/Max:	0/100%
	Display:	1%

Example:
Accel Time = 10 Seconds
S Curve Setting = 50%
S Curve Time = 10 × 0.5 = 5 Seconds
Total Time = 10 + 5 = 15 Seconds



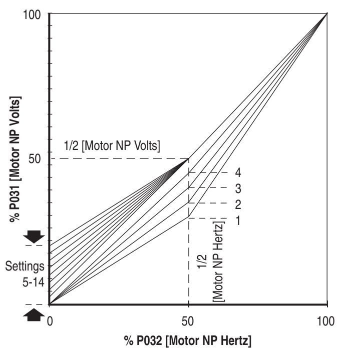
Advanced Program Group *(continued)*

A084 [Boost Select]

Related Parameter(s): d004, P031, P032, A085, A086, A087, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve.
Active when A125 [Torque Perf Mode] = 0 “V/Hz”.
Drive may add additional voltage unless Option 5 is selected.

Options	**0**	“Custom V/Hz”	
	1	“30.0, VT”	Variable Torque (Typical fan/pump curves.)
	2	“35.0, VT”	
	3	“40.0, VT”	
	4	“45.0, VT”	
	5	“0.0 no IR”	Constant Torque
	6	“0.0”	
	7	“2.5, CT” [Default for 4.0, 5.5, 7.5 & 11 kW (5.0, 7.5, 10 & 15 HP) Drives]	
	8	“5.0, CT” (Default)	
	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)*

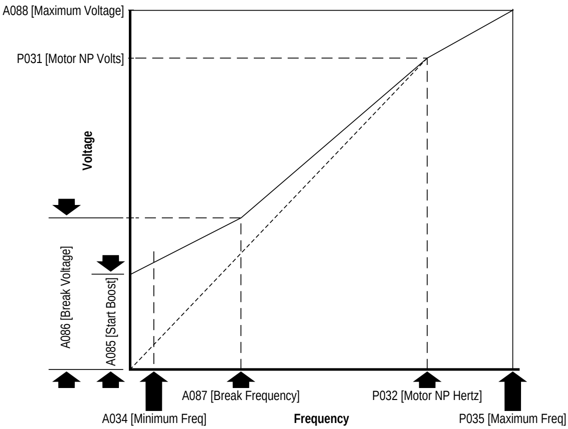
A085 [Start Boost]

Related Parameter(s): P031, P032, P034, P035, A084, A086, A087, A088, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”.

Drive may add additional voltage unless Option 5 is selected.

Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	0.1%



A086 [Break Voltage]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A087, A088, A125

Sets the frequency where break voltage is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A087 [Break Frequency]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A086, A088, A125

Sets the frequency where break frequency is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	15.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A088 [Maximum Voltage]

Related Parameter(s): d004, A085, A086, A087

Sets the highest voltage the drive will output.

Values	Default:	Drive Rated Volts
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

A089 [Current Limit 1]

Related Parameter(s): P033, A118

Maximum output current allowed before current limiting occurs.

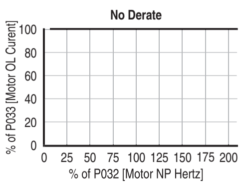
Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/Drive Rated Amps × 1.8
	Display:	0.1 Amps

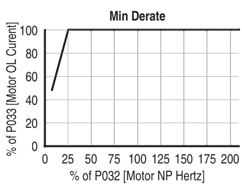
A090 [Motor OL Select]

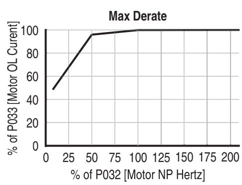
Related Parameter(s): P032, P033

Drive provides Class 10 motor 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"







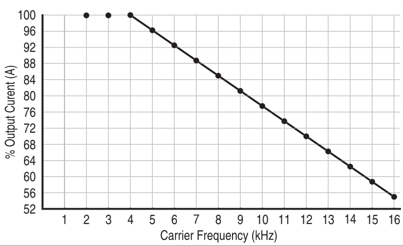
A091 [PWM Frequency]

Related Parameter(s): A124

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.

Values	Default:	4.0 kHz
	Min/Max:	2.0/16.0 kHz
	Display:	0.1 kHz



Advanced Program Group *(continued)*

A092 [Auto Rstrt Tries]

Related Parameter(s): A055, A058, A061, A093

Sets the maximum number of times the drive attempts to reset a fault and restart.

Clear a Type 1 fault and restart the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [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

A093 [Auto Rstrt Delay]

Related Parameter(s): A092

Sets the time between restart attempts when A092 [Auto Rstrt Tries] is set to a value other than zero.

Values	Default:	1.0 Secs
	Min/Max:	0.0/300.0 Secs
	Display:	0.1 Secs

A094 [Start At PowerUp]

Stop drive before changing this parameter.

Enables/disables a feature that allows a Start or Run command to automatically cause the drive to resume running at commanded speed after drive input power is restored. Requires a digital input configured for Run or Start and a valid start contact.

This parameter will not function if parameter P036 [Start Source] is set to 4 "2-W High Speed".

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"

Advanced Program Group *(continued)*

A095 [Reverse Disable]

Related Parameter(s): d006

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed. The reverse command may come from a digital command, the keypad or a serial command. All reverse inputs including two-wire Run Reverse will be ignored with reverse disabled.

Options	**0**	"Rev Enabled" (Default)
	1	"Rev Disabled"

A096 [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"

A097 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	**0**	"Disabled"	
	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"	

A098 [SW Current Trip]

Related Parameter(s): P033

Enables/disables a software instantaneous (within 100 ms) current trip.

Values	Default:	0.0 (Disabled)
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

A099 [Process Factor]

Related Parameter(s): d010

Scales the output frequency value displayed by d010 [Process Display].

$$\text{Output Freq} \times \text{Process Factor} = \text{Process Display}$$

Values	Default:	30.0
	Min/Max:	0.1/999.9
	Display:	0.1

Advanced Program Group *(continued)*

A100 [Fault Clear]

Stop drive before changing this parameter.

Resets a fault and clears the fault queue. Used primarily to clear a fault over network communications.

Options	**0**	"Ready/Idle" (Default)	
	1	"Reset Fault"	
	2	"Clear Buffer"	(Parameters d007-d009 [Fault x Code])

A101 [Program Lock]

Protects parameters against change by unauthorized personnel.

Options	**0**	"Unlocked" (Default)
	1	"Locked"

A102 [Testpoint Sel]

Related Parameter(s): d019

Used by Rockwell Automation field service personnel.

Values	Default:	400
	Min/Max:	0/FFFF
	Display:	1 Hex

A103 [Comm Data Rate]

Related Parameter(s): d015

Sets the serial port rate for the RS485 (DSI) port.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19.2K"
	5	"38.4K"

A104 [Comm Node Addr]

Related Parameter(s): d015

Sets the drive node address for the RS485 (DSI) port if using a network connection.

Important: Power to drive must be cycled before any changes will affect drive operation.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

Advanced Program Group *(continued)*

A105 [Comm Loss Action]

Related Parameter(s): d015, P037, A106

Selects the drive's response to a loss of the communication connection or excessive communication errors.

Options	**0**	"Fault" (Default)	Drive will fault on an F81 Comm Loss and coast to stop.
	1	"Coast Stop"	Stops drive via coast to stop.
	2	"Stop"	Stops drive via P037 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.

A106 [Comm Loss Time]

Related Parameter(s): d015, A105

Sets the time that the drive will remain in communication loss before implementing the option selected in A105 [Comm Loss Action].

Values	Default:	5.0 Secs
	Min/Max:	0.1/60.0 Secs
	Display:	0.1 Secs

A107 [Comm Format]

Related Parameter(s): d015

Selects the protocol (RTU only), data bits (8 data bits only), parity (None, Even, Odd), and stop bits (1 stop bit only) used by the RS485 port on the drive.

Refer to Appendix C for details on using the drive communication features.

Important: Power to drive must be cycled before any changes will affect drive operation.

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"

A108 [Language]

Selects the language displayed by the remote communications option.

Options	**1**	"English" (Default)
	2	"Français"
	3	"Español"
	4	"Italiano"
	5	"Deutsch"
	6	"Reserved"
	7	"Português"
	8	"Reserved"
	9	"Reserved"
	10	"Nederlands"

Advanced Program Group *(continued)*

A109 [Anlg Out Setpt]

Related Parameter(s): A065

When A065 [Analog Out Sel] is set to option 18, 19 or 20, this parameter sets the percentage of analog output desired.

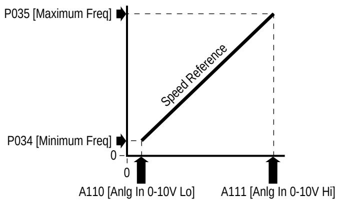
Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A110 [Anlg In 0-10V Lo]

Related Parameter(s): d020, P034, P038, A122

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 0-10V input is used by P038 [Speed Reference].
Analog inversion can be accomplished by setting this value larger than A111 [Anlg In 0-10V Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%



A111 [Anlg In 0-10V Hi]

Related Parameter(s): d020, P035, P038, A122, A123

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 0-10V input is used by P038 [Speed Reference].
Analog inversion can be accomplished by setting this value smaller than A110 [Anlg In 0-10V Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A112 [Anlg In4-20mA Lo]

Related Parameter(s): d021, P034, P038

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 4-20mA input is used by P038 [Speed Reference].
Analog inversion can be accomplished by setting this value larger than A113 [Anlg In4-20mA Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Advanced Program Group *(continued)*

A113 [Anlg In4-20mA Hi]

Related Parameter(s): d021, P035, P038

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 4-20mA input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value smaller than A112 [Anlg In4-20mA Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A114 [Slip Hertz @ FLA]

Related Parameter(s): P033

Compensates for the inherent slip in an induction motor. This frequency is added to the commanded output frequency based on motor current.

Values	Default:	2.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A115 [Process Time Lo]

Related Parameter(s): d010, P034

Scales the time value when the drive is running at P034 [Minimum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A116 [Process Time Hi]

Related Parameter(s): d010, P035

Scales the time value when the drive is running at P035 [Maximum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A117 [Bus Reg Mode]

Controls the operation of the drive voltage regulation, which is normally operational at decel or when the bus voltage rises.

Refer to the Attention statement on page P-3 for important information on bus regulation.

Options	**0**	"Disabled"
	1	"Enabled" (Default)

A118 [Current Limit 2]

Related Parameter(s): P033, A051-A054, A089

Maximum output current allowed before current limiting occurs. This parameter is only active if A051 - A054 [Digital Inx Sel] is set to 25 "Current Lmt2" and is active.

Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A119 [Skip Frequency]

Related Parameter(s): A120

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

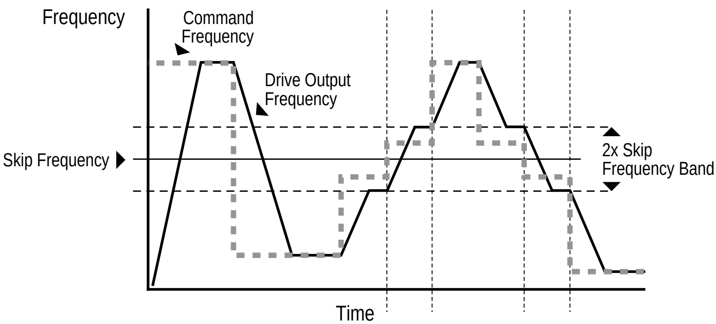
A120 [Skip Freq Band]

Related Parameter(s): A119

Determines the bandwidth around A119 [Skip Frequency]. A120 [Skip Frequency Band] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A121 [Stall Fault Time]

Sets the time that the drive will remain 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"

Advanced Program Group *(continued)*

A122 [Analog In Loss]

Related Parameter(s): A110, A111, A132

Selects drive action when an input signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3mA. If using a 0-10V analog input, set A110 [Anlg In 0-10V Lo] to a minimum of 20% (i.e. 2 volts).

Options	**0**	"Disabled" (Default)	
	1	"Fault (F29)"	F29 Analog Input Loss
	2	"Stop"	Uses P037 [Stop Mode]
	3	"Zero Ref"	Drive runs at zero speed reference.
	4	"Min Freq Ref"	Drive runs at minimum frequency.
	5	"Max Freq Ref"	Drive runs at maximum frequency.
	6	"Int Freq Ref"	Drive runs at internal frequency.

A123 [10V Bipolar Enbl]

Related Parameter(s): P038, A111

Enables/disables bipolar control. In bipolar mode direction is commanded by the sign of the reference.

Options	**0**	"Uni-Polar In" (Default)	0 to 10V only
	1	"Bi-Polar In"	±10V

A124 [Var PWM Disable]

Related Parameter(s): A091

Stop drive before changing this parameter.

Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A091 [PWM Frequency].

Disabling this feature when low frequency conditions exist may result in IGBT stress and nuisance tripping.

Options	**0**	"Enabled" (Default)
	1	"Disabled"

A125 [Torque Perf Mode]

Related Parameter(s): A084, A085, A086, A087, A127

Stop drive before changing this parameter.

Enables/disables sensorless vector control operation.

Options	**0**	"V/Hz"
	1	"Sensrls Vect" (Default)

A126 [Motor NP FLA]

Related Parameter(s): A127

Set to the motor nameplate rated full load amps.

Values	Default:	Drive Rated Amps
	Min/Max:	0.1/(Drive Rated Amps × 2)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A127 [Autotune]

Related Parameter(s): A125, A126, A128, A129

Stop drive before changing this parameter.

Provides an automatic method for setting A128 [IR Voltage Drop] and A129 [Flux Current Ref], which affect sensorless vector performance. Parameter A126 [Motor NP FLA] must be set to the motor nameplate full load amps before running the Autotune procedure.

Options	**0**	"Ready/Idle" (Default)
	1	"Static Tune"
	2	"Rotate Tune"

"Ready" (0) = Parameter returns to this setting following a "Static Tune" or "Rotate Tune."

"Static Tune" (1) = A temporary command that initiates a non-rotational motor stator resistance test for the best possible automatic setting of A128 [IR Voltage Drop]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required operate the drive in normal mode. Used when motor cannot be uncoupled from the load.

"Rotate Tune" (2) = A temporary command that initiates a "Static Tune" followed by a rotational test for the best possible automatic setting of A129 [Flux Current Ref]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required to operate the drive in normal mode. **Important:** Used when motor is uncoupled from the load. Results may not be valid if a load is coupled to the motor during this procedure.

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.

If the Autotune routine fails, an F80 SVC Autotune fault is displayed.

A128 [IR Voltage Drop]

Related Parameter(s): A127

Value of volts dropped across the resistance of the motor stator.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/230.0 VAC
	Display:	0.1 VAC

A129 [Flux Current Ref]

Related Parameter(s): A127

Value of amps for full motor flux.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/[Motor NP FLA]
	Display:	0.01 Amps

Advanced Program Group *(continued)*

A130 [PID Trim Hi]

Sets the maximum positive value that is added to the speed reference when PID trim is used.

Values	Default:	60.0
	Min/Max:	0.0/400.0
	Display:	0.1

A131 [PID Trim Lo]

Sets the maximum positive value that is subtracted from the PID reference when PID trim is used.

Values	Default:	0.0
	Min/Max:	0.0/400.0
	Display:	0.1

A132 [PID Ref Sel]

Related Parameter(s): P038, A122

Stop drive before changing this parameter.

Enables/disables PID mode and selects the source of the PID reference. Refer to Appendix F for details.

Options	**0**	"PID Disabled" (Default)
	1	"PID Setpoint"
	2	"0-10V Input"
	3	"4-20mA Input"
	4	"Comm Port"
	5	"Setpnt, Trim"
	6	"0-10V, Trim"
	7	"4-20mA, Trim"
	8	"Comm, Trim"

A133 [PID Feedback Sel]

Select the source of the PID feedback. Refer to Appendix F for details.

Options	**0**	"0-10V Input" (Default)	The PID will not function with a bipolar input. Negative voltages are treated as 0 volts.
	1	"4-20mA Input"	
	2	"Comm Port"	

A134 [PID Prop Gain]

Sets the value for the PID proportional component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01
	Min/Max:	0.00/99.99
	Display:	0.01

Advanced Program Group *(continued)*

A135 [PID Integ Time]

Sets the value for the PID integral component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.1 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A136 [PID Diff Rate]

Sets the value for the PID differential component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01 (1/Secs)
	Min/Max:	0.00/99.99 (1/Secs)
	Display:	0.01 (1/Secs)

A137 [PID Setpoint]

Provides an internal fixed value for process setpoint when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A138 [PID Deadband]

Sets the lower limit of the PID output.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A139 [PID Preload]

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A140 [Stp Logic 0]
A141 [Stp Logic 1]
A142 [Stp Logic 2]
A143 [Stp Logic 3]
A144 [Stp Logic 4]
A145 [Stp Logic 5]
A146 [Stp Logic 6]
A147 [Stp Logic 7]

Related Parameter(s): P038, P039, P040, A051-A054, A055, A058, A061, A067, A068, A070-A077, A150-A157

Stop drive before changing this parameter.

Values	Default:	00F1
	Min/Max:	0001/bAFF
	Display:	4 Digits

Parameters A140-A147 are only active if P038 [Speed Reference] is set to 6 "Stp Logic".

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 0-3 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 A051 - A054 [Digital Inx Sel], to 23 "Logic In1" and/or 24 "Logic In2".

A time interval between steps can be programmed using parameters A150 - A157 [Stp Logic Time x]. See the table below for related parameters.

The speed for any step is programmed using parameters A070 - A077 [Preset Freq x].

StepLogic Parameter (Active when P038 = 6 "Stp Logic")	Related Preset Frequency Parameter (Can be activated independent of StepLogic Parameters)	Related StepLogic Time Parameter (Active when A140-A147 Digit 0 or 1 are set to 1, b, C, d or E)
A140 [Stp Logic 0]	A070 [Preset Freq 0]	A150 [Stp Logic Time 0]
A141 [Stp Logic 1]	A071 [Preset Freq 1]	A151 [Stp Logic Time 1]
A142 [Stp Logic 2]	A072 [Preset Freq 2]	A152 [Stp Logic Time 2]
A143 [Stp Logic 3]	A073 [Preset Freq 3]	A153 [Stp Logic Time 3]
A144 [Stp Logic 4]	A074 [Preset Freq 4]	A154 [Stp Logic Time 4]
A145 [Stp Logic 5]	A075 [Preset Freq 5]	A155 [Stp Logic Time 5]
A146 [Stp Logic 6]	A076 [Preset Freq 6]	A156 [Stp Logic Time 6]
A147 [Stp Logic 7]	A077 [Preset Freq 7]	A157 [Stp Logic Time 7]

How StepLogic Works
The StepLogic sequence begins with a valid start command. A normal sequence always begins with A140 [Stp Logic 0].

Digit 0: 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 0 is set 3. When "Logic In2" becomes active, the program advances to the next step.

Digit 1: 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 2.

Digit 2: Different Step to Jump
When the condition for Digit 1 is met, the Digit 2 setting determines the next step or to end the program.

Digit 3: Step Settings

This digit defines what accel/decel profile the speed command will follow and the direction of the command for the current step. In addition, if a relay or opto output (parameters A055, A058 and A061) is set to 15 “StpLogic Out”, this parameter can control the status of that output.

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.

Refer to Appendix E for details.

0 0 0 0

Logic For Next Step	Digit 0
Logic to Jump to a Different Step	Digit 1
Different Step to Jump	Digit 2
Step Settings	Digit 3

Digit 3 Settings

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

Digit 2 Settings

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)

Digit 1 and Digit 0 Settings

0 = Skip Step (Jump Immediately)
1 = Step Based on [Stp Logic Time x]
2 = Step if “Logic In1” is Active
3 = Step if “Logic In2” is Active
4 = Step if “Logic In1” is Not Active
5 = Step if “Logic In2” is Not Active
6 = Step if either “Logic In1” or “Logic In2” is Active
7 = Step if both “Logic In1” and “Logic In2” is Active
8 = Step if neither “Logic In1” or “Logic In2” is Active
9 = Step if “Logic In1” is Active and “Logic In2” is Not Active
A = Step if “Logic In2” is Active and “Logic In1” is Not Active
b = Step after [Stp Logic Time x] and “Logic In1” is Active
C = Step after [Stp Logic Time x] and “Logic In2” is Active
d = Step after [Stp Logic Time x] and “Logic In1” is Not Active
E = Step after [Stp Logic Time x] and “Logic In2” is Not Active
F = Do Not Step/Ignore Digit 2 Settings

Advanced Program Group *(continued)*

A150 [Stp Logic Time 0]
A151 [Stp Logic Time 1]
A152 [Stp Logic Time 2]
A153 [Stp Logic Time 3]
A154 [Stp Logic Time 4]
A155 [Stp Logic Time 5]
A156 [Stp Logic Time 6]
A157 [Stp Logic Time 7]

Related Parameter(s): P038, A055, A058, A061, A070-A077, A140-A147

Sets the time to remain in each step if the corresponding StpLogic command word is set to "Step after Time".

Values	Default:	30.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A160 [EM Brk Off Delay]

Related Parameter(s): P037

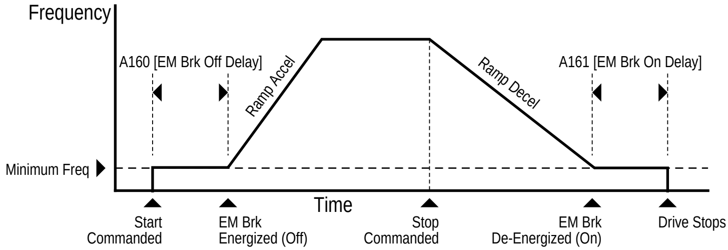
Sets the time the drive remains at minimum frequency before the relay or an opto output is energized and the drive ramps to the commanded frequency.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 "Ramp+EM B,CF" or 9 "Ramp+EM Brk" to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 "EM Brk Cntrl" to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs



Advanced Program Group *(continued)*

A161 [EM Brk On Delay]

Related Parameter(s): P037

Sets the time the drive remains at minimum frequency before the relay or an opto output is de-energizing and the drive stops.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 “Ramp+EM B,CF” or 9 “Ramp+EM Brk” to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 “EM Brk Cntrl” to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs

A162 [MOP Reset Sel]

Related Parameter(s): A069

Set the drive to save the current MOP reference command.

Options	**0**	“Zero MOP Ref”	This option clamps A069 [Internal Freq] at 0.0 Hz when the drive is not running.
	1	“Save MOP Ref” (Default)	Reference is saved in A069 [Internal Freq].

A163 [DB Threshold]

Related Parameter(s): P037, A080, A081, A082

Sets the DC bus Voltage Threshold for Dynamic Brake operation. If the DC bus voltage falls below the value set in this parameter, the Dynamic Brake will not turn on. Lower values will make the Dynamic Braking function more responsive but may result in nuisance Dynamic Brake activation.

Values	Default	100.0%
	Min/Max:	0.0/110.0%
	Display:	0.0%

ATTENTION: Equipment damage may result if this parameter is set 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 A082 [DB Resistor Sel] is set to 2 “No Protection”.

Advanced Program Group *(continued)*

A164 [Comm Write Mode]

Determines whether parameter changes made over communication port are saved and stored in Non-Volatile Storage (NVS) or RAM only. If they are stored in RAM, the values will be lost at power-down.

Options	**0**	"Save" (Default)
	1	"RAM Only"

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless A164 [Comm Write Mode] is set to option 1.

A165 [Anlg Loss Delay]

Related Parameter(s): A122

Sets the length of time after power-up during which the drive will not detect an analog signal loss. The drive response to an analog signal loss is set in A122 [Analog In Loss].

Values	Default:	0.0 Secs
	Min/Max:	0.0/20.0 Secs
	Display:	0.1 Secs

A166 [Analog In Filter]

Sets 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, etc...). No additional filtering is applied when set to "0".

Values	Default:	0
	Min/Max:	0/14
	Display:	1

A167 [PID Invert Error]

When set to "Inverted", changes the sign of the PID error. This causes an increase in the drive output frequency with PID Feedback greater than PID Setpoint, and a decrease in drive output frequency with PID Feedback less than PID Setpoint.

Options	**0**	"Not Inverted" (Default)
	1	"Inverted"

Parameter Cross Reference – by Name

Parameter Name	No.	Group
10V Bipolar Enbl	A123	Advanced Program
Accel Time 1	P039	Basic Program
Accel Time 2	A067	Advanced Program
Analog In 0-10V	d020	Display
Analog In 4-20mA	d021	Display
Analog In Filter	A166	Advanced Program
Analog In Loss	A122	Advanced Program
Analog Out High	A066	Advanced Program
Analog Out Sel	A065	Advanced Program
Anlg In 0-10V Hi	A111	Advanced Program
Anlg In 0-10V Lo	A110	Advanced Program
Anlg In4-20mA Hi	A113	Advanced Program
Anlg In4-20mA Lo	A112	Advanced Program
Anlg Loss Delay	A166	Advanced Program
Anlg Out Setpt	A109	Advanced Program
Auto Rstrt Delay	A093	Advanced Program
Auto Rstrt Tries	A092	Advanced Program
Autotune	A127	Advanced Program
Boost Select	A084	Advanced Program
Break Frequency	A087	Advanced Program
Break Voltage	A086	Advanced Program
Bus Reg Mode	A117	Advanced Program
Comm Data Rate	A103	Advanced Program
Comm Format	A107	Advanced Program
Comm Loss Action	A105	Advanced Program
Comm Loss Time	A106	Advanced Program
Comm Node Addr	A104	Advanced Program
Comm Status	d015	Display
Comm Write Mode	A164	Advanced Program
Commanded Freq	d002	Display
Compensation	A097	Advanced Program
Contrl In Status	d013	Display
Control Source	d012	Display
Control SW Ver	d016	Display
Counter Status	d025	Display
Current Limit x	A089, A118	Advanced Program
DB Resistor Sel	A082	Advanced Program
DB Threshold	A163	Advanced Program
DC Brake Level	A081	Advanced Program
DC Brake Time	A080	Advanced Program
DC Bus Voltage	d005	Display
Decel Time 1	P040	Basic Program
Decel Time 2	A068	Advanced Program
Dig In Status	d014	Display
Digital Inx Sel	A051-A054	Advanced Program
Drive Status	d006	Display
Drive Temp	d024	Display
Drive Type	d017	Display
Elapsed Run Time	d018	Display
EM Brk Off Delay	A160	Advanced Program
EM Brk On Delay	A161	Advanced Program
Fault Clear	A100	Advanced Program
Fault x Code	d007-d009	Display
Flux Current Ref	A129	Advanced Program
Flying Start En	A096	Advanced Program
Internal Freq	A069	Advanced Program
IR Voltage Drop	A128	Advanced Program
Jog Accel/Decel	A079	Advanced Program
Jog Frequency	A078	Advanced Program
Language	A108	Advanced Program
Maximum Freq	P035	Basic Program
Maximum Voltage	A088	Advanced Program
Minimum Freq	P034	Basic Program
MOP Reset Sel	A162	Advanced Program
Motor NP FLA	A126	Advanced Program
Motor NP Hertz	P032	Basic Program
Motor NP Volts	P031	Basic Program
Motor OL Current	P033	Basic Program
Motor OL Ret	P043	Basic Program
Motor OL Select	A090	Advanced Program
Opto Out Logic	A064	Advanced Program
Opto Outx Level	A059, A062	Advanced Program
Opto Outx Sel	A058, A061	Advanced Program
Output Current	d003	Display
Output Freq	d001	Display
Output Power	d022	Display
Output Powr Fctr	d023	Display
Output Voltage	d004	Display
PID Deadband	A138	Advanced Program
PID Diff Rate	A136	Advanced Program
PID Feedback Sel	A133	Advanced Program
PID Integ Time	A135	Advanced Program
PID Invert Error	A167	Advanced Program
PID Preload	A139	Advanced Program
PID Prop Gain	A134	Advanced Program
PID Ref Sel	A132	Advanced Program
PID Setpoint	A137	Advanced Program
PID Trim Hi	A130	Advanced Program
PID Trim Lo	A131	Advanced Program
Preset Freq x	A070-A077	Advanced Program
Process Display	d010	Display
Process Factor	A099	Advanced Program
Process Time Hi	A116	Advanced Program
Process Time Lo	A115	Advanced Program
Program Lock	A101	Advanced Program
PWM Frequency	A091	Advanced Program
Relay Out Level	A056	Advanced Program
Relay Out Sel	A055	Advanced Program
Reset To Defalts	P041	Basic Program
Reverse Disable	A095	Advanced Program
S Curve %	A083	Advanced Program
Skip Freq Band	A120	Advanced Program
Skip Frequency	A119	Advanced Program
Slip Hertz @ FLA	A114	Advanced Program
Stp Logic Status	d028	Display
Stp Logic x	A140-A147	Advanced Program
Stp Logic Time x	A150-A157	Advanced Program
Speed Reference	P038	Basic Program
Stall Fault Time	A121	Advanced Program
Start At PowerUp	A094	Advanced Program
Start Boost	A085	Advanced Program
Start Source	P036	Basic Program
Stop Mode	P037	Basic Program
SW Current Trip	A098	Advanced Program

Parameter Name	No.	Group
Testpoint Data	d019	Display
Testpoint Sel	A102	Advanced Program
Timer Status	d026	Display
Torque Current	d029	Display
Torque Perf Mode	A125	Advanced Program
Var PWM Disable	A124	Advanced Program
Voltage Class	P042	Basic Program

Troubleshooting

Chapter 4 provides information to guide you in troubleshooting the PowerFlex 40 drive. Included is a listing and description of drive faults (with possible solutions, when applicable).

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral keypad.

LED Indications

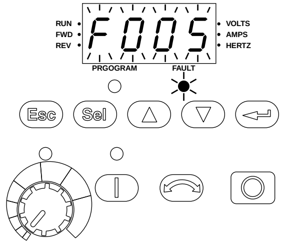
See page 2-4 for information on drive status indicators and controls.

Faults

A fault is a condition that stops the drive. There are two fault types.

Type	Fault Description	
①	Auto-Reset/Run	When this type of fault occurs, and A092 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A093 [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-Resetable	This type of fault may require drive or motor repair, or is caused by wiring or programing 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 keypad provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator Press the Escape key to regain control of the integral keypad.	

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 d007 [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 Table 4.A.	
3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P037 [Stop Mode] is set to a value between “0” and “3”. • Cycle drive power. • Set A100 [Fault Clear] to “1” or “2”. • Cycle digital input if A051-A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.	

Automatically Clearing Faults

Option / Step
Clear a Type 1 fault and restart the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to a value other than “0”.
Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to “0”.

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.

Caution should be used when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Table 4.A Fault Types, Descriptions and Actions

No.	Fault	Type(1)	Description	Action
F2	Auxiliary Input	①	Auxiliary input interlock is open.	1. Check remote wiring. 2. Verify communications programming for intentional fault.
F3	Power Loss	②	Excessive DC Bus voltage ripple.	1. Monitor the incoming line for phase loss or line imbalance. 2. Check input line fuse.
F4	UnderVoltage	①	DC bus voltage fell below the minimum value.	Monitor the incoming AC line for low voltage or line power interruption.
F5	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.
F6	Motor Stalled	①	Drive is unable to accelerate motor.	Increase P039 - A067 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit 1].
F7	Motor Overload	①	Internal electronic overload trip.	1. An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. 2. Verify A084 [Boost Select] setting
F8	Heatsink OvrTmp	①	Heatsink temperature exceeds a predefined value.	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40°C (104°F) for IP30, NEMA UL Type 1 installations or 50°C (122°F) for IP20/Open type installations. 2. Check fan.
F12	HW OverCurrent	②	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A084 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	②	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.
F29	Analog Input Loss	①	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with A122 [Analog In Loss].	1. Check parameters. 2. Check for broken/loose connections at inputs.

(1) See page 4-1 for a description of fault types.

No.	Fault	Type(1)	Description	Action
F33	Auto Rstrt Tries	②	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A092 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	②	A phase to ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd			
F40	Phase W to Gnd			
F41	Phase UV Short	②	Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive if fault cannot be cleared.
F42	Phase UW Short			
F43	Phase VW Short			
F48	Params Defaulted		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
F63	SW OverCurrent	①	Programmed A098 [SW Current Trip] has been exceeded.	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	②	Drive rating of 150% for 1 minute or 200% for 3 seconds has been exceeded.	Reduce load or extend Accel Time.
F70	Power Unit	②	Failure has been detected in the drive power section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.
F71	Net Loss		The communication network has faulted.	1. Cycle power. 2. Check communications cabling. 3. Check network adapter setting. 4. Check external network status.
F80	SVC Autotune		The autotune function was either cancelled by the user or failed.	Restart procedure.
F81	Comm Loss	②	RS485 (DSI) port stopped communicating.	1. If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. 2. Check connection. 3. An adapter was intentionally disconnected. 4. Turn off using A105 [Comm Loss Action].

No.	Fault	Type(1)	Description	Action
F100	Parameter Checksum	②	The checksum read from the board does not match the checksum calculated.	Set P041 [Reset To Defalts] to option 1 “Reset Defaults”.
F122	I/O Board Fail	②	Failure has been detected in the drive control and I/O section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.

(1) See page 4-1 for a description of fault types.

Common Symptoms and Corrective Actions

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 P036 [Start Source] matches your configuration. • Verify that A095 [Reverse Disable] is not prohibiting movement.
Improper boost setting at initial start-up.	None	Set A084 [Boost Select] to option 2 “35.0, VT”.
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A100 [Fault Clear] to option 1 “Clear Faults”. • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.

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 • Cycle power • Set A100 [Fault Clear] to option 1 "Clear Faults". • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 "Clear Fault".
Incorrect programming. • P036 [Start Source] is set to option 0 "Keypad" or option 5 "RS485 (DSI) Port". • A051 - A054 [Digital Inx Sel] is set to option 5 "Local" and the input is active.	None	Check parameter settings.
Incorrect input wiring. See 1-18 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.
Incorrect Sink/Source DIP switch setting.	None	Set switch to match wiring scheme.

Drive does not Start from Integral Keypad.

Cause(s)	Indication	Corrective Action
Integral keypad is not enabled.	Green LED above Start key is not illuminated.	• Set parameter P036 [Start Source] to option 0 "Keypad". • Set parameter A051 - A054 [Digital Inx Sel] to option 5 "Local" and activate the input.
I/O Terminal 01 "Stop" input is not present.	None	Wire inputs correctly and/or install jumper.

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 d012 [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 d002 [Commanded Freq] to verify correct command.
Incorrect reference source is being selected via remote device or digital inputs.	None	• Check d012 [Control Source] for correct source. • Check d014 [Dig In Status] to see if inputs are selecting an alternate source. Verify settings for A051 - A054 [Digital Inx Sel]. • Check P038 [Speed Reference] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 1-23.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P039 [Accel Time 1] or A067 [Accel Time 2].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	Compare d003 [Output Current] with A089 [Current Limit 1]. Remove excess load or reprogram P039 [Accel Time 1] or A067 [Accel Time 2]. Check for improper A084 [Boost Select] setting.
Speed command source or value is not as expected.	None	Verify d002 [Commanded Freq]. Check d012 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	Check P035 [Maximum Freq] to insure that speed is not limited by programming.
Torque performance does not match motor characteristics.	None	Set motor nameplate full load amps in parameter A126 [Motor NP FLA]. Perform A127 [Autotune] “Static Tune” or “Rotate Tune” procedure. Set A125 [Torque Perf Mode] to option 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 A097 [Compensation]. 3. Use A084 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Digital input is not selected for reversing control.	None	Check [Digital Inx Sel] (See page 3-14). Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring. (See page 1-17)
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.
Reverse is disabled.	None	Check A095 [Reverse Disable].

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.
Jumper between I/O Terminals P2 and P1 not installed and/or DC Bus Inductor not connected.	None	Install jumper or connect DC Bus Inductor.

Supplemental Drive Information

Drive, Fuse & Circuit Breaker Ratings

The tables on the following pages 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 below. 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 or J must be used.[2]

Circuit Breakers

The "non-fuse" listings in the following tables 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.

(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.

(2) Typical designations include; Type CC - KTK-R, FNQ-R
Type J - JKS, LPJ
Type T - JJS, JJN

Specifications

Drive Ratings

Catalog Number(1)	Output Ratings		Input Ratings			Branch Circuit Protection			
	kW (HP)	*Amps*	*Voltage Range*	*kVA*	*Amps*	*Fuses*	*140M Motor Protectors(3) (4)*	*Contactors*	*Min. Enclosure Volume(5) (in.3)*
100 - 120V AC (±10%) – 1-Phase Input, 0 - 230V 3-Phase Output									
22B-V2P3x104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12	1655
22B-V5P0x104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23	1655
22B-V6P0x104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37	1655
200 - 240V AC (±10%) – 1-Phase(2) Input, 0 - 230V 3-Phase Output									
22B-A2P3x104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09	1655
22B-A5P0x104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12	1655
22B-A8P0x104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23	1655
22B-A012x104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37	2069
200 - 240V AC (±10%) – 3-Phase Input, 0 - 230V 3-Phase Output									
22B-B2P3x104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07	1655
22B-B5P0x104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09	1655
22B-B8P0x104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12	1655
22B-B012x104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23	1655
22B-B017x104	3.7 (5.0)	17.5	180-264	8.6	21.0	30	140M-F8E-C25	100-C23	1655
22B-B024x104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37	2069
22B-B033x104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-G8E-C45	100-C60	2069
380 - 480V AC (±10%) – 3-Phase Input, 0 - 460V 3-Phase Output									
22B-D1P4x104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07	1655
22B-D2P3x104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07	1655
22B-D4P0x104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09	1655
22B-D6P0x104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09	1655
22B-D010x104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23	1655
22B-D012x104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23	2069
22B-D017x104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23	2069
22B-D024x104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43	2069
460 - 600V AC (±10%) – 3-Phase Input, 0 - 575V 3-Phase Output									
22B-E1P7x104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09	1655
22B-E3P0x104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09	1655
22B-E4P2x104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-D8E-B63	100-C09	1655
22B-E6P6x104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-D8E-C10	100-C09	1655
22B-E9P9x104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-D8E-C16	100-C16	2069
22B-E012x104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-D8E-C16	100-C23	2069
22B-E019x104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-F8E-C25	100-C30	2069

(1) In the Catalog Numbers listed "x" represents enclosure type. Specifications are valid for all enclosure types. IP66, NEMA/UL Type 4X drive ratings are only available as Frame B drives. Refer to Table B.B.

(2) 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114. Filter option is not available for IP66, NEMA/UL Type 4X rated drives.

(3) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(4) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(5) When using a Manual Self-Protected (Type E) Combination Motor Controller, 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.

Input/Output Ratings	**Approvals**
Output Frequency: 0-400 Hz (Programmable) *Efficiency:* 97.5% (Typical)	UL508C c CSA 22.2 EMC Directive 89/336 LV: EN 50178, EN 60204 EMC: EN 61800-3, EN 50081-1, EN 50082-2

Digital Control Inputs (Input Current = 6mA)		**Analog Control Inputs**
SRC (Source) Mode: 18-24V = ON 0-6V = OFF	SNK (Sink) Mode: 0-6V = ON 18-24V = OFF	*4-20mA Analog:* 250 ohm input impedance *0-10V DC Analog:* 100k ohm input impedance *External Pot:* 1-10k ohms, 2 Watt minimum

Control Output

Programmable Output (form C relay)	*Opto Outputs*	*Analog Outputs (10 bit)*
Resistive Rating: 3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC	30V DC, 50mA	0-10V, 1k ohm Min.
Inductive Rating: 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC	Non-inductive	4-20mA, 525 ohm Max.

Fuses and Circuit Breakers

Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.
Recommended Circuit Breakers: HMCP circuit breakers or equivalent.

Protective Features

Motor Protection: I^2t overload protection - 150% for 60 Secs, 200% for 3 Secs (Provides Class 10 protection)

Overcurrent: 200% hardware limit, 300% instantaneous fault

Over Voltage:
100-120V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 150V AC incoming line)
200-240V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 290V AC incoming line)
380-460V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)
460-600V AC Input – Trip occurs at 1005V DC bus voltage (equivalent to 711V AC incoming line)

Under Voltage:
100-120V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 75V AC incoming line)
200-240V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 150V AC incoming line)
380-480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)
460-600V AC Input – If P042 = 3 “High Voltage” trip occurs at 487V DC bus voltage (344V AC incoming line);
If P042 = 2 “Low Voltage” trip occurs at 390V DC bus voltage (275V AC incoming line)

Control Ride Through: Minimum ride through is 0.5 Secs - typical value 2 Secs

Faultless Power Ride Through: 100 milliseconds

Dynamic Braking

Internal brake IGBT included with all ratings except when no brake is specified.
Refer to Appendix B for DB resistor ordering information.

Category	Specification	
Environment	Altitude:	1000 m (3300 ft) max. without derating
	Maximum Surrounding Air Temperature without derating: IP20, NEMA/UL Type Open: IP30, NEMA/UL Type 1: Flange Mount: IP66, NEMA/UL Type 4X:	 –10 to 50° C (14 to 122° F) –10 to 40° C (14 to 104° F) Heatsink: –10 to 40° C (14 to 104° F) Drive: –10 to 50° C (14 to 122° F) –10 to 40° C (14 to 104° F)
	Cooling Method Convection: Fan:	 0.4 kW (0.5 HP) drives All other drive ratings and 0.4 kW (0.5 HP) 1-Phase drives with Integral “S Type” EMC Filter
	Storage Temperature:	–40 to 85 degrees C (–40 to 185 degrees 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 to 95% non-condensing
	Shock (operating):	15G peak for 11ms duration (±1.0ms)
	Vibration (operating):	1G peak, 5 to 2000 Hz
Control	Carrier Frequency	2-16 kHz. Drive rating based on 4 kHz.
	Frequency Accuracy Digital Input: Analog Input: Analog Output:	 Within ±0.05% of set output frequency. Within 0.5% of maximum output frequency, 10-Bit resolution ±2% of full scale, 10-Bit resolution
	Speed Regulation - Open Loop with Slip Compensation:	±1% of base speed across a 60:1 speed range.
	Stop Modes:	Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve.
	Accel/Decel:	Two independently programmable accel and decel times. Each time may be programmed from 0 - 600 seconds in 0.1 second increments.
	Intermittent Overload:	150% Overload capability for up to 1 minute 200% Overload capability for up to 3 seconds
	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.
Electrical	Voltage Tolerance:	100-120V ±10% 200-240V ±10% 380-480V ±10% 460-600V ±10%
	Frequency Tolerance:	48-63 Hz
	Input Phases:	Three-phase input provides full rating. Single-phase operation provides 35% rated current.
	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:	Insulated Gate Bipolar Transistor (IGBT)

PowerFlex 40 Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	kW (HP)	External Watts	Internal Watts	Total Watts Loss
100–120V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (1.5)	58	22	80
200–240V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (2.0)	63	22	85
	2.2 (3.0)	100	25	125
	3.7 (5.0)	150	30	180
	5.5 (7.5)	200	35	235
	7.5 (10)	265	40	305
380–480V	0.4 (0.5)	17	18	35
	0.75 (1.0)	30	20	50
	1.1 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	3.7 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300
460–600V	0.75 (1.0)	30	20	50
	1.5 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	4.0 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300

Notes:

Accessories and Dimensions

Product Selection

Table B.A Catalog Number Description

22B	-	A	1P5	N	1	1	4
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type

Table B.B PowerFlex 40 Drives

Drive Ratings				IP20, NEMA/UL Type Open		IP20 Flange Mount[1]	IP66, NEMA/UL Type 4X
Input Voltage	**kW**	**HP**	**Output Current**	**Catalog Number**	**Frame Size**	**Catalog Number**	**Catalog Number**
120V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-V2P3N104	B	22B-V2P3F104	22B-V2P3C104
	0.75	1.0	5.0A	22B-V5P0N104	B	22B-V5P0F104	22B-V5P0C104
	1.1	1.5	6.0A	22B-V6P0N104	B	22B-V6P0F104	22B-V6P0C104
240V 50/60 Hz 1-Phase With Integral “S Type” EMC Filter	0.4	0.5	2.3A	22B-A2P3N114	B	–	–
	0.75	1.0	5.0A	22B-A5P0N114	B	–	–
	1.5	2.0	8.0A	22B-A8P0N114	B	–	–
	2.2	3.0	12.0A	22B-A012N114	C	–	–
240V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-A2P3N104	B	22B-A2P3F104	22B-A2P3C104
	0.75	1.0	5.0A	22B-A5P0N104	B	22B-A5P0F104	22B-A5P0C104
	1.5	2.0	8.0A	22B-A8P0N104	B	22B-A8P0F104	22B-A8P0C104
	2.2	3.0	12.0A	22B-A012N104	C	22B-A012F104	–
240V 50/60 Hz 3-Phase No Filter	0.4	0.5	2.3A	22B-B2P3N104	B	22B-B2P3F104	22B-B2P3C104
	0.75	1.0	5.0A	22B-B5P0N104	B	22B-B5P0F104	22B-B5P0C104
	1.5	2.0	8.0A	22B-B8P0N104	B	22B-B8P0F104	22B-B8P0C104
	2.2	3.0	12.0A	22B-B012N104	B	22B-B012F104	22B-B012C104
	3.7	5.0	17.5A	22B-B017N104	B	22B-B017F104	22B-B017C104
	5.5	7.5	24.0A	22B-B024N104	C	22B-B024F104	–
	7.5	10.0	33.0A	22B-B033N104	C	22B-B033F104	–
480V 50/60 Hz 3-Phase No Filter	0.4	0.5	1.4A	22B-D1P4N104	B	22B-D1P4F104	22B-D1P4C104
	0.75	1.0	2.3A	22B-D2P3N104	B	22B-D2P3F104	22B-D2P3C104
	1.5	2.0	4.0A	22B-D4P0N104	B	22B-D4P0F104	22B-D4P0C104
	2.2	3.0	6.0A	22B-D6P0N104	B	22B-D6P0F104	22B-D6P0C104
	4.0	5.0	10.5A	22B-D010N104	B	22B-D010F104	22B-D010C104
	5.5	7.5	12.0A	22B-D012N104	C	22B-D012F104	–
	7.5	10.0	17.0A	22B-D017N104	C	22B-D017F104	–
	11.0	15.0	24.0A	22B-D024N104	C	22B-D024F104 [2]	–
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	1.7A	22B-E1P7N104	B	22B-E1P7F104	22B-E1P7C104
	1.5	2.0	3.0A	22B-E3P0N104	B	22B-E3P0F104	22B-E3P0C104
	2.2	3.0	4.2A	22B-E4P2N104	B	22B-E4P2F104	22B-E4P2C104
	4.0	5.0	6.6A	22B-E6P6N104	B	22B-E6P6F104	22B-E6P6C104
	5.5	7.5	9.9A	22B-E9P9N104	C	22B-E9P9F104	–
	7.5	10.0	12.0A	22B-E012N104	C	22B-E012F104	–
	11.0	15.0	19.0A	22B-E019N104	C	22B-E019F104	–

(1) Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

(2) Requires use of external DC Bus Inductor or AC Line Reactor. See Table B.E for details.

Table B.C Dynamic Brake Modules

Drive Ratings				
Input Voltage	**kW**	**HP**	**Minimum Resistance Ω**	**Catalog Number [1] [2]**
120V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.1	1.5	48	AK-R2-091P500
240V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
240V 50/60 Hz 3-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
	3.7	5.0	19	AK-R2-047P500
	5.5	7.5	13	AK-R2-030P1K2
	7.5	10.0	10	AK-R2-030P1K2
480V 50/60 Hz 3-Phase	0.4	0.5	97	AK-R2-360P500
	0.75	1.0	97	AK-R2-360P500
	1.5	2.0	97	AK-R2-360P500
	2.2	3.0	97	AK-R2-120P1K2
	4.0	5.0	77	AK-R2-120P1K2
	5.5	7.5	55	AK-R2-120P1K2
	7.5	10.0	39	AK-R2-120P1K2
	11.0	15.0	24	AK-R2-120P1K2 [3]
600V 50/60 Hz 3-Phase	0.75	1.0	120	AK-R2-360P500
	1.5	2.0	120	AK-R2-360P500
	2.2	3.0	82	AK-R2-120P1K2
	4.0	5.0	82	AK-R2-120P1K2
	5.5	7.5	51	AK-R2-120P1K2
	7.5	10.0	51	AK-R2-120P1K2
	11.0	15.0	51	AK-R2-120P1K2 [3]

(1) The resistors listed in this tables are rated for 5% duty cycle.

(2) Use of Rockwell 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. Refer to the P*owerFlex Dynamic Braking Resistor Calculator*, publication PFLEX-AT001.

(3) Requires two resistors wired in parallel.

Table B.D Bulletin 1321-3R Series Line Reactors

Input Voltage	kW	HP	Fundamental Amps	Maximum Continuous Amps	Inductance mh	Watts Loss	Catalog Number (1)
240V 50/60 Hz 3-Phase	0.4	0.5	4	6	12.0	21 W	1321-3R4-D
	0.75	1.0	8	12	3.0	29 W	1321-3R8-B
	1.5	2.0	8	12	1.5	19.5 W	1321-3R8-A
	2.2	3.0	12	18	1.25	26 W	1321-3R12-A
	3.7	5.0	18	27	0.8	36 W	1321-3R18-A
	5.5	7.5	25	37.5	0.5	48 W	1321-3R25-A
	7.5	10.0	35	52.5	0.4	49 W	1321-3R35-A
480V 50/60 Hz 3-Phase	0.4	0.5	2	3	20.0	11.3 W	1321-3R2-B
	0.75	1.0	4	6	9.0	20 W	1321-3R4-C
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	8	12	5.0	25.3 W	1321-3R8-C
	4.0	5.0	12	18	2.5	31 W	1321-3R12-B
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	18	27	1.5	43 W	1321-3R18-B
	11.0	15.0	25	37.5	1.2	52 W	1321-3R25-B
600V 50/60 Hz 3-Phase	0.75	1.0	2	3	20.0	11.3 W	1321-3R2-B
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	4	6	6.5	20 W	1321-3R4-B
	4.0	5.0	8	12	5.0	25.3 W	1321-3R8-C
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	12	18	2.5	31 W	1321-3R12-B
	11.0	15.0	18	27	1.5	43 W	1321-3R18-B

(1) Catalog numbers listed are for 3% impedance open style units. NEMA Type 1 and 5% impedance reactor types are also available. Refer to publication 1321-TD001….

Table B.E DC Bus Inductors

Input Voltage	kW	HP	Amps	Inductance mh	MTE Catalog Number (2)
240V 50/60 Hz 3-Phase	5.5	7.5	32	0.85	32RB001
	7.5	10.0	40	0.5	40RB001
480V 50/60 Hz 3-Phase	5.5	7.5	18	3.75	18RB004
	7.5	10.0	25	4.0	25RB005
	11.0	15.0	32	2.68	32RB003
600V 50/60 Hz 3-Phase	5.5	7.5	12	6.0	12RB004
	7.5	10.0	18	6.0	18RB005
	11.0	15.0	25	4.0	25RB005

(2) Use MTE RB Series or equivalent inductors.

Table B.F EMC Line Filters

Drive Ratings			S Type Filter Catalog Number [1]	L Type Filter Catalog Number [4]
Input Voltage	**kW**	**HP**		
120V 50/60 Hz 1-Phase	0.4	0.5	–	22-RF018-BL
	0.75	1.0	–	22-RF018-BL
	1.1	1.5	–	22-RF018-BL
240V 50/60 Hz 1-Phase	0.4	0.5	[2]	22-RF018-BL
	0.75	1.0	[2]	22-RF018-BL
	1.5	2.0	[2]	22-RF018-BL
	2.2	3.0	[2]	22-RF025-CL
240V 50/60 Hz 3-Phase	0.4	0.5	22-RF021-BS[3]	22-RF021-BL
	0.75	1.0	22-RF021-BS[3]	22-RF021-BL
	1.5	2.0	22-RF021-BS[3]	22-RF021-BL
	2.2	3.0	22-RF021-BS[3]	22-RF021-BL
	3.7	5.0	22-RF021-BS[3]	22-RF021-BL
	5.5	7.5	22-RF034-CS	22-RF034-CL
	7.5	10.0	22-RF034-CS	22-RF034-CL
480V 50/60 Hz 3-Phase	0.4	0.5	22-RF012-BS	22-RF012-BL
	0.75	1.0	22-RF012-BS	22-RF012-BL
	1.5	2.0	22-RF012-BS	22-RF012-BL
	2.2	3.0	22-RF012-BS	22-RF012-BL
	4.0	5.0	22-RF012-BS	22-RF012-BL
	5.5	7.5	22-RF018-CS	22-RF018-CL
	7.5	10.0	22-RF018-CS	22-RF018-CL
	11.0	15.0	22-RF026-CS	22-RF026-CL
600V 50/60 Hz 3-Phase	0.75	1.0	–	22-RF8P0-BL
	1.5	2.0	–	22-RF8P0-BL
	2.2	3.0	–	22-RF8P0-BL
	4.0	5.0	–	22-RF8P0-BL
	5.5	7.5	–	22-RF015-CL
	7.5	10.0	–	22-RF015-CL
	11.0	15.0	–	22-RF024-CL

(1) This filter is suitable for use with a cable length of at least 10 meters (33 feet) for Class A and 1 meter for Class B environments.

(2) These ratings can be ordered with internal “S Type” filters. Refer to the Catalog Number explanation on page P-4 and Table B.B for details.

(3) Filter must be Series B or later.

(4) This filter is suitable for use with a cable length of at least 100 meters for Class A and 5 meters for Class B environments.

Table B.G Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog Number
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 Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2
LCD Display, Remote Handheld	Digital speed control Full numeric keypad CopyCat capable IP30 (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, IP30 (NEMA Type 1)	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 Meter (3.3 Feet) 2.9 Meter (9.51 Feet)	22-HIM-H10 22-HIM-H30

Table B.H IP30/NEMA 1/UL Type 1 Kit

Item	Description	Drive Frame	Catalog Number
IP30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	B	22-JBAB
		C	22-JBAC
IP30/NEMA 1/UL Type 1 Kit for Communication Option	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes communication option conduit box with mounting screws and plastic top panel.	B	22-JBCB
		C	22-JBCC

Table B.I Communication Option Kits and Accessories

Item	Description	Catalog Number
Communication Adapters	Embedded communication options for use with the PowerFlex 4-Class drives. Requires a Communication Adapter Cover (IP20, NEMA/UL Type 1 only. Ordered Separately) BACnet® ControlNet™ DeviceNet™ EtherNet/IP™ LonWorks® PROFIBUS™ DP	 22-COMM-B 22-COMM-C 22-COMM-D 22-COMM-E 22-COMM-L 22-COMM-P
External DSI™ Communications Kit	External mounting kit for 22-COMM communication options	22-XCOMM-DC-BASE
External Comms Power Supply	Optional 100-240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1
Compact I/O Module	Three channel.	1769-SM2
Communication Adapter Cover	Cover that houses the DeviceNet Communication Adapter (IP20, NEMA/UL Type 1 only) B Frame Drive C Frame Drive	 22B-CCB 22B-CCC
Serial Converter Module (RS485 to RS232)	Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive software. Includes: DSI to RS232 serial converter (1) 1203-SFC serial cable (1) 22-RJ45CBL-C20 cable (1) DriveExplorer Lite CD (1)	22-SCM-232
DSI Cable	2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 meter 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
Null Cable Converter	For use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Splitter Cable	RJ45 one to two port splitter cable	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
DriveExplorer Software (CD-ROM) Version 3.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online. Compatibility: Windows 95, 98, ME, NT 4.0 (Service Pack 3 or later), 2000, XP and CE(1)	9306-4EXP01ENE
DriveExecutive software (CD-ROM) Version 1.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online and offline. Compatibility: Windows 98, ME, NT 4.0 (Service Pack 3 or later), 2000 and XP	9303-4DTE01ENE

(1) See www.ab.com/drives/driveexplorer.htm for supported devices.

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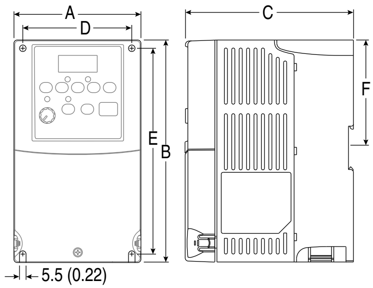
Product Dimensions

Table B.J PowerFlex 40 Frames – Ratings are in kW and (HP)

Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase		480V AC – 3-Phase		600V AC – 3-Phase	
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	2.2 (3.0) 3.7 (5.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	2.2 (3.0) 4.0 (5.0)	0.75 (1.0) 1.5 (2.0)	2.2 (3.0) 4.0 (5.0)
C(1)		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)		5.5 (7.5) 7.5 (10.0)	11.0 (15.0)	5.5 (7.5) 7.5 (10.0)	11.0 (15.0)

(1) IP66, NEMA/UL Type 4X rated drives are not availble in Frame C drive ratings.

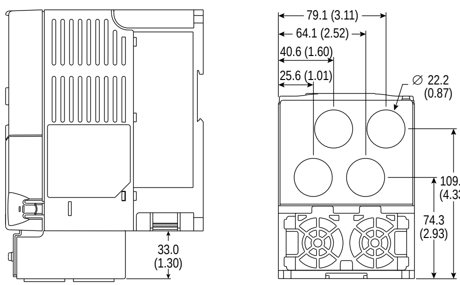
Figure B.1 IP20, NEMA/UL Type Open



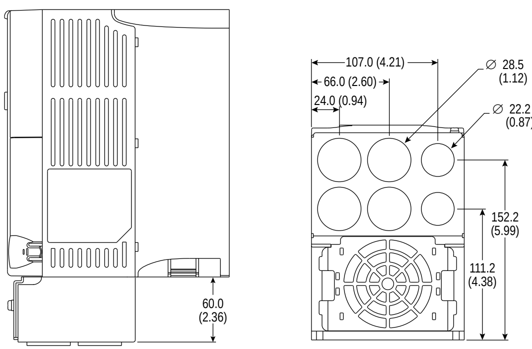
Dimensions are in millimeters and (inches).
Weights are in kilograms and (pounds).

Frame	A	B	C	D	E	F	Ship Weight
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	–	4.3 (9.5)

Figure B.2 IP30, NEMA/UL Type 1 Option Kit without Communication Option

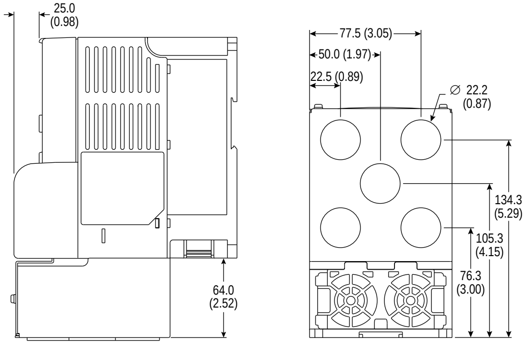


Frame B - 22-JBAB

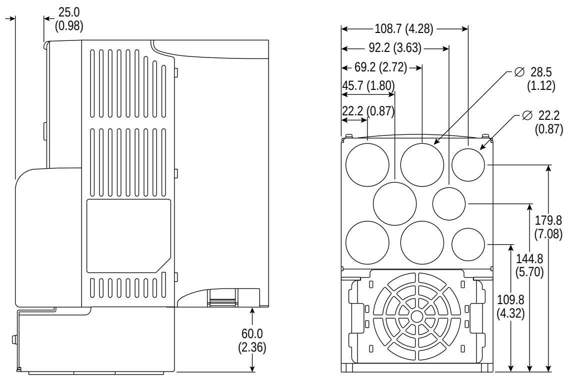


Frame C - 22-JBAC

Figure B.3 IP30, NEMA/UL Type 1 Option Kit with Communication Option – Dimensions are in millimeters and (inches)

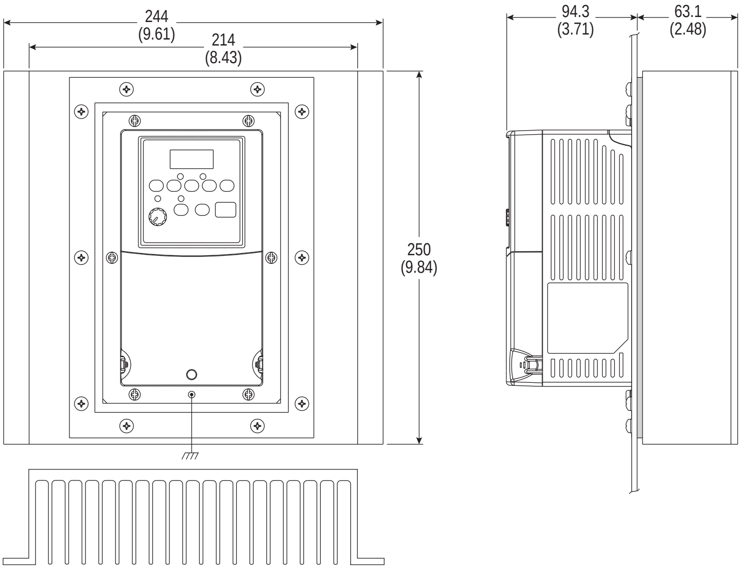


Frame B - 22-JBCB

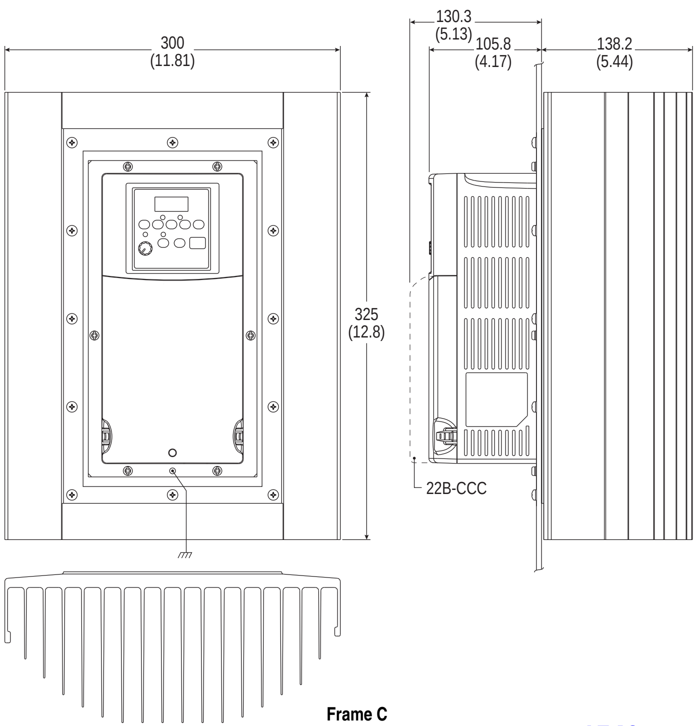


Frame C - 22-JBCC

Figure B.4 PowerFlex 40 Flange Mount Drives – Dimensions are in millimeters and (inches)

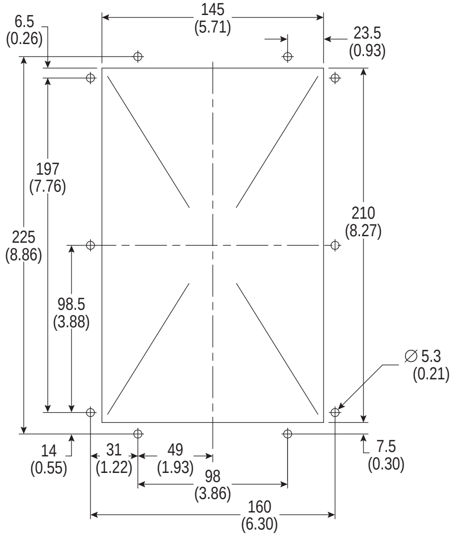


Frame B

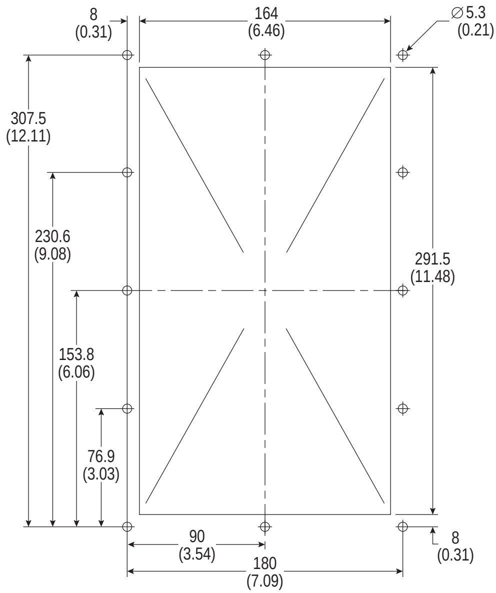


Frame C

Figure B.5 PowerFlex 40 Flange Mount Cutout Dimensions – Dimensions are in millimeters and (inches)



Frame B



Frame C

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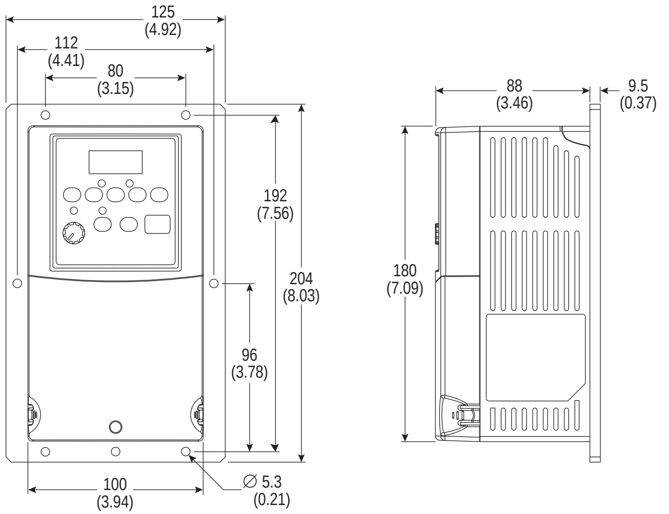
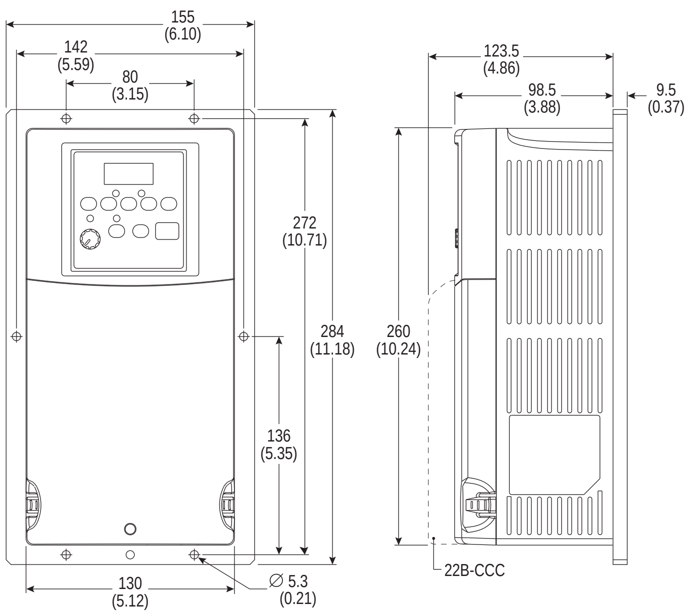
Figure B.6 PowerFlex 40 Replacement Plate Drive Dimensions – Dimensions are in millimeters and (inches)

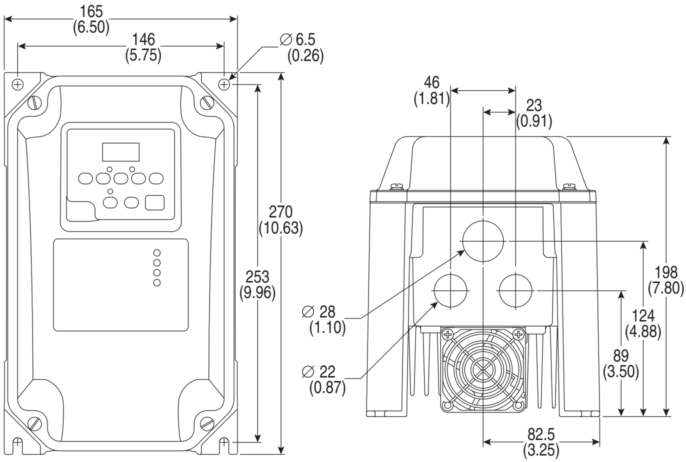


Frame B



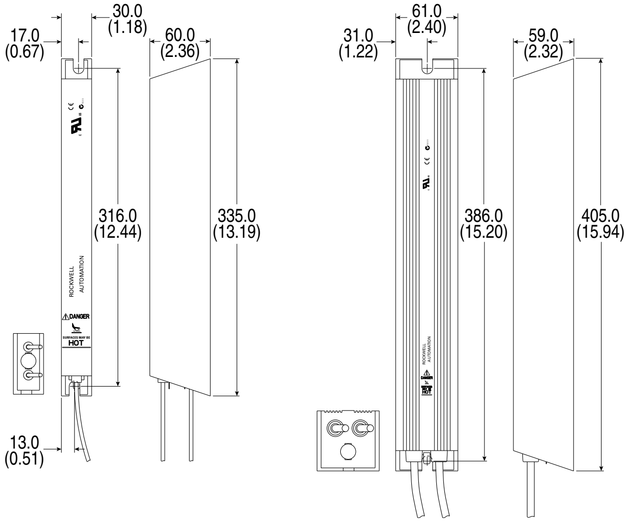
Frame C

Figure B.7 IP66, NEMA Type/UL Type 4X – Dimensions are in millimeters and (inches) Weights are in kilograms and (pounds).



Weight
5.2 (11.5)

Figure B.8 Dynamic Brake Modules – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Frame	Catalog Number	Weight
A	AK-R2-091P500, AK-R2-047P500, AK-R2-360P500	1.1 (2.5)
B	AK-R2-030P1K2, AK-R2-120P1K2	2.7 (6)

Figure B.9 Recommended External Brake Resistor Circuitry

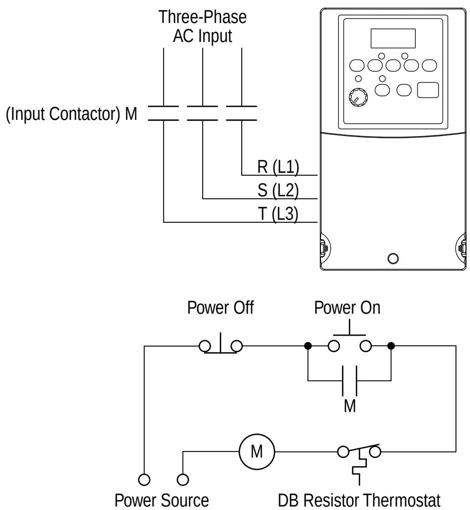
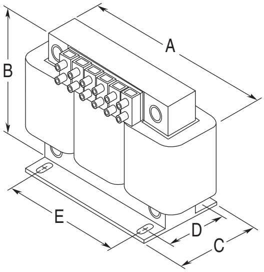


Figure B.10 Bulletin 1321-3R Series Line Reactors – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Catalog Number	A	B	C	D	E	Weight
1321-3R2-A	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R2-B	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-A	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-B	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-C	112 (4.40)	104 (4.10)	86 (3.38)	60 (2.35)	37 (1.44)	2.3 (5)
1321-3R4-D	112 (4.40)	104 (4.10)	92 (3.62)	66 (2.60)	37 (1.44)	2.7 (6)
1321-3R8-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.1 (7)
1321-3R8-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.6 (8)
1321-3R8-C	152 (6.00)	127 (5.00)	85 (3.35)	63 (2.48)	51 (2.00)	4.9 (11)
1321-3R12-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.1 (9)
1321-3R12-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.5 (10)
1321-3R18-A	152 (6.00)	133 (5.25)	79 (3.10)	54 (2.13)	51 (2.00)	4.1 (9)
1321-3R18-B	152 (6.00)	133 (5.25)	86 (3.40)	63 (2.48)	51 (2.00)	5.4 (12)
1321-3R25-A	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	4.9 (11)
1321-3R35-A	193 (7.60)	146 (5.76)	91 (3.60)	66 (2.60)	76 (3.00)	6.3 (14)

Figure B.11 Frame B EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF8P0-BL, 22-RF012-BS, -BL (Series B); 22-RF018-BS; 22-RF021-BS, -BL

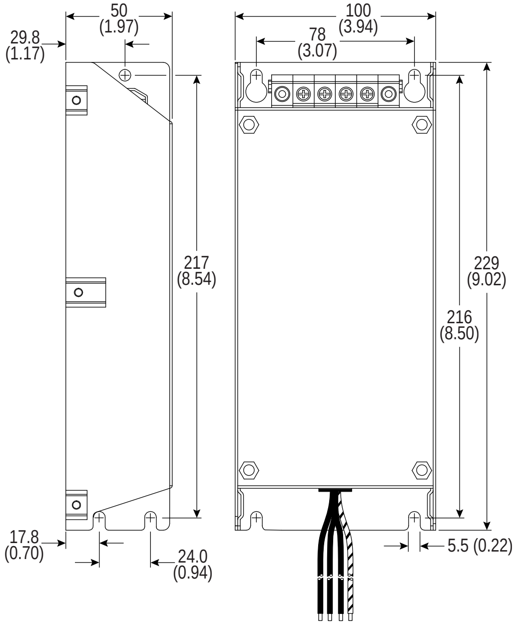


Figure B.12 Frame C EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF018-CS, -CL; 22-RF025-CL; 22-RF026-CS, -CL; 22-RF034-CS, -CL

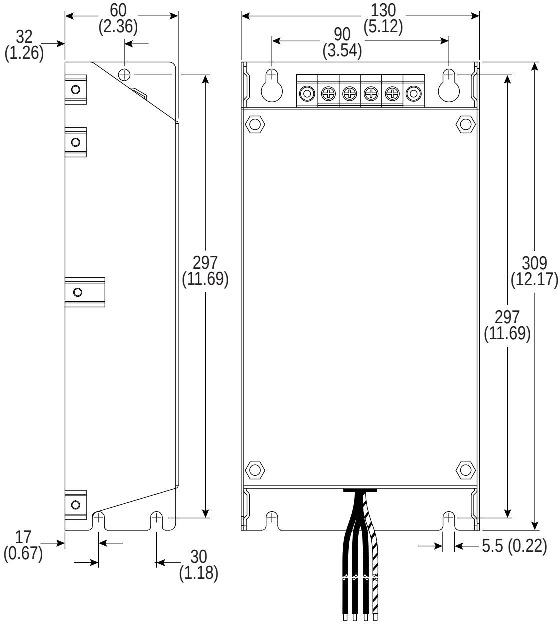


Figure B.13 Remote (Panel Mount) Small HIM – Dimensions are in millimeters and (inches) Catalog Number: 22-HIM-C2S

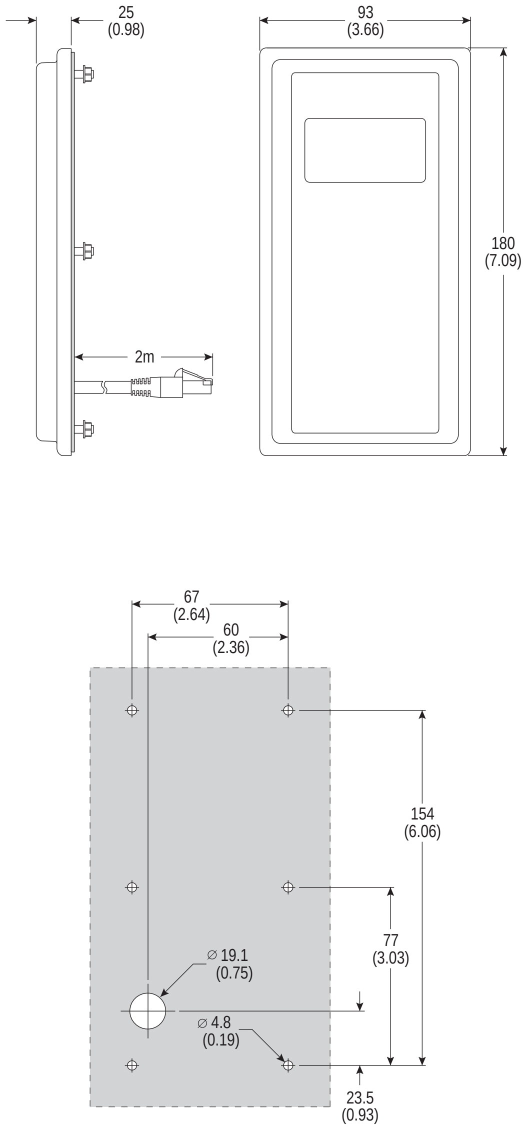
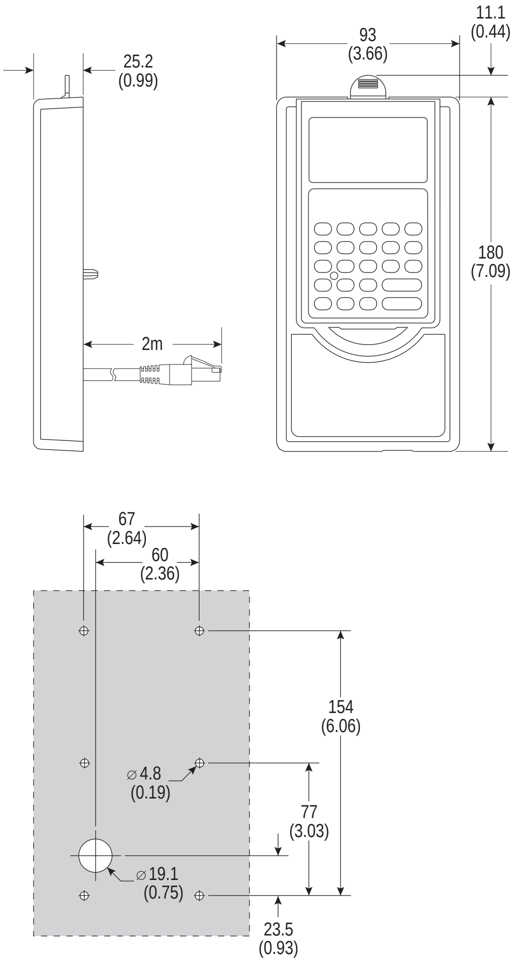
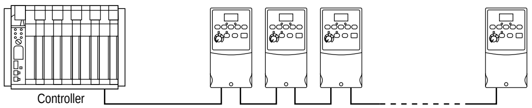


Figure B.14 NEMA Type 1 Bezel – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-B1



RS485 (DSI) Protocol

PowerFlex 40 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 40 drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

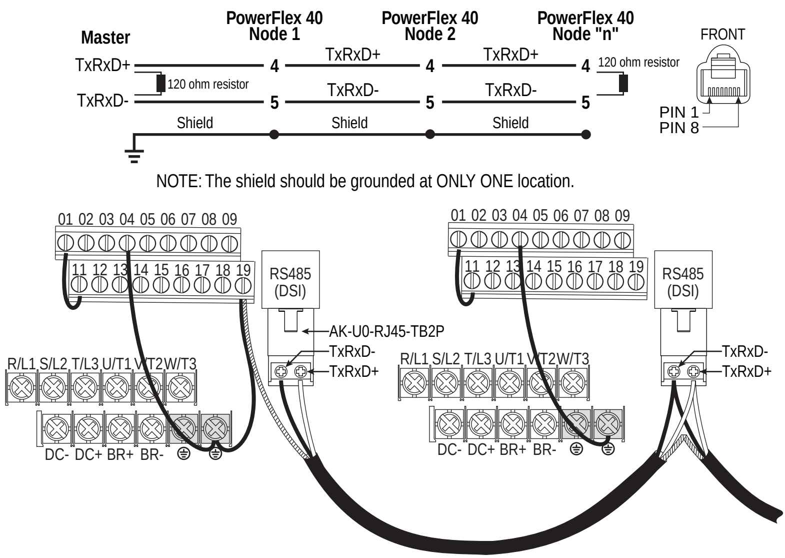


For information regarding DeviceNet or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

Figure C.1 Network Wiring Diagram



Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 40 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 19 on the PowerFlex 40 is connected to the metal shield around the RJ45 connector. It is recommended to ground this terminal (there are two PE terminals on the drive). See Table 1.H for more information.

Network Common is internally tied to I/O Terminal 04 (Digital Common). Tying I/O Terminal 04 to PE ground may improve noise immunity in some applications.

Parameter Configuration

The following PowerFlex 40 parameters are used to configure the drive to operate on a network.

Parameter	Details	Reference
P036 [Start Source]	Set to 5 “RS485 (DSI) Port” if Start is controlled from the network.	Page 3-10
P038 [Speed Reference]	Set to 5 “RS485 (DSI) Port” if the Speed Reference is controlled from the network.	Page 3-12
A103 [Comm 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 3-31
A104 [Comm Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	Page 3-31
A105 [Comm Loss Action]	Selects the drive’s response to communication problems.	Page 3-32
A106 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements A105 [Comm Loss Action].	Page 3-32
A107 [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 3-32

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 40 drives supports some of the 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 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8192 (Logic Command). P036 [Start Source] must be set to 5 “RS485 (DSI) Port” in order to accept the commands.

In addition to being written, register address 8192 can be read using Function Code 03.

Logic Command		
Address (Decimal)	**Bit(s)**	**Description**
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	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 1. Note: This bit controls the output when the value of parameter A058 is set to 20.
	7	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 2. Note: This bit controls the output when the value of parameter A061 is set to 20.
	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 = P038 [Speed Reference]
		010 = Freq. Source = A069 [Internal Freq]
		011 = Freq. Source = Comms (Addr 8193)
		100 = A070 [Preset Freq 0]
		101 = A071 [Preset Freq 1]
		110 = A072 [Preset Freq 2]
		111 = A073 [Preset Freq 3]
	15	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates C-form relay. Note: This bit controls the output when the value of parameter A055 is set to 20.

Writing (06) Reference

The Speed Reference to a PowerFlex 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8193 (Reference). P038 [Speed Reference] must be set to 5 "RS485 (DSI) Port" in order to accept the Speed Reference.

In addition to being written, register address 8193 can be read using Function Code 03.

Reference	
Address (Decimal)	**Description**
8193	A decimal value entered as xxx.x where the decimal point is fixed. For example, a decimal "100" equals 10.0 Hz and "543" equals 54.3 Hz.

Reading (03) Logic Status Data

The PowerFlex 40 Logic Status data can be read via the network by sending Function Code 03 reads to register address 8448 (Logic Status).

Logic Status		
Address (Decimal)	**Bit(s)**	**Description**
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 = Alarm, 0 = No Alarm
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Reference Controlled by Comm
	10	1 = Operation Cmd Controlled by Comm
	11	1 = Parameters have been locked
	12	Digital Input 1 Status
	13	Digital Input 2 Status
	14	Digital Input 3 Status[1]
	15	Digital Input 4 Status[1]

[1] This status is available only with firmware revision FRN 2.xx and higher.

Reading (03) Feedback

The Feedback (Output Frequency) from the PowerFlex 40 drive can be read via the network by sending Function Code 03 reads to register address 8451 (Feedback).

Feedback[2]	
Address (Decimal)	**Description**
8451	A xxx.x decimal value where the decimal point is fixed. For example, a decimal "123" equals 12.3 Hz and "300" equals 30.0 Hz.

(2) Returns the same data as Reading (03) Parameter d001 [Output Freq].

Reading (03) Drive Error Codes

The PowerFlex 40 Error Code data can be read via the network by sending Function Code 03 reads to register address 8449 (Drive Error Codes).

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
8449	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	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
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	80	AutoTune Fail
	81	Communication Loss
	100	Parameter Checksum Error
	122	I/O Board Fail

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 d001 [Output Freq] and decimal "39" is used to address Parameter P039 [Accel Time 1].

Additional Information

Refer to **http://www.ab.com/drives/** for additional information.

Notes:

RJ45 DSI Splitter Cable

The PowerFlex 40 drive provides a RJ45 port to allow the connection of a single peripheral device. The RJ45 DSI Splitter Cable can be used to connect a second DSI peripheral device to the drive.

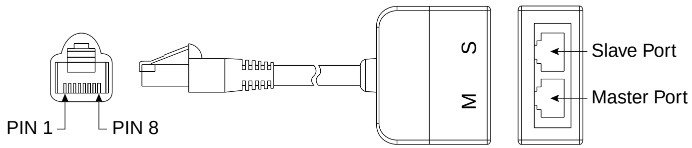
Connectivity Guidelines

ATTENTION: Risk of injury or equipment damage exists. The peripherals may not perform as intended if these Connectivity Guidelines are not followed. Precautions should be taken to follow these Connectivity Guidelines.

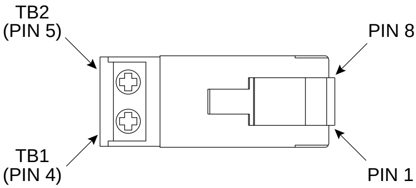
- Two peripherals maximum can be attached to a drive.
- If a single peripheral is used, it must be connected to the Master port (M) on the splitter and configured for "Auto" (default) or "Master." Parameter 9 [Device Type] on the DSI / MDI keypads and Parameter 1 [Adapter Cfg] on the Serial Converter are used to select the type (Auto / Master / Slave).
- **Do not use the RJ45 Splitter Cable with a drive that has an internal network communication adapter installed.** Since only one additional peripheral can be added, the second peripheral can be connected directly to the RJ45 port on the drive. The internal Comm is always the Master, therefore the external peripheral must be configured as "Auto" (for temporary connections) or "Slave" (for permanent connections).
- If two peripherals will be powered up at the same time, one must be configured as the "Master" and connected to the Master port (M) and the other must be connected as the "Slave" and connected to the Slave port (S).

DSI Cable Accessories

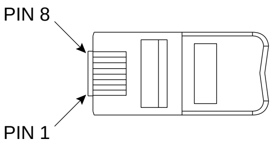
RJ45 Splitter Cable – Catalog Number: AK-U0-RJ45-SC1



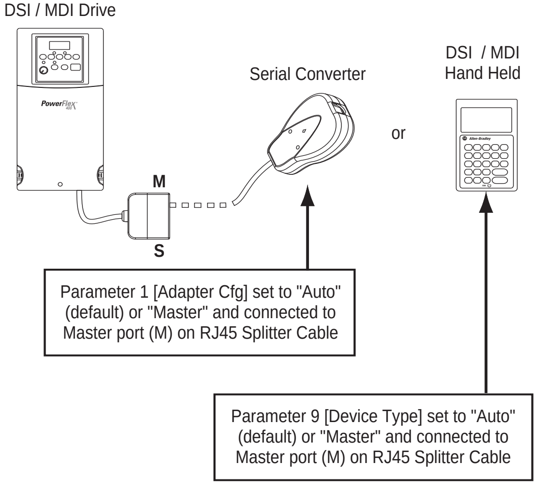
RJ45 Two-Position Terminal Block Adapter –
Catalog Number: AK-U0-RJ45-TB2P



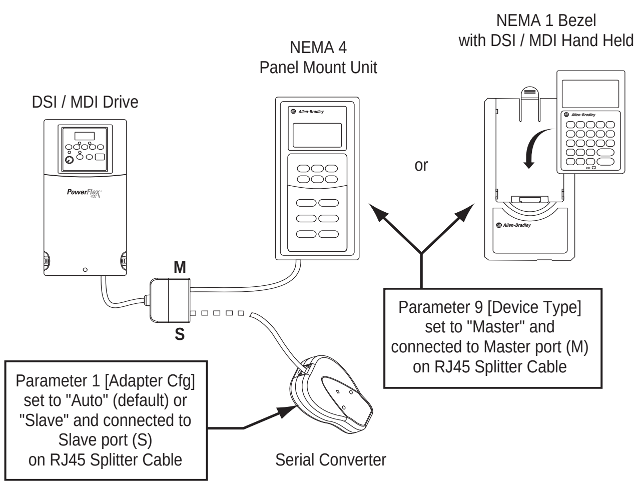
RJ45 Adapter with Integrated Termination Resistor –
Catalog Number: AK-U0-RJ45-TR1



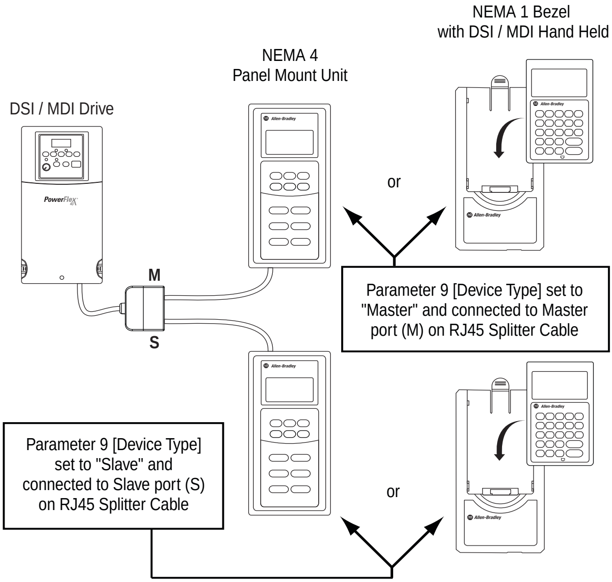
Connecting One Temporary Peripheral



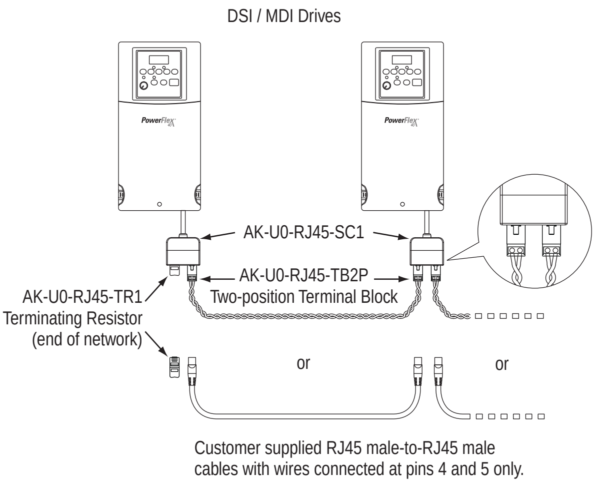
Connecting One Temporary Peripheral and One Permanent Peripheral



Connecting Two Permanent Peripherals



Connecting an RS-485 Network



Both the Master (M) and Slave (S) ports on the RJ45 Splitter Cable operate as standard RS-485 ports in this configuration.

StepLogic™, Basic Logic and Timer/Counter Functions

Four PowerFlex 40 logic functions provide the capability to program simple logic functions without a separate controller.

- StepLogic Function

  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 In1" and "Logic In2" 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

  Up to two digital inputs can be programmed as "Logic In1" and/or "Logic In2". 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 via 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 via a digital input programmed as "Reset Counter".

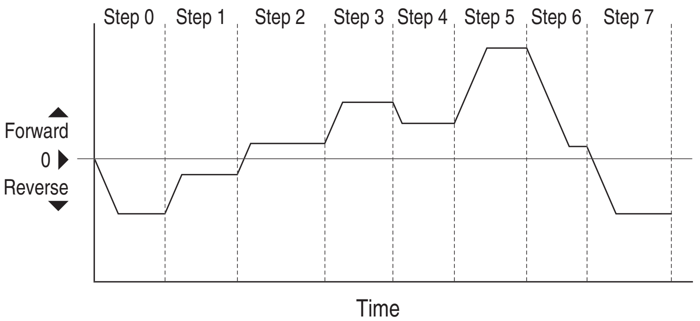
StepLogic Using Timed Steps

To activate this function, set parameter P038 [Speed Reference] to 6 “Stp Logic”. Three parameters are used to configure the logic, speed reference and time for each step.

- Logic is defined using parameters A140-A147 [Stp Logic x].
- Preset Speeds are set with parameters A070-A077 [Preset Freq x].
- Time of operation for each step is set with parameters A150-A157 [Stp Logic Time x].

The direction of motor rotation can be forward or reverse.

Figure E.1 Using Timed Steps



StepLogic Sequence

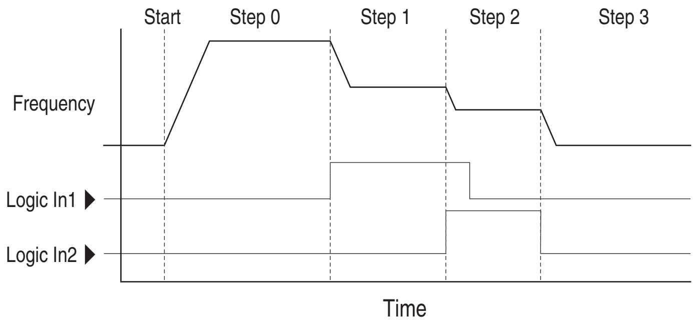
- Sequence begins with a valid start command.
- A normal sequence begins with Step 0 and transition to the next step when the corresponding StepLogic time has expired.
- Step 7 is followed by Step 0
- Sequence repeats until a stop is issued or a fault condition occurs.

StepLogic Using Basic Logic Functions

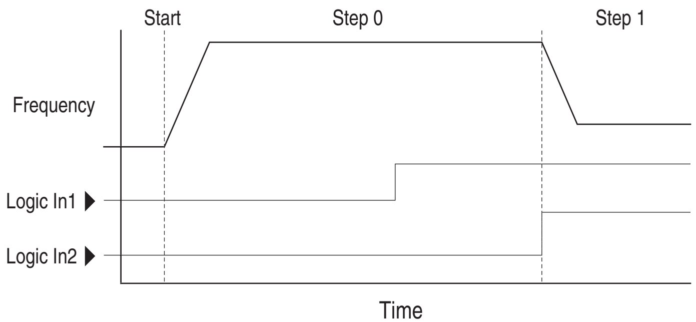
Digital input and digital output parameters can be configured to use logic to transition to the next step. Logic In1 and Logic In2 are defined by programming parameters A051-A054 [Digital Inx Sel] to option 23 “Logic In1” or option 24 “Logic In2”.

Example

- Run at Step 0.
- Transition to Step 1 when Logic In1 is true.
  Logic senses the edge of Logic In1 when it transitions from off to on. Logic In1 is not required to remain “on”.
- Transition to Step 2 when both Logic In1 and Logic In2 are true.
  The drive senses the level of both Logic In1 and Logic In2 and transitions to Step 2 when both are on.
- Transition to Step 3 when Logic In2 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

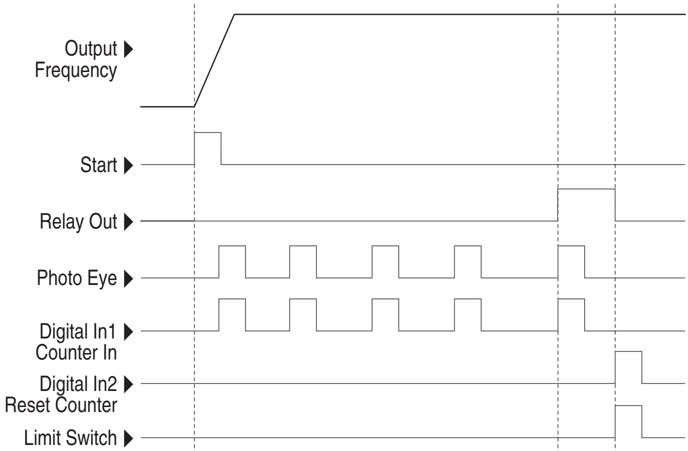
Digital inputs and outputs control the timer function and are configured with parameters A051-A054 [Digital Inx Sel] set to 18 “Timer Start” and 20 “Reset Timer”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired time in seconds.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to option 16 “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 30Hz has been maintained for 20 seconds, a 4-20mA 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:
  - P038 [Speed Reference] = 3 “4-20mA Input”
  - A051 [Digital In1 Sel] = 4 “Preset Freq”
  - A052 [Digital In2 Sel] = 18 “Timer Start”
  - A055 [Relay Out Sel] = 16 “Timer Out”
  - A056 [Relay Out Level] = 20.0 Secs
  - A071 [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 05 (Digital Input 1) 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 A051-A054 [Digital Inx Sel] set to 19 "Counter In" and 21 "Reset Counter".

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired count value.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to 17 "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:
  - A051 [Digital In1 Sel] set to 19 to select "Counter In"
  - A052 [Digital In2 Sel] set to 21 to select "Reset Counter"
  - A055 [Relay Out Sel] set to 17 to select "Counter Out"
  - A056 [Relay Out Level] set to 5.0 (counts)

StepLogic Parameters

Table E.A Code Descriptions for Parameters A140-A147

Digit 3	Digit 2	Digit 1	Digit 0
0	0	F	1

Table E.B Digit 3 – Defines the action during the step currently executing.

Setting	Accel/Decel Parameters 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

Table E.C Digit 2 – Defines what step to jump to or how to end program when the logic conditions specified in Digit 1 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 (F2)

Table E.D Digit 1 – 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 In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Do not step OR no “jump to”, so use Digit 0 logic	IGNORE

Table E.E Digit 0 – 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 In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Use logic programmed in Digit 1	IGNORE

PID Set Up

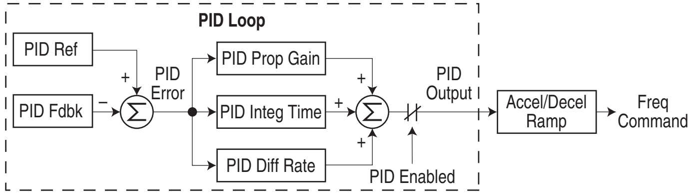
PID Loop

The PowerFlex 40 has a built-in PID (proportional, integral, differential) control loop. 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, parameter A132 [PID Ref Sel] must be set to an option other than 0 “PID Disabled”.

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

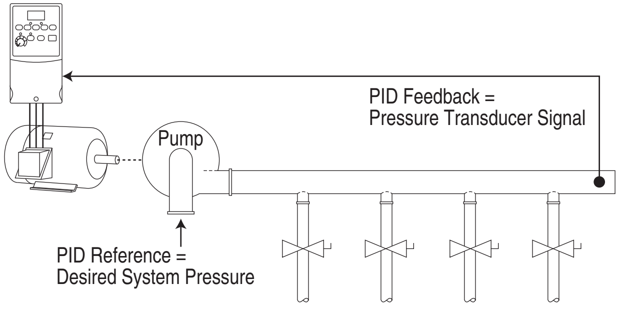
Exclusive Control

In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A132 [PID Ref Sel] is set to option 1, 2, 3 or 4. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



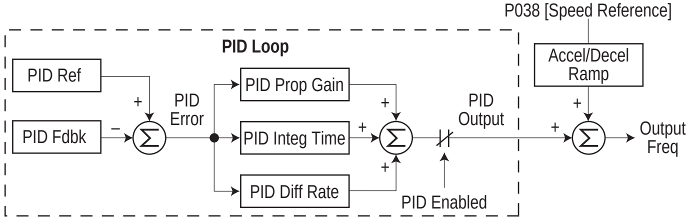
Example

- 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.



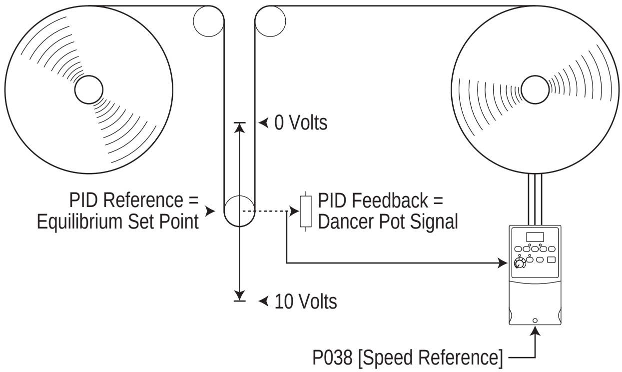
Trim Control

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 A132 [PID Ref Sel] is set to option 5, 6, 7 or 8.



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

Parameter A132 [PID Ref Sel] is used to enable the PID mode (A132 ¦ 0 “PID Disabled”) and to select the source of the PID Reference. If A132 [PID Ref Sel] is not set to 0 “PID Disabled”, PID can still be disabled by select programmable digital input options (parameters A051-A054) such as “Jog”, “Local” or “PID Disable”.

Table F.A A132 [PID Ref Sel] Options

Option	Description
0 “PID Disabled”	Disables the PID loop (default setting)
1 “PID Setpoint“	Selects Exclusive Control. A137 [PID Setpoint] will be used to set the value of the PID Reference
2 “0-10V Input”	Selects Exclusive Control. 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.
3 “4-20mA Input”	Selects Exclusive Control. Selects the 4-20mA Input.
4 “Comm Port”	Selects Exclusive Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.
5 “Setpnt, Trim”	Selects Trim Control. A137 [PID Setpoint] will be used to set the value of the PID Reference.
6 “0-10V, Trim”	Selects Trim Control. 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.
7 “4-20mA, Trim”	Selects Trim Control. Selects the 4-20mA Input.
8 “Comm, Trim”	Selects Trim Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.

A133 [PID Feedback Sel] is used to select the source of the PID feedback.

Table F.B A133 [PID Feedback Sel] Options

Option	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 4-20mA Input.
2 “Comm Port”	The reference word from a communication network (see Appendix C of the PowerFlex 40 User Manual for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Feedback. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% Feedback. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% Feedback.

Analog PID Reference Signals

Parameters A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] are used to scale or invert an analog PID Reference.

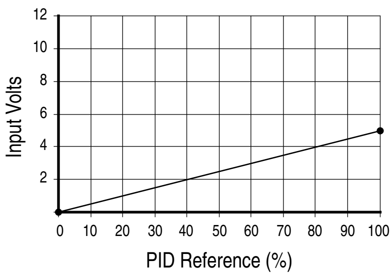
Important: Firmware version FRN 2.xx also allows PID Feedback scaling from an analog input.

Examples

Scale Function

For a 0-5 volt signal, the following parameter settings are used so that a 0 volt signal = 0% PID Reference and a 5 volt signal = 100% PID Reference.

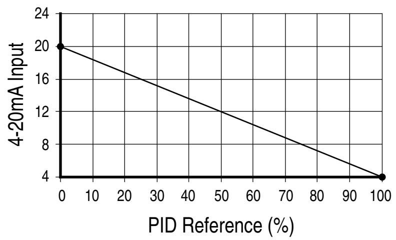
- A110 [Anlg In 0-10V Lo] = 0.0%
- A111 [Anlg In 0-10V Hi] = 50.0%
- A132 [PID Ref Sel] = 0 “0-10V Input”



Invert Function

For a 4-20mA signal, the following parameter settings are used so that a 20mA signal = 0% PID Reference and a 4mA signal = 100% PID Reference.

- A112 [Anlg In 4-20mA Lo] = 100.0%
- A113 [Anlg In 4-20mA Hi] = 0.0%
- A132 [PID Ref Sel] = 3 “4-20mA Input”



Alternatively, you can set the value of A167 [PID Invert Error] to 1 to change the sign of the PID error. See A167 [PID Invert Error] in Chapter 3 for more details.

PID Deadband

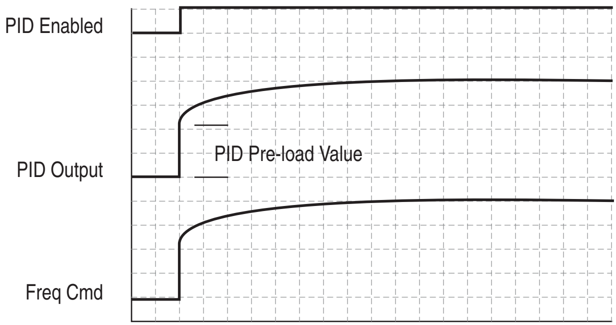
Parameter A138 [PID Deadband] is used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- [PID Deadband] is set to 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 A139 [PID Preload], in Hertz, 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 Pre-load Value > 0

PID Limits

A130 [PID Trim Hi] and A131 [PID Trim Lo] are used to limit the PID output and are only used in trim mode. [PID Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID 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.

- A134 [PID 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 Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID Prop Gain] to 0.00 disables the proportional component of the PID loop.
- A135 [PID 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 Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID Integ Time] to 0 disables the integral component of the PID loop.
- A136 [PID 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 [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID 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 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 A134 [PID Prop Gain].

– If the response is too quick and/or unstable (see Figure F.1), decrease A134 [PID Prop Gain].

– Typically, A134 [PID 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 Figure F.2), or the PID Feedback does not become equal to the PID Reference, decrease A135 [PID Integ Time].

– If there is a lot of oscillation in the PID Feedback before settling out (see Figure F.3), increase A135 [PID Integ Time].

3. At this point, the differential gain may not be needed. However, if after determining the values for A134 [PID Prop Gain] and A135 [PID Integ Time]:

– Response is still slow after a step change, increase A136 [PID Diff Rate].

– Response is still unstable, decrease A136 [PID Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

Figure F.1 Unstable

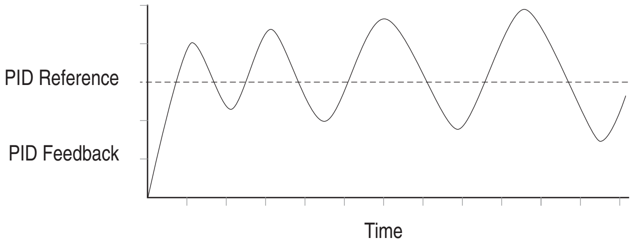


Figure F.2 Slow Response – Over Damped

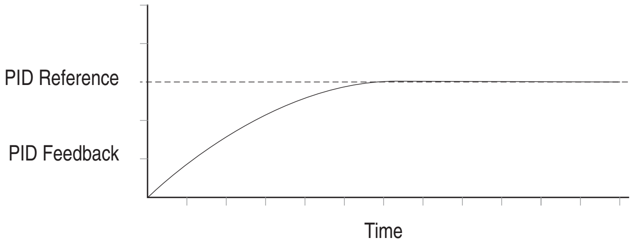


Figure F.3 Oscillation – Under Damped

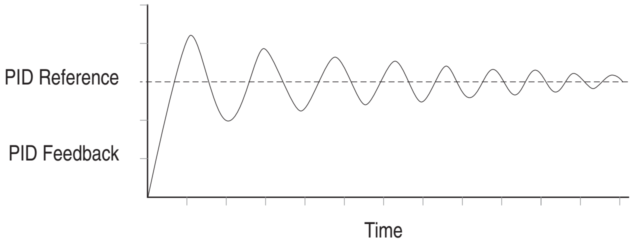
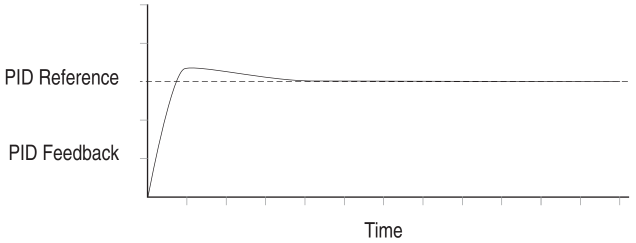


Figure F.4 Good Response – Critically Damped



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PowerFlex 400 Adjustable Frequency AC Drive

FRN 4.xx

This Quick Start guide summarizes the basic steps needed to install, start-up and program the PowerFlex 400 Adjustable Frequency AC Drive. **The information provided Does Not replace the User Manual and is intended for qualified drive service personnel only.**
For detailed PowerFlex 400 information including EMC instructions, application considerations and related precautions refer to the PowerFlex 400 *User Manual*, Publication 22C-UM001… supplied with the drive or at **www.rockwellautomation.com/literature.**

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.

A darkened LCD display and 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 A187).

Mounting Considerations

- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)
D	M8 (5/16 in.)	6.0-7.4 N-m (53.2-65.0 lb.-in.)
E	M8 (5/16 in.)	8.8-10.8 N-m (78.0-95.3 lb.-in.)
F	M10 (3/8 in.)	19.6-23.5 N-m (173.6-208.3 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.

Maximum Surrounding Air Temperature

Frame	Enclosure Rating	Temperature Range	Minimum Mounting Clearances
C	IP 20/UL Open-Type	-10° to 45°C (14° to 113°F)	Figure 1: Option A
	IP 30/NEMA 1/UL Type 1[1]	-10° to 45°C (14° to 113°F)	Figure 1: Option B
	IP 20/UL Open-Type	-10° to 50°C (14° to 122°F)	Figure 1: Option B
D, E, F	IP 30/NEMA 1/UL Type 1	-10° to 45°C (14° to 113°F)	Figure 2:

(1) Frame C drives require installation of the PowerFlex 400 IP 30/NEMA 1/UL Type 1 option kit to achieve this rating.

Minimum Mounting Clearances

Figure 1: Frame C Mounting Clearances

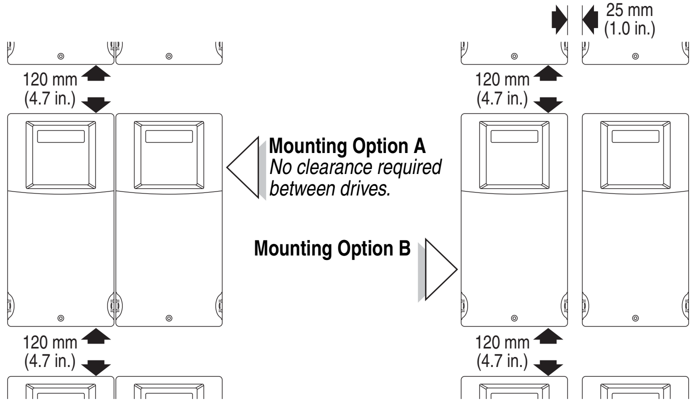
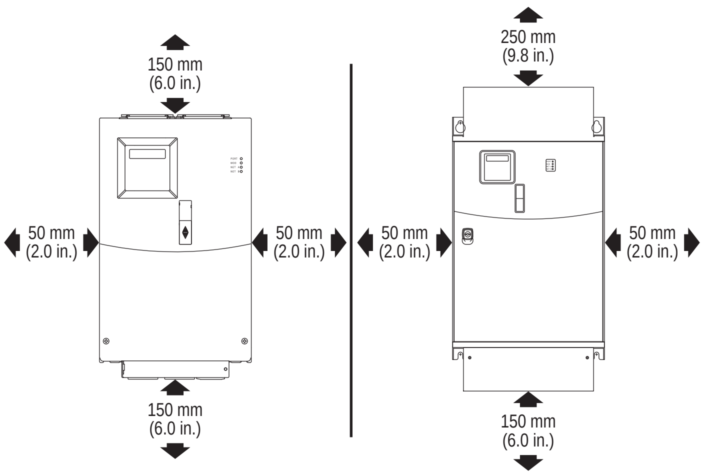
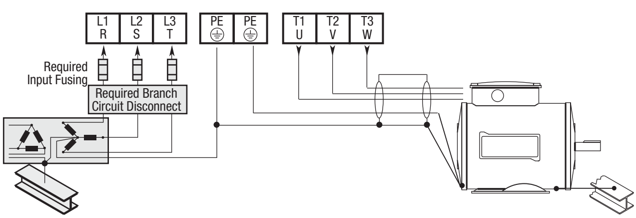


Figure 2: Frames D, E and F Mounting Clearances



General Grounding Requirements



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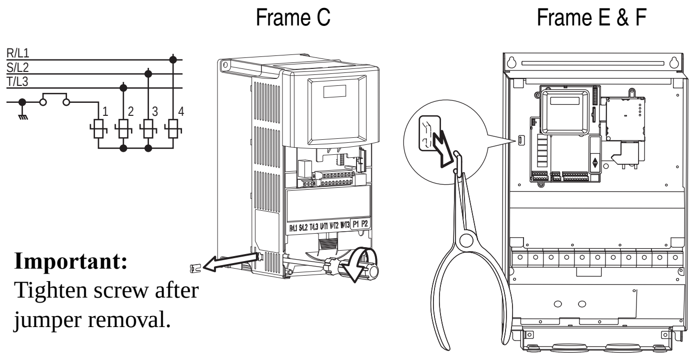
Ungrounded Distribution Systems

ATTENTION: PowerFlex 400 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.

Phase to Ground MOV Removal



Note: Frame D drives do not contain a MOV to ground connection and are suitable for operation in both grounded and ungrounded distribution systems without modification.

CE Conformity

Refer to the PowerFlex 400 *User Manual* supplied with the drive for details on how to comply with the Low Voltage (LV) and Electromagnetic Compatibility (EMC) Directives.

EMC Line Filters

240V 50/60 Hz 3-Phase		
kW	**HP**	**Catalog Number**
2.2	3.0	22-RF034-CS
4.0	5.0	22-RF034-CS
5.5	7.5	22-RF034-CS
7.5	10	22-RF034-CS
11	15	22-RFD070
15	20	22-RFD100
18.5	25	22-RFD100
22	30	22-RFD150
30	40	22-RFD150
37	50	22-RFD180

480V 50/60 Hz 3-Phase		
kW	**HP**	**Catalog Number**
2.2	3.0	22-RF018-CS
4.0	5.0	22-RF018-CS
5.5	7.5	22-RF018-CS
7.5	10	22-RF018-CS
11	15	22-RF026-CS
15	20	22-RFD036
18.5	25	22-RFD050
22	30	22-RFD050
30	40	22-RFD070
37	50	22-RFD100
45	60	22-RFD100
55	75	22-RFD150
75	100	22-RFD180
90	125	Consult Factory
110	150	Consult Factory

Specifications, Fuses and Circuit Breakers

Drive Ratings

Catalog Number	Output Ratings		Input Ratings			Branch Circuit Protection				Power Dissipation
	kW (HP)	*Amps 50°C*	*Voltage Range*	*kVA*	*Amps*	*Fuses* (1)	*140M Motor Protectors* (2) (3)	*Contactors*	*Min. Enclosure Volume*(4) *(in.^{3})*	*IP20 Open Watts*
200 - 240V AC – 3-Phase Input, 0 - 230V 3-Phase Output										
22C-B012N103	2.2 (3.0)	12	180-265	6.5	15.5	20	140M-F8E-C16	100-C23	5098	146
22C-B017N103	3.7 (5.0)	17.5	180-265	8.8	21	30	140M-F8E-C25	100-C37	5098	207
22C-B024N103	5.5 (7.5)	24	180-265	10.9	26.1	35	140M-F8E-C32	100-C37	5098	266
22C-B033N103	7.5 (10)	33	180-265	14.4	34.6	45	140M-F8E-C45	100-C45	5098	359
22C-B049A103	11 (15)	49	180-265	21.3	51	70	–	100-C60	–	488
22C-B065A103	15 (20)	65	180-265	28.3	68	90	–	100-C85	–	650
22C-B075A103	18.5 (25)	75	180-265	32.5	78	100	–	100-D95	–	734
22C-B090A103	22 (30)	81	180-265	38.3	92	125	–	100-D110	–	778
22C-B120A103	30 (40)	120	180-265	51.6	124	175	–	100-D180	–	1055
22C-B145A103	37 (50)	130	180-265	62.4	150	200	–	100-D180	–	1200
380 - 480V AC – 3-Phase Input, 0 - 460V 3-Phase Output										
22C-D6P0N103	2.2 (3.0)	6	340-528	6.3	7.5	10	140M-D8E-C10	100-C09	5098	105
22C-D010N103	4.0 (5.0)	10.5	340-528	10.9	13	20	140M-D8E-C16	100-C16	5098	171
22C-D012N103	5.5 (7.5)	12	340-528	11.9	14.2	20	140M-D8E-C16	100-C23	5098	200
22C-D017N103	7.5 (10)	17	340-528	15.3	18.4	25	140M-D8E-C20	100-C23	5098	267
22C-D022N103	11 (15)	22	340-528	19.2	23	30	140M-F8E-C32	100-C30	5098	329
22C-D030N103	15 (20)	27	340-528	25.8	31	40	140M-F8E-C32	100-C37	5098	435
22C-D038A103	18.5 (25)	38	340-528	33.3	40	50	140M-F8E-C45	100-C60	9086	606
22C-D045A103	22 (30)	45.5	340-528	39.1	47	60	–	100-C60	–	738
22C-D060A103	30 (40)	54	340-528	53.3	64	80	–	100-C85	–	664
22C-D072A103	37 (50)	72	340-528	60.7	73	100	–	100-C85	–	1019
22C-D088A103	45 (60)	88	340-528	74.9	90	125	–	100-D110	–	1245
22C-D105A103	55 (75)	105	340-528	89	107	150	–	100-D140	–	1487
22C-D142A103	75 (100)	128	340-528	124.8	150	200	–	100-D180	–	2043
22C-D170A103	90 (125)	170	340-528	142	170	250	–	100-D250	–	2617
22C-D208A103	110 (150)	208	340-528	167	200	250	–	100-D250	–	3601

(1) Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

(2) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

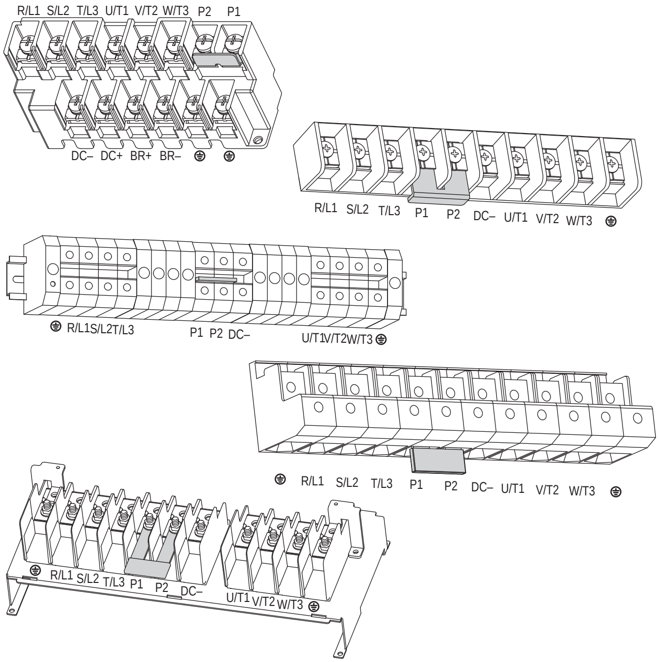
(3) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

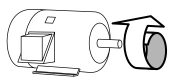
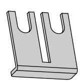
(4) When using a Manual Self-Protected (Type E) Combination Motor Controller, the drive must be installed in a ventilated or non-ventilated enclosure with the minimum volume specified in this column. Application specific thermal considerations may require a larger enclosure.

Category	Specification		
Agency Certification	cULus		Listed to UL508C and CAN/CSA-22.2 Listed to UL508C for plenums
	C-Tick		Certified to AS/NZS, 1997 Group 1, Class A
	CE		Marked for all applicable European Directives EMC Directive (89/336) EN 61800-3, EN 50081-1, EN 50082-2 Low Voltage Directive (73/23/EEC) EN 50178, EN 60204
	The drive is also designed to meet the appropriate portions of the following specifications: NFPA 70 - US National Electrical Code NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems. IEC 146 - International Electrical Code.		
Protection	Bus Overvoltage Trip:		200-240V AC Input: 405V DC bus voltage (equivalent to 290V AC incoming line) 380-460V AC Input: 810V DC bus voltage (equivalent to 575V AC incoming line)
	Bus Undervoltage Trip:		200-240V AC Input: 210V DC bus voltage (equivalent to 150V AC incoming line) 380-480V AC Input: 390V DC bus voltage (equivalent to 275V AC incoming line)
	Power Ride-Thru:		100 milliseconds
	Logic Control Ride-Thru:		0.5 seconds minimum, 2 seconds 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:		180% hardware limit, 220% instantaneous fault
	Ground Fault Trip:		Phase-to-ground on drive output
	Short Circuit Trip:		Phase-to-phase on drive output
Electrical	Efficiency:		97.5% at rated amps, nominal line voltage
Control	Output Frequency:		0-320 Hz (programmable)
Control Inputs	Digital:	Quantity:	(3) Semi-programmable (4) Programmable
		Type Source Mode (SRC): Sink Mode (SNK):	 18-24V = ON, 0-6V = OFF 0-6V = ON, 18-24V = OFF
	Analog:	Quantity:	(1) Isolated, –10 to 10V or 4-20mA (1) Non-isolated, 0 to 10V or 4-20mA
		Specification Resolution: 0 to 10V DC Analog: 4-20mA Analog: External Pot:	 10-bit 100k ohm input impedance 250 ohm input impedance 1-10k ohm, 2 Watt minimum
Control Outputs	Relay:	Quantity:	(2) Programmable Form C
		Specification Resistive Rating: Inductive Rating:	 3.0A at 30V DC, 3.0A at 125V, 3.0A at 240V AC 0.5A at 30V DC, 0.5A at 125V, 0.5A at 240V AC
	Optional Relay Card:	Quantity:	(6) Optional Programmable Form A (Drive Frames D, E & F Only)
		Specification Resistive Rating: Inductive Rating:	 0.1A at 30V DC Class II circuits, 3.0A at 125V, 3.0A at 240V AC 0.1A at 30V DC Class II circuits, 3.0A at 125V 3.0A at 240V AC
	Opto:	Quantity:	(1) Programmable
		Specification:	30V DC, 50mA Non-inductive
	Analog:	Quantity:	(2) Non-Isolated, 0-10V or 4-20mA
		Specification Resolution: 0 to 10V DC Analog: 4-20mA Analog:	 10-bit 1k ohm minimum 525 ohm maximum

Power Wiring

Figure 3: Power Terminal Blocks



Terminal [1]	Description
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1 =  Switch any two motor leads to change forward direction.
V/T2	To Motor V/T2
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection Drives are shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected. 
DC–, DC+	DC Bus Connection (Frame C Drives)
P2, DC–	DC Bus Connection (Frame D, E, and F Drives)
BR+, BR–	Not Used
⏚	Safety Ground - PE

(1) **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 Specifications

Frame	Maximum Wire Size[1]	Minimum Wire Size[1]	Recommended Torque
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9 N-m (26 lb.-in.)
D	33.6 mm^2 (2 AWG)	8.4 mm^2 (8 AWG)	5.1 N-m (45 lb.-in.)
E 480V 37-45 kW (50-60 HP)	33.6 mm^2 (2 AWG)	3.5 mm^2 (12 AWG)	5.6 N-m (49.5 lb.-in.)
E 240V 30-37 kW (40-50 HP) 480V 55-75 kW (75-100 HP)	107.2 mm^2 (4/0 AWG)	53.5 mm^2 (1/0 AWG)	19.5 N-m (173 lb.-in.)
F	152.5 mm^2 (300 MCM)	85.0 mm^2 (3/0 AWG)	19.5 N-m (173 lb.-in.)

[1] Maximum/minimum sizes that the terminal block will accept - these are not recommendations. If national or local codes require sizes outside this range, lugs may be used.

Important: Frame C, D, and F drives utilize a finger guard over the power wiring terminals. Replace the finger guard when wiring is complete.

Refer to the PowerFlex 400 *User Manual* for maximum power cable length recommendations.

Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance)	• Install Line Reactor[1] • or Isolation Transformer
Line has power factor correction capacitors	• Install Line Reactor[1] • 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 (Frame C, E & F drives only) • or Install Isolation Transformer with grounded secondary if necessary
Ungrounded distribution system	

[1] Refer to the PowerFlex 400 *User Manual* for accessory ordering information.

I/O Wiring Recommendations

Wire Type(s)	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18AWG), 3 conductor, shielded for remote pot only.	

(1) 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.

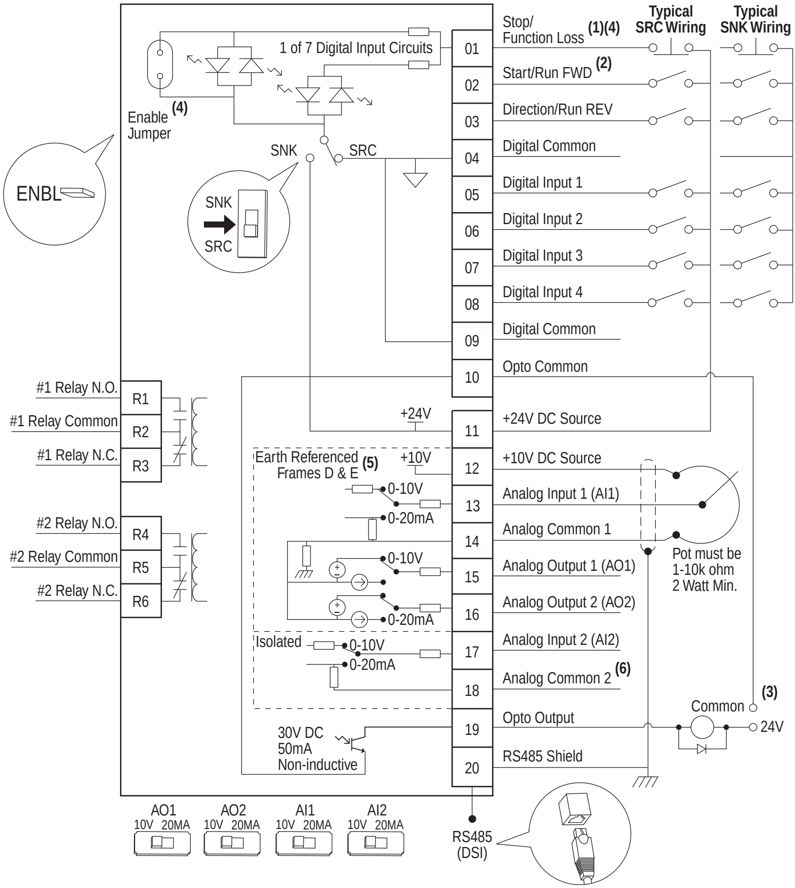
I/O Terminal Block Specifications

Frame	Maximum Wire Size (2)	Minimum Wire Size (2)	Torque
C, D, E, F	1.3 mm^2 (16 AWG)	0.13 mm^2 (26 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(2) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Refer to the PowerFlex 400 *User Manual* for maximum control cable length recommendations.

Control Terminal Block



(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to option 1 "3-Wire" or 6 "2-W Lvl/Enbl". In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [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.

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037(4)
2-Wire	Per P037	Coast
RS485 Port	Per P037	Coast

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. If reverse is enabled by A166, 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.

(4) When the ENBL enable jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation.

(5) Most I/O terminals labeled "Common" are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference. On Frame D and E drives, Analog Common 1 is referenced to ground.

(6) Common for Analog Input 2 (AI2). Electronically isolated from digital I/O and opto output. Not to be used with Analog Input 1 (AI1), Analog Output 1 (AO1) or Analog Output 2 (AO2). With Analog Input 2, provides one fully isolated analog input channel.

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Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
01	Stop [1] / Function Loss	Coast	Factory installed jumper or a normally closed input must be present for the drive to start. Program with P036 [Start Source].	P036 [1]
02	Start/Run FWD	–	HAND Mode: Command comes from Integral Keypad. AUTO Mode: I/O Terminal 02 is active. Program with P036 [Start Source].	P036, P037
03	Direction/Run REV	Rev Disabled	To enable reverse operation, program with A166 [Reverse Disable]. Program with P036 [Start Source].	P036, P037, A166
04	Digital Common	–	For digital inputs. Tied to I/O Terminal 09. Electronically isolated with digital inputs from analog I/O and opto output.	
05	Digital Input 1	Purge [2]	Program with T051 [Digital In1 Sel].	T051
06	Digital Input 2	Local	Program with T052 [Digital In2 Sel].	T052
07	Digital Input 3	Clear Fault	Program with T053 [Digital In3 Sel].	T053
08	Digital Input 4	Comm Port	Program with T054 [Digital In4 Sel].	T054
09	Digital Common	–	For digital inputs. Tied to I/O Terminal 04. Electronically isolated with digital inputs from analog I/O and opto output.	
10	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto output from analog I/O and digital inputs.	
11	+24V DC	–	Drive supplied power for digital inputs. Referenced to Digital Common. Max. Output: 100mA.	
12	+10V DC	–	Drive supplied power for 0-10V external potentiometer. Referenced to Analog Common. Max. Output: 15mA.	P038
13	Analog Input 1	0-10V	External 0-10V (unipolar), 0-20mA or 4-20mA input supply or potentiometer wiper. Default input is 0-10V. For current (mA) input, set AI1 DIP Switch to 20mA. Program with T069 [Analog In 1 Sel]. Input Impedance: 100k ohm (Voltage Mode) 250 ohm (Current Mode)	T069, T070, T071, T072
14	Analog Common 1	–	Common for Analog Input 1 and Analog Output 1 and 2. Electrically isolated from digital I/O and opto output.	
15	Analog Output 1	OutFreq 0-10	Default analog output is 0-10V. For current (mA) value, set AO1 DIP Switch to 20mA. Program with T082 [Analog Out1 Sel]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	P038, T051-T054, A152
16	Analog Output 2	OutCurr 0-10	Default analog output is 0-10V. For a current (mA) value, set AO2 DIP Switch to 20mA. Program with T085 [Analog Out2 Sel]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	T082, T084, T085, T086, T087
17	Analog Input 2	0-10V	Optically isolated external 0-10V (unipolar), ±10V (bipolar), 0-20mA or 4-20mA input supply or potentiometer wiper. Default input is 0-10V. For current (mA) input, set AI2 DIP Switch to 20mA. Program with T073 [Analog In 2 Sel]. Input Impedance: 100k ohm (Voltage Mode) 250 ohm (Current Mode)	T073, T074, T075, T076
18	Analog Common 2	–	For Analog Input 2. Electronically isolated from digital I/O and opto output. With Analog Input 2, provides one fully isolated analog input channel.	
19	Opto Output	At Frequency	Program with T065 [Opto Out Sel].	T065, T066, T068
20	RS485 (DSI) Shield	–	Terminal connected to Safety Ground - PE when using the RS485 (DSI) Communication Port.	

(1) See Footnotes (1) and (4) on previous page.

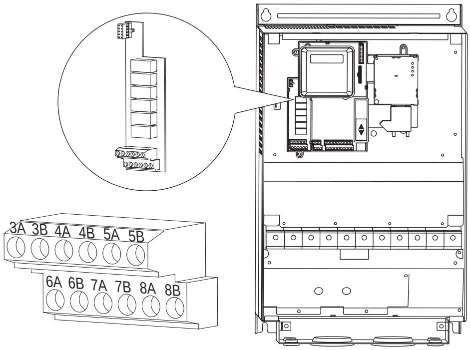
(2) See the *User Manual* for **Important** information regarding Stop commands and the [Digital Inx Sel] Purge option.

Relay Terminal Designations and DIP Switches

No.	Signal	Default	Description	Param.
R1	#1 Relay N.O.	Ready/Fault	Normally open contact for No. 1 output relay.	T055
R2	#1 Relay Common	–	Common for output relay.	
R3	#1 Relay N.C.	Ready/Fault	Normally closed contact for No. 1 output relay.	T055
R4	#2 Relay N.O.	Motor Running	Normally open contact for No. 2 output relay.	T060
R5	#2 Relay Common	–	Common for output relay.	
R6	#2 Relay N.C.	Motor Running	Normally closed contact for No. 2 output relay.	T060

Selection DIP Switches: Analog Input (AI1 & AI2) Analog Output (AO1 & AO2)	0-10V	Sets analog output to either voltage or current. Settings must match: AI1 & T069 [Analog In 1 Sel] AI2 & T073 [Analog In 2 Sel] AO1 & T082 [Analog Out1 Sel] AO2 & T085 [Analog Out2 Sel]
Sink/Source DIP Switch	Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

Figure 4: User Installed Auxiliary Relay Card (Frames D, E, & F Only)



Important: If using auxiliary motor control, ensure that wiring and parameter configuration are correct before wiring contactor outputs. All relays on the Auxiliary Relay Card will energize on power-up by default. Failure to verify proper wiring and parameter configuration can result in improper motor operation or drive damage. Refer to Appendix D for more details.

User Installed Relay Board Terminal Designations

No.	Signal	Default	Description	Param.
3A	#3 Relay N.O.	Ready/Fault	Normally open contact for Number 3 Output Relay	R221
3B	#3 Relay Common	–	Common for Number 3 Output Relay	
4A	#4 Relay N.O.	Ready/Fault	Normally open contact for Number 4 Output Relay	R224
4B	#4 Relay Common	–	Common for Number 4 Output Relay	
5A	#5 Relay N.O.	Ready/Fault	Normally open contact for Number 5 Output Relay	R227
5B	#5 Relay Common	–	Common for Number 5 Output Relay	
6A	#6 Relay N.O.	Ready/Fault	Normally open contact for Number 6 Output Relay	R230
6B	#6 Relay Common	–	Common for Number 6 Output Relay	
7A	#7 Relay N.O.	Ready/Fault	Normally open contact for Number 7 Output Relay	R233
7B	#7 Relay Common	–	Common for Number 7 Output Relay	
8A	#8 Relay N.O.	Ready/Fault	Normally open contact for Number 8 Output Relay	R236
8B	#8 Relay Common	–	Common for Number 8 Output Relay	

Prepare For Drive Start-Up

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.

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. 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.

❑ **5.** 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.

❑ **6.** Verify that the Analog I/O DIP Switches are set to 10 volts.

Applying Power to the Drive

❑ **7.** Apply AC power and control voltages to the drive.

❑ **8.** Familiarize yourself with the integral keypad features before setting any Program Group parameters.

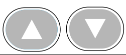
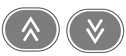
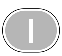
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, and control speed directly from the integral keypad.

If a fault appears on power up, refer to page 25 for an explanation of the fault code. For complete troubleshooting information, refer to the PowerFlex 400 *User Manual* supplied with the drive.

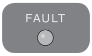
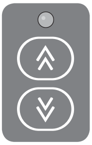
Intergral Keypad

Operator Keys

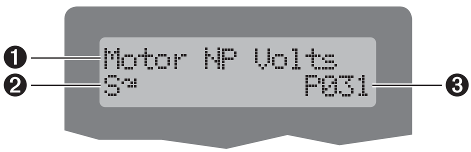
Key	Name	Description
	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit.
	Enter	Advance one step in programming menu. Save a change to a parameter value.
	Digital Speed Increment and Decrement Arrows	Used to control speed of drive. Default is active. Control is activated by parameter P038 [Speed Reference] or P042 [Auto Mode].
 HAND	Run/Start & Hand [(1)]	Used to start the drive. Default is Hand mode as controlled by parameter P042 [Auto Mode]. Control is activated by parameter P036 [Start Source] or P042 [Auto Mode].
 AUTO	Auto [(1)]	Used to select Auto control mode. Controlled by parameter P042 [Auto Mode].
 OFF	Stop/Off	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) **Important:** Certain digital input settings can override drive operation. Refer to the PowerFlex 400 *User Manual* for details.

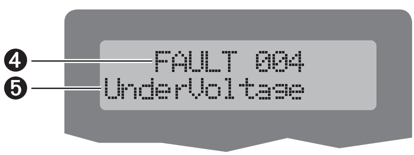
LED Status Indicators

LED		LED State	Description
	Program Status	Steady Red	Indicates parameter value can be changed. Selected digit will flash.
	Fault Status	Flashing Red	Indicates that the drive is faulted.
	Speed Status	Steady Green	Indicates that the digital speed control keys are enabled.
	Hand Status	Steady Green	Indicates that the Run/Start key is enabled.
	Auto Status	Steady Yellow	Indicates that the drive is in Auto mode.

LCD Display



No.	Description
❶	Parameter Name
❷	**Run/Stop Status:** S & S = Stopped / R & R = Running R or R flashes to indicate that the drive is stopping, but is still decelerating. R or R flashes when DC Injection is commanded. **Direction Indication:** The Direction Arrow & indicates the commanded direction of rotation. If the Arrow is flashing, the drive has been commanded to change direction, but is still decelerating. **Sleep Mode Indication:** R or R flashes to indicate that the drive is in sleep mode.
❸	Parameter Group and Number: b = Basic Display, P = Basic Program, T = Terminal Block C = Communications, A = Advanced Program, R = Aux Relay Card d = Advanced Display



❹	Fault Indication and Fault Number
❺	Fault Name

Keypad Hand-Off-Auto Functions

Parameter P042 [Auto Mode] defines the operation mode of the control keys on the integral keypad. Hand-Off-Auto is the default operation mode for PowerFlex 400 drives. For detailed information on other operation modes, refer to the PowerFlex 400 *User Manual* supplied with the drive.

Hand-Off-Auto Mode

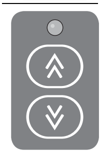
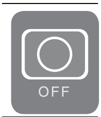
In HAND mode:

- Control keys operate as Hand-Off-Auto.
- Start command and speed reference come from the integral keypad Start/Hand and Digital Speed Increment and Decrement keys.
- Auto key switches control from HAND mode to AUTO mode in a bumpless transfer as long as there is an active Run command.

In AUTO mode:

- Auto key LED is illuminated.
- Start command is defined by P036 [Start Source].
- Speed Reference command is defined by P038 [Speed Reference].
- Start/Hand key switches control to the integral keypad in a bumpless transfer and switches the speed reference to the integral keypad.
- Stop key stops the drive and the drive switches to HAND mode.

Table 4.A P042 [Auto Mode] = 1 “Hnd-Off-Auto” (Default)
T051-T054 [Digital Inx Sel] ≠ 2 “Auto Mode” or 3 “Local”

	HAND Mode		AUTO Mode	
Key	LED	Key Function	LED	Key Function
	On	Starts drive. Runs according to Speed Increment/ Decrement keys.	On	Changes to HAND Mode and Starts drive. Runs according to Speed Increment/ Decrement keys.
	On	Changes speed.	Off	Not active. Keys are only active if P038 [Speed Source] = 0 “Drive Pot”.
	Off	Changes to AUTO Mode.	On	Not active.
	N/A	Stops drive.	N/A	Changes to HAND Mode and Stops drive.

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 the first Basic Program Group parameter.

Step	Key(s)	Example Displays
1. When power is applied, the last user-selected Basic Display Group parameter number is 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.)		Output Freq 0.00 Hz
2. Press the Up Arrow or Down Arrow to scroll through the Basic Display Group parameters. (Only in Display Groups)	▲ or ▼	
3. Press Esc once to display the Basic Display Group parameter number shown on power-up. The parameter number will flash.	ESC	Output Freq b001
4. Press Esc again to enter the group menu. The group menu letter will flash.	ESC	Basic Display b001
5. Press the Up Arrow or Down Arrow to scroll through the group menu (b, P, T, C, A and d).	▲ or ▼	Basic Program P031
6. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or SEL	Basic Program P031
7. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	▲ or ▼	
8. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or SEL	Motor NP Volts 230 Vac
9. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or SEL	Motor NP Volts 230 Vac
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	Motor NP Volts 230 Vac
11. Press the Up Arrow or Down Arrow to change the parameter value.	▲ or ▼	
12. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off.	ESC	
Or		
Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	↵	Motor NP Volts 220 Vac
13. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu.	ESC	Basic Program P031
If pressing Esc does not change the display, then b001 [Output Freq] is displayed. Press Enter or Sel to enter the last group menu viewed.		

Basic Display Group Parameters

The Basic Program Group contains the most commonly changed parameters.

No.	Parameter	Min/Max	Display/Options
b001	[Output Freq]	0.00/[Maximum Freq]	0.01 Hz
b002	[Commanded Freq]	0.00/[Maximum Freq]	0.01 Hz
b003	[Output Current]	0.0/(Drive Amps × 2)	0.1 Amps
b004	[Output Voltage]	0/510	1 VAC
b005	[DC Bus Voltage]	0/820	1 VDC
b006	[Drive Status]	0/1 (1 = Condition True)	Bit 4 Decelerating; Bit 3 Accelerating; Bit 2 Forward; Bit 1 Running
b007	[Fault 1 Code]	0/122	1
b008	[Process Display]	0.00/9999.99	0.01
b010	[Output Power]	0.0/999.9 kW	0.1 kW
b011	[Elapsed MWh]	0/3276.7 MWh	0.1 MWh
b012	[Elapsed Run Time]	0/9999 Hrs	1 = 10 Hrs
b013	[Torque Current]	0.0/(Drive Amps × 2)	0.1 Amps
b014	[Drive Temp]	0/120 degC	1 degC
b015	[Elapsed kWh]	0.0/100.0 kWh	0.1 kWh

Smart Start-Up with Basic Program Group

The PowerFlex 400 is designed so that start up is simple and efficient. The Program Group contains the most commonly used parameters.

= Stop drive before changing this parameter.

No.	Parameter	Min/Max	Display/Options	Default
P031	[Motor NP Volts] Set to the motor nameplate rated volts.	20/Drive Rated Volts	1 VAC	Based on Drive Rating
P032	[Motor NP Hertz] Set to the motor nameplate rated frequency.	15/320 Hz	1 Hz	60 Hz
P033	[Motor OL Current] Set to the maximum allowable motor current.	0.0/(Drive Amps × 2)	0.1 Amps	Based on Drive Rating
P034	[Minimum Freq] Sets the lowest frequency the drive will output continuously.	0.0/320.0 Hz	0.1 Hz	0.0 Hz
P035	[Maximum Freq] Sets the highest frequency the drive will output.	0.0/320.0 Hz	0.1 Hz	60.0 Hz
P036	[Start Source] Sets the control scheme used to start the drive when in Auto/Remote mode.	0/6	0 = "Keypad" 1 = "3-Wire" 2 = "2-Wire" 3 = "2-W Lvl Sens" 4 = "2-W Hi Speed" 5 = "Comm Port" 6 = "2-W Lvl/Enbl"	3
P037	[Stop Mode] Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below. **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].	0/7	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" (1) Stop input also clears active fault.	0

= Stop drive before changing this parameter.

No.	Parameter	Min/Max	Display/Options	Default
P038	[Speed Reference] Sets the source of the speed reference to the drive. **Important:** When T051 – T054 [Digital Inx Sel] is set to option 1, 2, 3, 4, 5, 8, 14, 15, 16 or 17 and the digital input is active, or if A152 [PID Ref Sel] is not set to option 0, the speed reference commanded by this parameter will be overridden. Refer to Chapter 1 of the PowerFlex 400 *User Manual* for details.	0/5	0 = “Drive Keypad” 1 = “InternalFreq” 2 = “Analog In 1” 3 = “Analog In 2” 4 = “Preset Freq” 5 = “Comm Port”	2
P039	[Accel Time 1] Sets the rate of accel for all speed increases.	0.00/600.00 Secs	0.01 Secs	20.00 Secs
P040	[Decel Time 1] Sets the rate of decel for all speed decreases.	0.00/600.00 Secs	0.01 Secs	20.00 Secs
P041	[Reset To Defalts] Resets all parameter values to factory defaults.	0/1	0 = “Ready/Idle” 1 = “Factory Rset”	0
P042	[Auto Mode] Determines the operation of the “Auto” key on the integral keypad.	0/3	0 = “No Function” 1 = “Hnd-Off-Auto” 2 = “Local/Remote” 3 = “Auto/Manual”	1
P043	[Motor OL Ret] Enables/disables the Motor Overload Retention function.	0/1	0 = “Disabled” 1 = “Enabled”	0 = “Disabled”

Terminal Block Group Parameters

No.	Parameter	Min/Max	Display/Options		Default
T051 T052 T053 T054	[Digital In1 Sel] *I/O Terminal 05* [Digital In2 Sel] *I/O Terminal 06* [Digital In3 Sel] *I/O Terminal 07* [Digital In4 Sel] *I/O Terminal 08*	0/36	0 = “Not Used” 1 = “Purge” 2 = “Auto Mode” 3 = “Local” 4 = “Comm Port” 5 = “PID Disable” 6 = “PID Hold” 7 = “PID Reset” 8 = “Preset Freq” 9 = “Aux Fault” 10 = “Clear Fault” 11 = “RampStop,CF” 12 = “CoastStop,CF” 13 = “DCInjStop,CF”	14 = “Anlg1 InCtrl” 15 = “Anlg2 InCtrl” 16 = “MOP Up” 17 = “MOP Down” 18 = “Acc & Dec 2” 19 = “Current Lmt2” 20 = “Force DC” 21 = “Mtr I-Lock 1” 22 = “Mtr I-Lock 2” 23 = “Mtr I-Lock 3” 24 = “Mtr I-Lock 4” 25 = “Cmd Reverse” 31 = “Logic In 1” 32 = “Logic In 2” 36 = “Damper Input”	1 3 10 4
T055 T060	[Relay Out1 Sel] [Relay Out2 Sel]	0/23	0 = “Ready/Fault” 1 = “At Frequency” 2 = “MotorRunning” 3 = “Hand Active” 4 = “Motor Overld” 5 = “Ramp Reg” 6 = “Above Freq” 7 = “Above Cur” 8 = “Above DCVolt”	9 = “Above Anlg 2” 10 = “Above PF Ang” 11 = “Anlg In Loss” 12 = “ParamControl” 13 = “Retries Exst” 14 = “NonRec Fault” 15 = “Reverse” 16 = “Logic In 1” 17 = “Logic In 2” 23 = “Aux Motor”	0 2
T056	[Relay Out1 Level]	0.0/9999	0.1		0.0
T058	[Relay 1 On Time]	0.0/600.0 Secs	0.1 Secs		0.0 Secs
T059	[Relay 1 Off Time]	0.0/600.0 Secs	0.1 Secs		0.0 Secs
T061	[Relay Out2 Level]	0.0/9999	0.1		0.0

T060 Setting	T061 Min/Max
6	0/320 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

No.	Parameter	Min/Max	Display/Options	Default
T063	[Relay 2 On Time]	0.0/600.0 Secs	0.1 Secs	0.0 Secs

No.	Parameter	Min/Max	Display/Options	Default
T064	[Relay 2 Off Time]	0.0/600.0 Secs	0.1 Secs	0.0 Secs
T065	[Opto Out Sel]	0/17	0 = "Ready/Fault" 1 = "At Frequency" 2 = "MotorRunning" 3 = "Hand Active" 4 = "Motor Overld" 5 = "Ramp Reg" 6 = "Above Freq" 7 = "Above Cur" 8 = "Above DCVolt" 9 = "Above Anlg 2" 10 = "Above PF Anlg" 11 = "Anlg In Loss" 12 = "ParamControl" 13 = "Retries Exst" 14 = "NonRec Fault" 15 = "Reverse" 16 = "Logic In 1" 17 = "Logic In 2"	1
T066	[Opto Out Level]	0.0/9999	0.1	0.0

T065 Setting	T066 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

No.	Parameter	Min/Max	Display/Options	Default
T068	[Opto Out Logic]	0/1	1	0

T068 Option	Opto Out Logic
0	NO (Normally Open)
1	NC (Normally Closed)

No.	Parameter	Min/Max	Display/Options	Default
T069	[Analog In 1 Sel]	0/6	1	2

T069 Option	Setting	Input Range	DIP Switch AI1 Setting
0	Current Mode	0-20 mA	0-10V
1	Current Mode	4-20 mA	0-10V
2	Voltage Mode - Unipolar	0-10V	0-10V
4	Current Mode (Square Root)	0-20 mA	0-10V
5	Current Mode (Square Root)	4-20 mA	0-10V
6	Voltage Mode - Unipolar (Square Root)	0-10V	0-20 mA

No.	Parameter	Min/Max	Display/Options	Default
T070 T074	[Analog In 1 Lo] [Analog In 2 Lo]	0.0/100.0%	0.1%	0.0%
T071 T075	[Analog In 1 Hi] [Analog in 2 Hi]	0.0/100.0%	0.1%	100.0%
T072 T076	[Analog In 1 Loss] [Analog In 2 Loss]	0/6	0 = "Disabled" 1 = "Fault (F29)" 2 = "Stop" 3 = "Zero Ref" 4 = "Min Freq Ref" 5 = "Max Freq Ref" 6 = "Int Freq Ref"	0
T073	[Analog In 2 Sel]	0/7	1	2

T073 Option	Setting	Input Range	DIP Switch AI1 Setting
0	Current Mode	0-20 mA	20 mA
1	Current Mode	4-20 mA	20 mA
2	Voltage Mode - Unipolar	0-10V	10V
3	Voltage Mode - Bipolar	-10 to +10V	10V
4	Current Mode (Square Root)	0-20 mA	20 mA
5	Current Mode (Square Root)	4-20 mA	20 mA
6	Voltage Mode - Unipolar (Square Root)	0-10V	10V
7	Voltage Mode - Bipolar (Square Root)	-10 to +10V	10V

No.	Parameter	Min/Max	Display/Options	Default
T077	[Sleep-Wake Sel]	0/3	0 = "Disabled" 1 = "Analog In 1" 2 = "Analog In 2" 3 = "Command Freq"	0
T078	[Sleep Level]	0.0/100.0%	0.1%	10.0%
T079	[Sleep Time]	0.0/600.0 Secs	0.1 Secs	0.0 Secs
T080	[Wake Level]	0.0/100.0%	0.1%	15.0%
T081	[Wake Time]	0.0/600.0 Secs	0.1 Secs	0.0 Secs

No.	Parameter	Min/Max	Display/Options	Default
T082 T085	[Analog Out1 Sel] [Analog Out2 Sel]	0/20	1	0 1

Setting	Output Range	Min. Output Value	Max. Output Value	Filter	DIP Switch AO1	Related Parameter
0 OutFreq 0-10	0-10V	0V = 0 Hz	[Maximum Frequency]	None	10V	b001
1 OutCurr 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b003
2 OutTorq 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b013
3 OutVolt 0-10	0-10V	0V = 0 Volts	120% Drive Rated Output V	None	10V	b004
4 OutPowr 0-10	0-10V	0V = 0 kW	200% Drive Rated Power	Filter A	10V	b010
5 Setpnt 0-10	0-10V	0V = 0.0%	100.0% Setting	None	10V	T084
6 TstData 0-10	0-10V	0V = 0000	65535 (Hex FFFF)	None	10V	A196
7 OutFreq 0-20	0-20 mA	0 mA = 0 Hz	[Maximum Frequency]	None	20 mA	b001
8 OutCurr 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
9 OutTorq 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
10 OutVolt 0-20	0-20 mA	0 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
11 OutPowr 0-20	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
12 Setpnt 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	None	20 mA	T084
13 TstData 0-20	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196
14 OutFreq 4-20	4-20 mA	4 mA = 0 Hz	[Maximum Frequency]	None	20 mA	b001
15 OutCurr 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
16 OutTorq 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
17 OutVolt 4-20	4-20 mA	4 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
18 OutPowr 4-20	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
19 Setpnt 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	None	20 mA	T084
20 TstData 4-20	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196

No.	Parameter	Min/Max	Display/Options	Default
T083 T086	[Analog Out1 High] [Analog Out2 High]	0/800%	1%	100%

T083 Setting	T082 Setting	T082 Max. Output Value
50%	1 "OutCurr 0-10"	5V for 200% Drive Rated Output Current
90%	11 "OutPowr 0-20"	18 mA for 200% Drive Rated Power

No.	Parameter	Min/Max	Display/Options	Default
T084 T087	[Anlg Out1 Setpt] [Anlg Out2 Setpt]	0.0/100.0%	0.1%	0.0%
T088	[Anlg Loss Delay]	0.0/20.0 Secs	0.1 Secs	0.0 Secs

Communications Group Parameters

No.	Parameter	Min/Max	Display/Options		Default
C101	[Language]	1/10	1 = "English" 2 = "Français" 3 = "Español" 4 = "Italiano" 5 = "Deutsch"	6 = "Reserved" 7 = "Português" 8 = "Reserved" 9 = "Reserved" 10 = "Nederlands"	1
C102	[Comm Format] Power to drive must be cycled before any changes will affect drive operation.	0/9	0 = "RTU 8-N-1" 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" 6 = "MetaSys N2" 7 = "P1 8-N-1" 8 = "P1 8-E-1" 9 = "P1 8-O-1"	0
C103	[Comm Data Rate]	0/5	0 = "1200" 1 = "2400" 2 = "4800"	3 = "9600" 4 = "19.2K" 5 = "38.4K"	0
C104	[Comm Node Addr]	1/247	1		100
C105	[Comm Loss Action]	0/5	0 = "Fault" 1 = "Coast Stop" 2 = "Stop"	3 = "Continu Last" 4 = "Run Preset 0" 5 = "Kypd Inc/Dec"	0
C106	[Comm Loss Time]	0.1/60.0 Secs	0.1 Secs		5.0 Secs
C107	[Comm Write Mode]	0/1	0 = "Save"	1 = "RAM Only"	0
C108	[Start Source 2] Sets the control scheme used to start the drive when in Auto/Remote mode.	0/6	0 = "Keypad" 1 = "3-Wire" 2 = "2-Wire"	3 = "2-W Lvl Sens" 4 = "2-W Hi Speed" 5 = "Comm Port" 6 = "2-W Lvl/Enbl"	3
C109	[Speed Ref 2]	0/5	0 = "Drive Keypad" 1 = "InternalFreq" 2 = "Analog In 1"	3 = "Analog In 2" 4 = "Preset Freq" 5 = "Comm Port"	2

Advanced Program Group Parameters

No.	Parameter	Min/Max	Display/Options	Default
A141	[Purge Frequency]	0.0/320.0 Hz	0.1 Hz	5.0 Hz
A142	[Internal Freq]	0.00/320.00 Hz	0.01 Hz	60.00 Hz
A143 A144 A145 A146	[Preset Freq 0] [Preset Freq 1] [Preset Freq 2] [Preset Freq 3]	0.0/320.0 Hz	0.1 Hz	0.0 Hz 5.0 Hz 10.0 Hz 20.0 Hz
A147	[Accel Time 2]	0.00/600.00 Secs	0.01 Secs	30.00 Secs
A148	[Decel Time 2]	0.00/600.00 Secs	0.01 Secs	30.00 Secs
A149	[S Curve %]	0/100%	1%	20%
A150	[PID Trim Hi]	0.0/320.0 Hz	0.1 Hz	60.0 Hz
A151	[PID Trim Lo]	0.0/320.0 Hz	0.1 Hz	0.0 Hz
A152	[PID Ref Sel]	0/8	0 = “PID Disabled” 1 = “PID Setpoint” 2 = “Analog In 1” 3 = “Analog In 2” 4 = “Comm Port” 5 = “Setpnt, Trim” 6 = “A-In 1, Trim” 7 = “A-In 2, Trim” 8 = “Comm, Trim”	0
A153	[PID Feedback Sel]	0/2	0 = “Analog In 1” 1 = “Analog In 2” 2 = “Comm Port”	0
A154	[PID Prop Gain]	0.00/99.99	0.01	1.00
A155	[PID Integ Time]	0.0/999.9 Secs	0.1 Secs	2.0 Secs
A156	[PID Diff Rate]	0.00/99.99 (1/Secs)	0.01 (1/Secs)	0.00 (1/Secs)
A157	[PID Setpoint]	0.0/100.0%	0.1%	0.0%
A158	[PID Deadband]	0.0/10.0%	0.1%	0.0%
A159	[PID Preload]	0.0/320.0 Hz	0.1 Hz	0.0%
A160	[Process Factor]	0.1/999.9	0.1	30.0
A163	[Auto Rstrt Tries]	0/9	1	0
A164	[Auto Rstrt Delay]	0.0/160.0 Secs	0.1 Secs	1.0 Secs
A165	[Start At PowerUp]	0/1	0 = “Disabled” 1 = “Enabled”	0
A166	[Reverse Disable]	0/1	0 = “Rev Enabled” 1 = “Rev Disabled”	1
A167	[Flying Start En]	0/1	0 = “Disabled” 1 = “Enabled”	0
A168	[PWM Frequency]	2.0/8.0, 10.0 kHz	0.1 kHz	4.0 kHz
A169	[PWM Mode]	0/1	0 = “Space Vector” 1 = “2-Phase”	1
A170	[Boost Select] Only active when A125 [Torque Perf Mode] is set to 0 “V/Hz”.	0/15	Settings in % of base voltage. 0 = “Custom V/Hz” Variable Torque 1 = “30.0, VT” 2 = “35.0, VT” 3 = “40.0, VT” 4 = “45.0, VT” Constant Torque 5 = “0.0, no IR” 6 = “0.0” 7 = “2.5, CT” 8 = “5.0, CT” 9 = “7.5, CT” 10 = “10.0, CT” 11 = “12.5, CT” 12 = “15.0, CT” 13 = “17.5, CT” 14 = “20.0, CT” 15 = “Kepco”	4
A171	[Start Boost] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to “0”.	0.0/25.0%	1.1%	2.5%
A172	[Break Voltage] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to “0”.	0.0/100.0%	0.1%	25.0%
A173	[Break Frequency] Only active when A084 [Boost Select] and A125 [Torque Perf Mode] are set to “0”.	0.0/320.0 Hz	0.1 Hz	15.0 Hz
A174	[Maximum Voltage]	20/Rated Volts	1 VAC	Rated Volts
A175	[Slip Hertz @ FLA]	0.0/10.0 Hz	0.1 Hz	2.0 Hz
A176	[DC Brake Time]	0.0/99.9 Secs	0.1 Secs	0.0 Secs
A177	[DC Brake Level]	0.0/(Drive Amps × 1.5)	0.1 Amps	Amps × 0.05
A178	[DC Brk Time@Strt]	0.0/99.9 Secs	0.1 Secs	0.0 Secs
A179 A180	[Current Limit 1] [Current Limit 2]	0.0/(Drive Amps × 1.5)	0.1 Amps	Amps × 1.1
A181	[Motor OL Select]	0/2	0 = “No Derate” 1 = “Min Derate” 2 = “Max Derate”	0

No.	Parameter	Min/Max	Display/Options	Default
A182	[Drive OL Mode]	0/3	0 = “Disabled” 1 = “Reduce CLim” 2 = “Reduce PWM” 3 = “Both-PWM 1st”	3
A183	[SW Current Trip]	0.0/(Drive Amps × 1.8)	0.1 Amps	0.0 (Disabled)
A184	[Load Loss Level]	0.0/Drive Amps	0.1 Amps	0.0 (Disabled)
A185	[Load Loss Time]	0/9999 Secs	1 Secs	0 (Disabled)
A186	[Stall Fault Time]	0/5	0 = “60 Seconds” 1 = “120 Seconds” 2 = “240 Seconds” 3 = “360 Seconds” 4 = “480 Seconds” 5 = “Flt Disabled”	0
A187	[Bus Reg Mode]	0/1	0 = “Disabled” 1 = “Enabled”	1
A188	[Skip Frequency 1]	0/320 Hz	1 Hz	0 Hz
A189	[Skip Freq Band 1]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
A190	[Skip Frequency 2]	0/320 Hz	1 Hz	0 Hz
A191	[Skip Freq Band 2]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
A192	[Skip Frequency 3]	0/320 Hz	1 Hz	0 Hz
A193	[Skip Freq Band 3]	0.0/30.0 Hz	0.1 Hz	0.0 Hz
A194	[Compensation]	0/3	0 = “Disabled” 1 = “Electrical” 2 = “Mechanical” 3 = “Both”	3
A195	[Reset Meters]	0/2	0 = “Ready/Idle” 1 = “Reset MWh” 2 = “Reset Time”	0
A196	[Testpoint Sel]	1024/65535	1	1024
A197	[Fault Clear]	0/2	0 = “Ready/Idle” 1 = “Reset Fault” 2 = “Clear Buffer”	0
A198	[Program Lock]	0/3	0 = “Unlocked” 1 = “Locked” (All) 2 = “Locked” (Not Network) 3 = “Locked” (P035, A170)	0
A199	[Motor NP Poles]	2/40	1	4
A200	[Motor NP FLA]	0.1/(Drive Amps × 2)	0.1 Amps	Rated Amps

Aux Relay Card Group Parameters

No.	Parameter	Min/Max	Display/Options	Default
R221 R224 R227 R230 R233 R236	[Relay Out3 Sel] [Relay Out4 Sel] [Relay Out5 Sel] [Relay Out6 Sel] [Relay Out7 Sel] [Relay Out8 Sel]	0/23	0 = “Ready/Fault” 1 = “At Frequency” 2 = “MotorRunning” 3 = “Hand Active” 4 = “Motor Overld” 5 = “Ramp Reg” 6 = “Above Freq” 7 = “Above Cur” 8 = “Above DCVolt” 9 = “Above Anlg 2” 10 = “Above PF Ang” 11 = “Anlg In Loss” 12 = “ParamControl” 13 = “Retries Exst” 14 = “NonRec Fault” 15 = “Reverse” 16 = “Logic In 1” 17 = “Logic In 2” 23 = “Aux Motor”	0
R222 R225 R228 R231 R234 R237	[Relay Out3 Level] [Relay Out4 Level] [Relay Out5 Level] [Relay Out6 Level] [Relay Out7 Level] [Relay Out8 Level]	0.0/9999 Hz	0.1	0.0

[Relay OutX Select] Setting	[Relay OutX Level] Min/Max
6	0/320 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

No.	Parameter	Min/Max	Display/Options	Default
R239	[Aux Motor Mode]	0/1	0 = “Disabled” 1 = “Enabled”	0
R240	[Aux Motor Qty]	1/6	1 = “1 Aux Mtr” 2 = “2 Aux Mtr” 3 = “3 Aux Mtr” 4 = “1 Mtr + Swap” 5 = “2 Mtr + Swap” 6 = “3 Mtr + Swap”	1
R241 R244 R247	[Aux 1 Start Freq] [Aux 2 Start Freq] [Aux 3 Start Freq]	0.0/320.0 Hz	0.1 Hz	50.0 Hz

No.	Parameter	Min/Max	Display/Options	Default
R242 R245 R248	[Aux 1 Stop Freq] [Aux 2 Stop Freq] [Aux 3 Stop Freq]	0.0/320.0 Hz	0.1 Hz	25.0 Hz
R243 R246 R249	[Aux 1 Ref Add] [Aux 2 Ref Add] [Aux 3 Ref Add]	0.0/100.0%	0.1%	0.0%
R250	[Aux Start Delay]	0.0/999.9 Secs	0.1 Secs	5.0 Secs
R251	[Aux Stop Delay]	0.0/999.9 Secs	0.1 Secs	3.0 Secs
R252	[Aux Prog Delay]	0.00/60.00 Secs	0.01 Secs	0.50 Secs
R253	[Aux AutoSwap Tme]	0.0/999.9 Hrs	0.1 Hrs	0.0 Hr
R254	[Aux AutoSwap Lvl]	0.0/100.0%	0.1%	50.0%

Advanced Display Group Parameters

No.	Parameter	Min/Max	Display/Options	Default
d301	[Control Source]	0/99	Digit 0: Start Command 0 = Keypad 1 = Terminal Block 2 = Communications Digit 1: Speed Command 0 = Local Keypad Pot 1 = A142 2 = Analog Input 1 3 = Analog Input 2 4 = A143-146 5 = Communications	Read Only
d302	[Control In Status]	0/1 (1 = Condition True)		Read Only

Display Digit (Right to Left)	I/O Terminal	Control Input
0	02	Start/FWD In
1	03	Dir/Rev In
2	01	Stop Input
3	05	Digital In 1
4	06	Digital In 2
5	07	Digital In 3
6	08	Digital In 4

No.	Parameter	Min/Max	Display/Options	Default
d303	[Comm Status]	0/1 (1 = Condition True)	Digit 0: Received Good Message Packet Digit 1: Transmitting Message Digit 2: DSI Peripheral Connected Digit 3: Received Bad Message Packet	Read Only
d304	[PID Setpnt Displ]	0.0/100.0%	0.1%	0.0%
d305 d306	[Analog In 1] [Analog In 2]	0.0/120.0%	0.1%	0.0%
d307 d308 d309	[Fault 1 Code] [Fault 2 Code] [Fault 3 Code]	0/122	1	Read Only
d310 d312 d314	[Fault 1 Time-hr] [Fault 2 Time-hr] [Fault 3 Time-hr]	0/9999 Hrs	1 Hrs	Read Only
d311 d313 d315	[Fault 1 Time-min] [Fault 2 Time-min] [Fault 3 Time-min]	0.0/60.0 Min	0.1 Min	Read Only
d316	[Elapsed Time-hr]	0/32767	1 Hr	Read Only
d317	[Elapsed Time-min]	0.0/60.0 Min	0.1 Min	Read Only
d318	[Output Powr Fctr]	0.0/180.0 deg	0.1 deg	Read Only
d319	[Testpoint Data]	0/FFFF	1 Hex	Read Only
d320	[Control SW Ver]	1.00/99.99	0.01	Read Only
d321	[Drive Type]	Used by Rockwell Automation field service personnel.		
d322	[Output Speed]	0.0/100.0%	0.1%	Read Only
d323	[Output RPM]	0/24000 RPM	1 RPM	Read Only
d324	[Fault Frequency]	0.00/320.00 Hz	0.01 Hz	Read Only
d325	[Fault Current]	0.0/(Drive Amps × 2)	0.1 Amps	Read Only
d326	[Fault Bus Volts]	0/820 VDC	1 VDC	Read Only
d327	[Status @ Fault]	0/1	1	Read Only

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Fault Codes

To clear a fault, press the Stop key, cycle power or set A100 [Fault Clear] to 1 or 2.

No.	Fault	Description
F2	Auxiliary Input[1]	Check remote wiring.
F3	Power Loss	Monitor the incoming AC line for low voltage or line power interruption.
F4	UnderVoltage[1]	Monitor the incoming AC line for low voltage or line power interruption.
F5	OverVoltage[1]	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 a dynamic brake chopper.
F6	Motor Stalled[1]	Increase [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit].
F7	Motor Overload[1]	An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current].
F8	Heatsink OvrTmp[1]	Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40°C (104°F) for IP 30/NEMA 1/UL Type 1 installations or 50°C (122°F) for Open type installations. Check fan.
F12	HW OverCurrent	Check programming. Check for excess load, improper DC boost setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	Check the motor and external wiring to the drive output terminals for a grounded condition.
F15	Load Loss	Check for load loss (i.e., a broken belt).
F29	Analog Input Loss[1]	An analog input is configured to fault on signal loss. A signal loss has occurred.
F33	Auto Rstrt Tries	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	Check the wiring between the drive and motor. Check motor for grounded phase. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd	
F40	Phase W to Gnd	
F41	Phase UV Short	Check the motor and drive output terminal wiring for a shorted condition. Replace drive if fault cannot be cleared.
F42	Phase UW Short	
F43	Phase VW Short	
F48	Params Defaulted	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.
F63	SW OverCurrent[1]	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	Reduce load or extend Accel Time.
F70	Power Unit	Cycle power. Replace drive if fault cannot be cleared.
F71	Net Loss	The communication network has faulted.
F81	Comm Loss	If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. Check connection. An adapter was intentionally disconnected. Turn off using C105 [Comm Loss Action].
F94	Function Loss	Close input to terminal 01 and re-start the drive.
F100	Parameter Checksum	Restore factory defaults.
F122	I/O Board Fail	Cycle power. Replace drive if fault cannot be cleared.

(1) Auto-Reset/Run type fault. Configure with parameters A092 and A093.

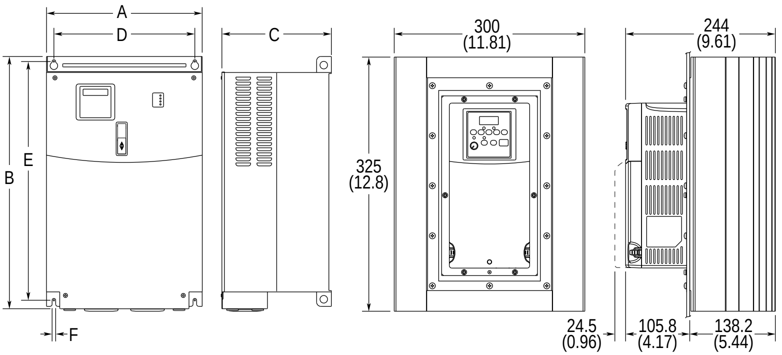
For a complete listing of Faults and Alarms, refer to the PowerFlex 400 *User Manual*.

Dimensions

PowerFlex 400 Frames

Output Power		Frame Size	
kW	HP	208-240V AC Input	400-480V AC Input
2.2-7.5	3-10	C	C
11-15	15-20	D	C
18.5-22	25-30	D	D
30-37	40-50	E	E
45-75	60-100	–	E
90-110	125-150	–	F

Figure 5: PowerFlex 400 Frames C-F



Dimensions are in millimeters and (inches).

Frame	A	B	C	D	E	F	Weight [1] *kg (lbs.)*
C	130.0 (5.1)	260.0 (10.2)	180.0 (7.1)	116.0 (4.57)	246.0 (9.7)	5.8 (0.23)	4.33 (9.5)
D	250.0 (9.84)	436.2 (17.17)	206.1 (8.11)	226.0 (8.90)	383.4 (15.09)	9.0 (0.35)	14.0 (30.9)
E	370.0 (14.57)	605.5 (23.84)	259.2 (10.21)	335.0 (13.19)	567.4 (22.34)	8.5 (0.33)	51.2 (112.9)
F	425.0 (16.73)	850.0 (33.46)	264.0 (10.39)	381.0 (15.00)	647.5 (25.49)	13.0 (0.51)	88.0 (194.0)

(1) Weights include HIM and Standard I/O.

EMC Line Filters

Figure 6: Catalog Numbers: 22-RF018-CS, 22-RF018-CL, 22-RF026-CS, 22-RF026-CL, 22-RF026-CL, 22-RF034-CS

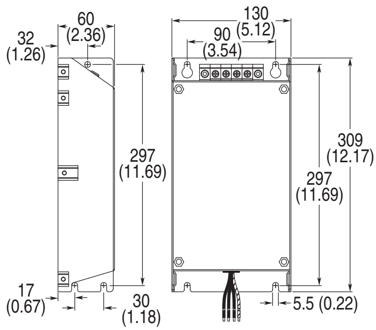
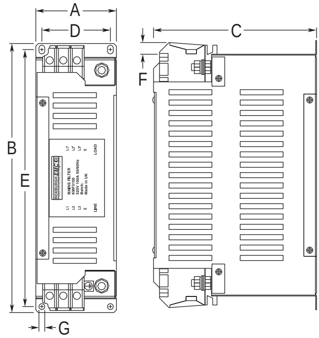


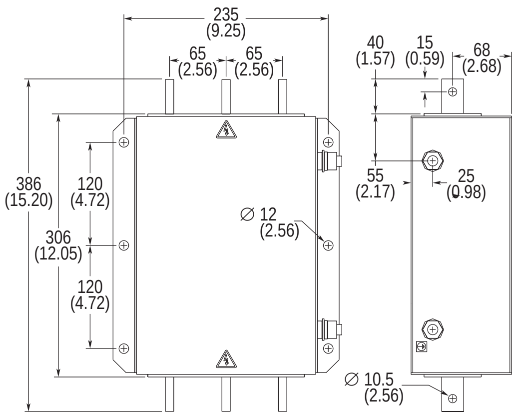
Figure 7: Catalog Numbers: 22-RFD036, 22-RFD050, 22-RFD070, 22-RFD100, 22-RFD150, 22-RFD180



Catalog Number	A	B	C	D	E	F	G
22-RFD036	74 (2.91)	272 (10.71)	161 (6.34)	60 (2.36)	258 (10.16)	7.5 (0.30)	7 (0.28)
22-RFD050	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD070	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD100	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD150	126 (4.96)	312 (12.28)	224 (8.82)	112 (4.41)	298 (11.73)	19.5 (0.77)	7 (0.28)
22-RFD180	126 (4.96)	312 (12.28)	224 (8.82)	112 (4.41)	298 (11.73)	27 (1.06)	7 (0.28)

Dimensions are in millimeters and (inches).

Figure 8: Catalog Numbers: 22-RFD330



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Allen-Bradley

PowerFlex® 400

Adjustable Frequency AC Drive for Fan & Pump Applications

FRN 1.xx - 7.xx

User Manual

Rockwell Automation

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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.

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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.

Important: Identifies information that is critical for successful application and understanding of the product.

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 the hazard
- recognize the consequences

Shock Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

Burn Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be at dangerous temperatures.

Manual Updates

The information below summarizes the changes to the PowerFlex 400 *User Manual* since the June 2013 release.

Description of New or Updated Information	See Page(s)
Maximum Surrounding Air Temperature table updated.	1-5
Frames G & H Mounting Clearances diagram updated.	1-7
Multiple Digital Input Connections example updated.	1-27
New parameters added to Parameter Organization table.	3-2
Parameter T055 [Relay Out1 Sel]: Option 24 "Fault" added.	3-14
Parameter T060 [Relay Out2 Sel]: Option 24 "Fault" added.	3-16
Parameter T065 [Opto Out Sel]: Option 24 "Fault" added.	3-18
Parameter T077 [Sleep-Wake Sel]: Option 4 "Ind Slp Wake" added.	3-23
Parameter T082 [Analog Out1 Sel]: Settings 24...29 added.	3-25
Parameter T085 [Analog Out2 Sel]: Settings 24...29 added.	3-27
Parameter A153 [PID Feedback Sel]: Options 3...8 added.	3-38
Parameter d328 [PID Fdbk Disply]: Minimum value updated.	3-64
New parameters added to Parameter Cross-Reference table.	3-70
Internal DC Bus Choke specification corrected.	A-4
Table D.B Parameter A153 [PID Feedback Sel] Options updated.	D-5
Writing (06) Logic Command Data description updated.	E-3
Writing (06) Reference description updated.	E-4

New Parameters

The following parameters have been added with the release of Firmware Release Number (FRN) 7.xx.

Parameter	Number	Page
[Sleep Sel]	T090	3-29
[Wake Sel]	T091	3-30
[Wake Deviation]	A203	3-52
[ACT1 Input]	A204	3-52
[ACT2 Input]	A205	3-52

Parameter	Number	Page
[ACT1 Minimum]	A206	3-53
[ACT1 Maximum]	A207	3-53
[ACT2 Minimum]	A208	3-53
[ACT2 Maximum]	A209	3-53

Manual Updates

The information below summarizes the changes to the PowerFlex 400 *User Manual* since the September 2009 release.

Description of New or Updated Information	See Page(s)
Minimum Enclosure Volume column and new footnotes added.	1-13, A-2
Drive, Fuse & Circuit Breaker Ratings topic updated.	A-1
Electronic Motor Overload Protection description updated.	A-3, A-4

Manual Updates

The information below summarizes the changes to the PowerFlex 400 *User Manual* since the October 2006 release.

Description of New or Updated Information	See Page(s)
Note on placement of wiring for Frame E 240V, 30-37kW (40-50HP) and 480V, 55-75 kW (75-100HP) drives added.	1-17
Parameter T072 [Analog In 1 Loss]: Description revised, and Option 7 'Hold Last' added	3-21
Parameter T076 [Analog In 2 Loss]: Description revised, and Option 7 'Hold Last' added	3-23
Fault F003 (Power Loss) description changed.	4-3
Fault F004 (UnderVoltage) description changed.	4-3
Fault F017 (Input Phase Loss) description added.	4-4
Fault F032 (Fan Fdbck Loss) description added.	4-4
Altitude derating specification revised.	A-3
Internal DC Bus Choke specification corrected.	A-4

New Parameters

The following parameters have been added with the release of Firmware Release Number (FRN) 6.xx.

Parameter	Number	Page	Parameter	Number	Page
[PID Invert Error]	A201	3-52	[Fault 5 Time-hr]	d339	3-67
[MOP Reset Sel]	A202	3-52	[Fault 5 Time-min]	d340	3-67
[PID Fdbk Display]	d328	3-64	[Fault 6 Time-hr]	d341	3-67
[DC Bus Ripple V]	d329	3-64	[Fault 6 Time-min]	d342	3-67
[Fault 4 Code]	d330	3-65	[Fault 7 Time-hr]	d343	3-68
[Fault 5 Code]	d331	3-65	[Fault 7 Time-min]	d344	3-68
[Fault 6 Code]	d332	3-65	[Fault 8 Time-hr]	d345	3-68
[Fault 7 Code]	d333	3-65	[Fault 8 Time-min]	d346	3-68
[Fault 8 Code]	d334	3-66	[Fault 9 Time-hr]	d347	3-68

Parameter	Number	Page
[Fault 9 Code]	d335	3-66
[Fault 10 Code]	d336	3-66
[Fault 4 Time-hr]	d337	3-66
[Fault 4 Time-min]	d338	3-67

Parameter	Number	Page
[Fault 9 Time-min]	d348	3-69
[Fault10 Time-hr]	d349	3-69
[Fault10 Time-min]	d350	3-69

Manual Updates

The information below summarizes the changes to the PowerFlex 400 *User Manual* since the November 2005 release.

Description of New or Updated Information	See Page(s)
Information for Frames G and H added	Throughout
Frame C mounting requirements clarified	1-6
Analog Output DIP switch setting corrected	1-25
Parameter T072 [Analog In 1 Loss]: Option 6 renamed "Preset Freq0"	3-21
Parameters T082 and T085 [Analog Outx Sel]: Settings 18, 19 and 20 added	3-25
Parameter C107 [Comm Write Mode] description clarified.	3-32
Parameter A170 [Boost Select]: Options added for Frames G and H	3-43
Parameters R221-R236 [Relay Outx Sel]: Default changed from option 0 to option 23	3-54
Current rating for Single Phase operation corrected to 35%	A-4
EMC Line Filters added for Frames G and H	B-5, B-19, B-20

New Parameter

The following parameter has been added with the release of Firmware Release Number (FRN) 5.xx.

Parameter	Number	Page
[Analog In Filter]	T089	3-28

Notes:

Table of Contents

Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex 400 Adjustable Frequency AC Drive.

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.

Reference Materials

The following manuals are recommended for general drive information:

Title	Publication	Available Online at …
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001…	**www.rockwellautomation.com/literature**
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	

Manual Conventions

- In this manual we refer to the PowerFlex 400 Adjustable Frequency AC Drive as; drive, PowerFlex 400 or PowerFlex 400 Drive.
- Parameter numbers and names are shown in this format:

P031 [Motor NP Volts]

Name

Number

Group

b = Basic Display Group
P = Basic Program Group
T = Terminal Block Group
C = Communications Group
A = Advanced Program Group
R = Aux Relay Card Group
d = Advanced Display Group

- The following words are used throughout the manual to describe an action:

Word	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

Drive Frame Sizes

Similar PowerFlex 400 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: 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 at the –DC and P2 terminals on the Power Terminal Block (refer to Chapter 1 Power Terminal descriptions). The voltage must be zero.

A darkened LCD display and 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 A187).

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12
22C	**-**	**D**	**038**	**A**	**1**	**0**	**3**
Drive	Dash	Voltage Rating	Rating	Enclosure	HIM	Emission Class	Comm Slot

Code	
22C	PowerFlex 400

Code	Voltage	Ph.
B	240V AC	3
D	480V AC	3

Output Current @ 200-240V 60Hz Input

Code	Amps	kW (HP)	Frame
012	12	2.2 (3.0)	C
017	17.5	3.7 (5.0)	C
024	24	5.5 (7.5)	C
033	33	7.5 (10)	C
049	49	11 (15)	D
065	65	15 (20)	D
075	75	18.5 (25)	D
090	90	22 (30)	D
120	120	30 (40)	E
145	145	37 (50)	E

Output Current @ 380-480V Input

Code	Amps	kW (HP)	Frame
6P0	6.0	2.2 (3.0)	C
010	10.5	4.0 (5.0)	C
012	12	5.5 (7.5)	C
017	17	7.5 (10)	C
022	22	11 (15)	C
030	30	15 (20)	C
038	38	18.5 (25)	D
045	45.5	22 (30)	D
060	60	30 (40)	D
072	72	37 (50)	E
088	88	45 (60)	E
105	105	55 (75)	E
142	142	75 (100)	E
170	170	90 (125)	F
208	208	110 (150)	F
260	260	132 (200)	G
310	310	160 (250)	G
370	370	200 (300)	H
460	460	250 (350)	H

Code	Enclosure
N	Panel Mount - IP20/UL Open-Type[1]
A	Panel Mount - IP30/NEMA 1/UL Type 1[2]
F	Flange Mount - IP20/UL Open Type[3]

Code	Interface Module
1	Fixed Keypad

Code	Rating
0	Not Filtered

Code	Version
3	RS485

(1) Frame C drives only available with IP20/UL Open-Type enclosure. Field installed conversion kit available to achieve IP30/NEMA 1/UL Type 1 rating.

(2) Frame D, E, F, G and H drives only available with IP30/NEMA 1/UL Type 1 enclosure.

(3) Frame C drives only.

Additional accessories, options and adapters are available. See Appendix B for details.

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Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 400 Drive.

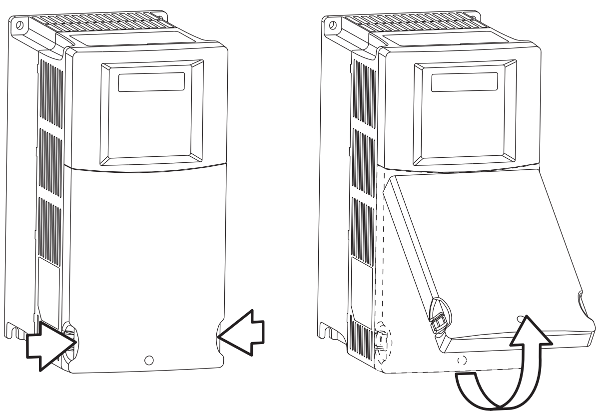
Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. 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.

Opening the Cover

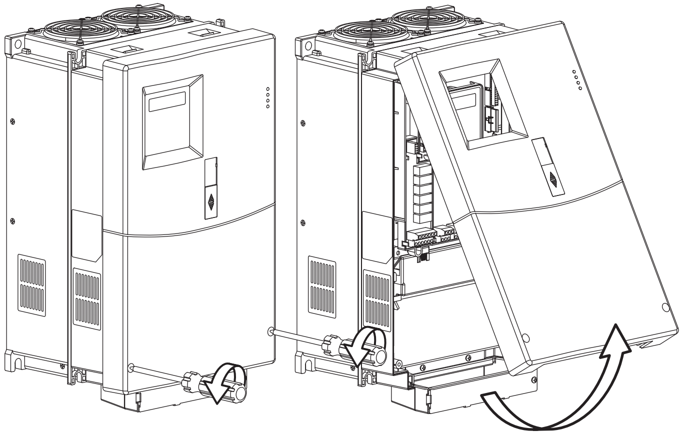
Frame C Drives

1. Press and hold in the tabs on each side of the cover.
2. Pull the cover out and up to release.



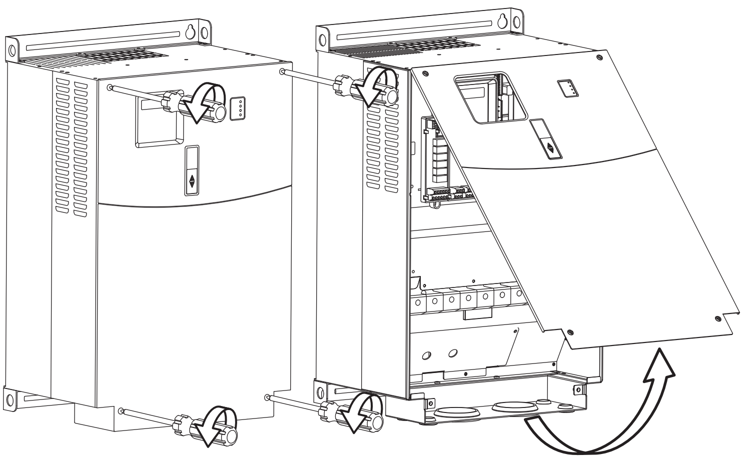
Frame D Drives

1. Loosen the two captive cover screws.
2. Pull the bottom of the cover out and up to release.



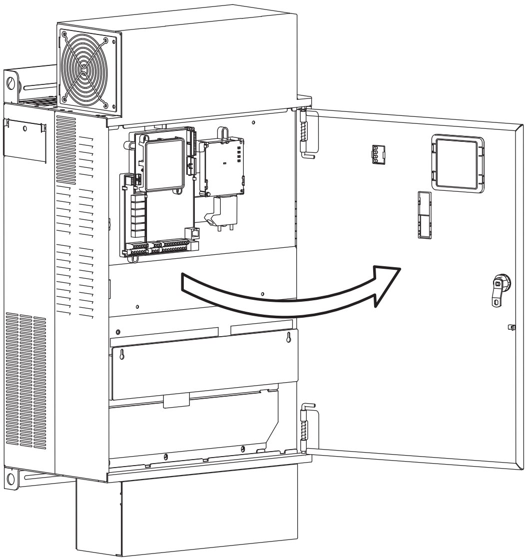
Frame E Drives

1. Loosen the four captive cover screws.
2. Pull the bottom of the cover out and up to release.



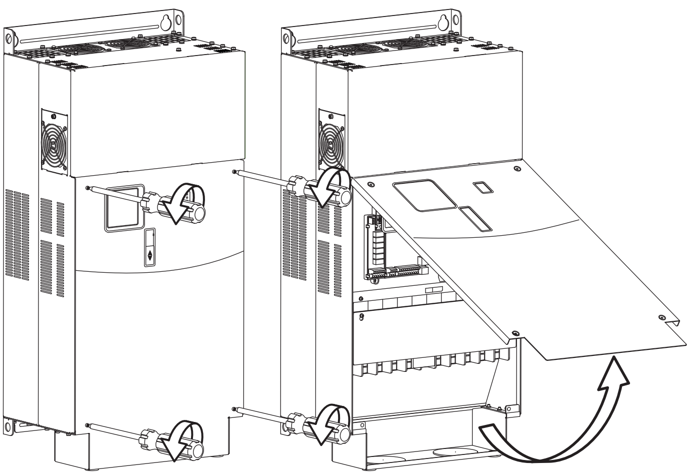
Frame F Drives

1. Turn the latch counterclockwise.
2. Pull on the latch to swing the door open.



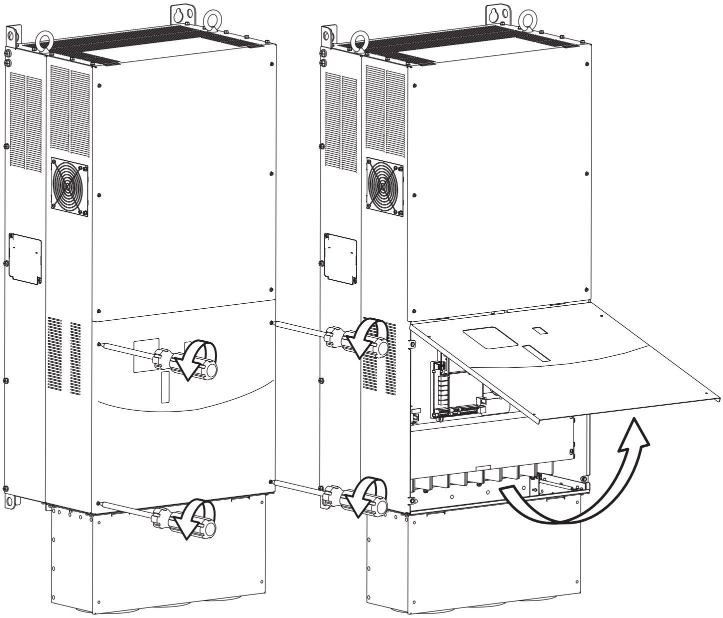
Frame G Drives

1. Loosen the four captive cover screws.
2. Pull the bottom of the cover out and up to release.



Frame H Drives

1. Loosen the four captive cover screws.
2. Pull the bottom of the cover out and up to release.



Mounting Considerations

- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)
D	M8 (5/16 in.)	6.0-7.4 N-m (53.2-65.0 lb.-in.)
E	M8 (5/16 in.)	8.8-10.8 N-m (78.0-95.3 lb.-in.)
F	M10 (3/8 in.)	19.6-23.5 N-m (173.6-208.3 lb.-in.)
G	M12 (1/2 in.)	33.5-41.0 N-m (296.5-362.9 lb.-in.)
H	M12 (1/2 in.)	33.5-41.0 N-m (296.5-362.9 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.

Maximum Surrounding Air Temperature

Frame	Enclosure Rating	Temperature Range	Minimum Mounting Clearances
C	IP 20/UL Open-Type	-10° to 45°C (14° to 113°F)	See Figure 1.1, Mounting Option A
	IP 30/NEMA 1/UL Type 1[1]	-10° to 45°C (14° to 113°F)	See Figure 1.1, Mounting Option B
	IP 20/UL Open-Type	-10° to 50°C (14° to 122°F)	See Figure 1.1, Mounting Option B
D	IP 30/NEMA 1/UL Type 1	-10° to 45°C (14° to 113°F)	See Figure 1.2
E			
F			See Figure 1.3
G			See Figure 1.4
H			

(1) Frame C drives require installation of the PowerFlex 400 IP 30/NEMA 1/UL Type 1 option kit to achieve this rating.

Minimum Mounting Clearances

Refer to Appendix B for mounting dimensions.

Figure 1.1 Frame C Mounting Clearances

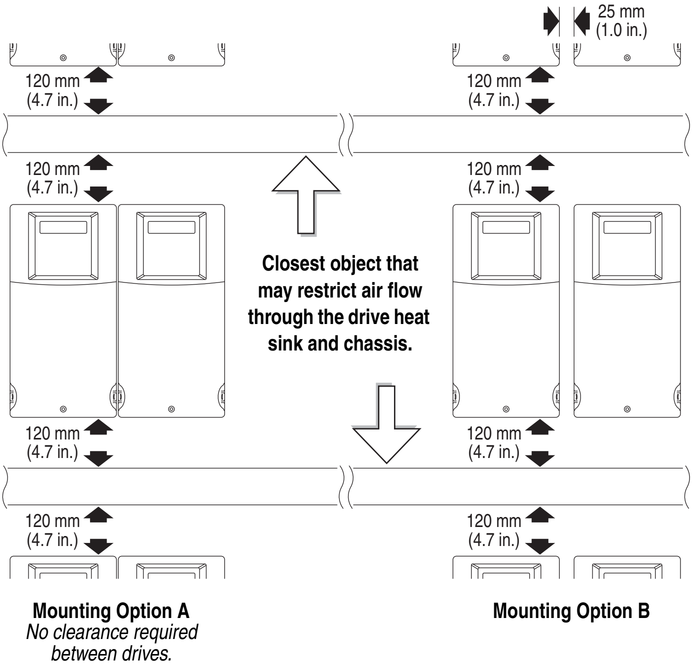


Figure 1.2 Frames D & E Mounting Clearances

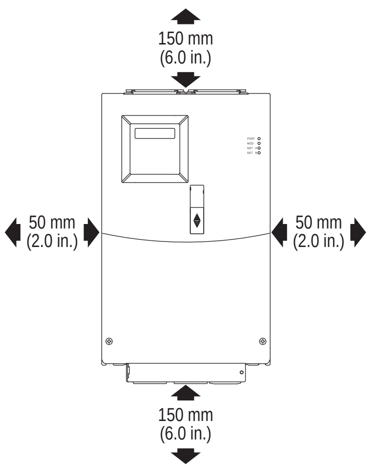


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Figure 1.3 Frame F Mounting Clearances

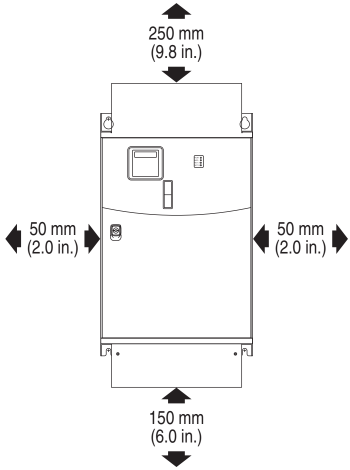
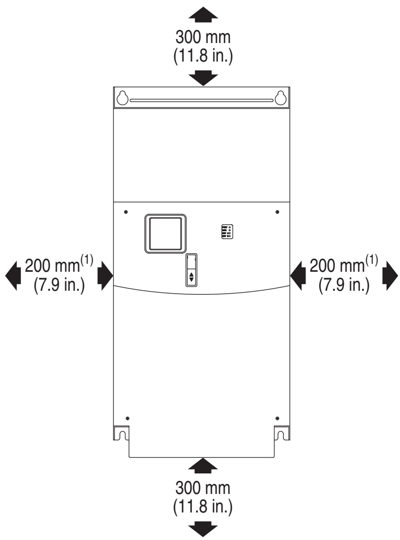


Figure 1.4 Frames G & H Mounting Clearances



(1) If the drive is installed with a side gap of 200 mm, it has to be removed from the shelf to change the fan. If the drive is installed with a side gap of 300 mm, it does not need to be removed from the shelf to change the fan.

Debris Protection

Frame C Drives – A plastic top panel is included with the drive. Install the panel to prevent debris from falling through the vents of the drive housing during installation. Remove the panel for IP 20/Open Type applications.

Frame D, E, F, G and H Drives – These drives have built-in debris protection. Installation of a protective panel is not required.

Storage

- Store within an ambient temperature range of -40° to +85°C.
- Store within a relative humidity range of 0% to 95%, non-condensing.
- Do not expose to a corrosive atmosphere.

AC Supply Source Considerations

Ungrounded Distribution Systems

ATTENTION: PowerFlex 400 drive frames 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.

Disconnecting MOVs (Drive Frames C, E and F only.)

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system 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 Figure 1.6.

Figure 1.5 Phase to Ground MOV Removal

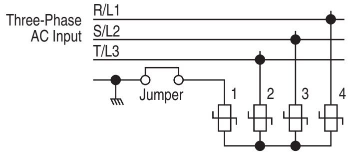
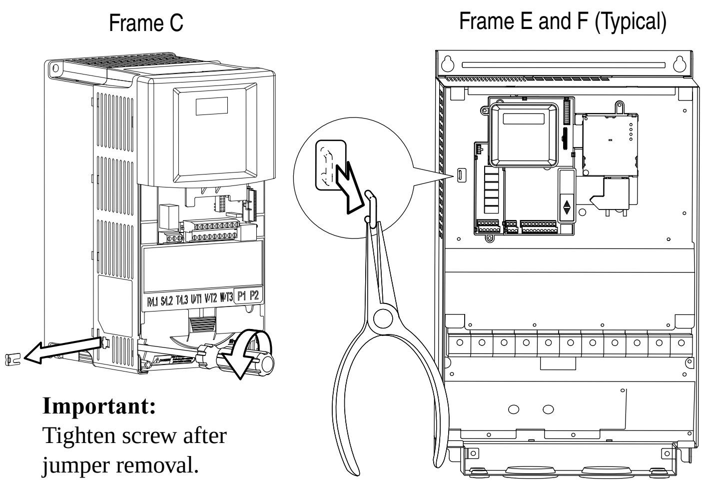


Figure 1.6 MOV Jumper Location



Note: Frame D, G and H drives do not contain a MOV to ground connection and are suitable for operation in both grounded and ungrounded distribution systems without modification.

Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see Appendix A). Listed in Table 1.A are certain input power conditions which may cause component damage or reduction in product life. If any of the conditions exist, as described in Table 1.A, 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. The device should be mounted closest to the branch and sized to handle the total current of the branch circuit.

Table 1.A Input Power Conditions

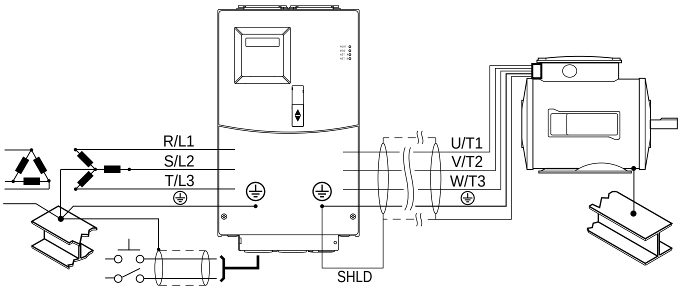
Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance)	• Install Line Reactor[1] • or Isolation Transformer
Line has power factor correction capacitors	• Install Line Reactor[1] • or Isolation Transformer
Line has frequent power interruptions	
Line has intermittent noise spikes in excess of 6000V (lightning)	
Phase to ground voltage exceeds 125% of normal line to line voltage	• Remove MOV jumper to ground (Frame C, E and F drives only) • or Install Isolation Transformer with grounded secondary if necessary
Ungrounded distribution system	

(1) Refer to 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.

Figure 1.7 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 conduit box 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 an external filter with any drive rating, 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 400 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.

Fusing

The ratings in the table that follows are the recommended values for use with each drive rating. The devices listed in this table are provided to serve as a guide.

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 and group motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

Table 1.B Recommended Branch Circuit Protective Devices

Voltage Rating	**Drive Rating** *kW (HP)*	**Fuse Rating**[1] *Amps*	**140M Motor Protectors**[2] [3] *Catalog No.*	**Recommended MCS Contactors** *Catalog No.*	**Min. Enclosure Volume**[4] *Inches*^{3}
200-240V AC – 3-Phase	2.2 (3.0)	20	140M-F8E-C16	100-C23	5098
	3.7 (5.0)	30	140M-F8E-C25	100-C37	5098
	5.5 (7.5)	35	140M-F8E-C32	100-C37	5098
	7.5 (10)	45	140M-F8E-C45	100-C45	5098
	11 (15)	70	–	100-C60	–
	15 (20)	90	–	100-C85	–
	18.5 (25)	100	–	100-D95	–
	22 (30)	125	–	100-D110	–
	30 (40)	175	–	100-D180	–
	37 (50)	200	–	100-D180	–
380-480V AC – 3-Phase	2.2 (3.0)	10	140M-D8E-C10	100-C09	5098
	4.0 (5.0)	20	140M-D8E-C16	100-C16	5098
	5.5 (7.5)	20	140M-D8E-C16	100-C23	5098
	7.5 (10)	25	140M-D8E-C20	100-C23	5098
	11 (15)	30	140M-F8E-C32	100-C30	5098
	15 (20)	40	140M-F8E-C32	100-C37	5098
	18.5 (25)	50	140M-F8E-C45	100-C60	9086
	22 (30)	60	–	100-C60	–
	30 (40)	80	–	100-C85	–
	37 (50)	100	–	100-C85	–
	45 (60)	125	–	100-D110	–
	55 (75)	150	–	100-D140	–
	75 (100)	200	–	100-D180	–
	90 (125)	250	–	100-D210	–
	110 (150)	250	–	100-D250	–
	132 (200)	300	–	100-D300	–
	160 (250)	400	–	100-D420	–
	200 (300)	500	–	100-D420	–
	250 (350)	600	–	100-D630	–

(1) Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

(2) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(3) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(4) When using a Manual Self-Protected (Type E) Combination Motor Controller, 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 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 200-600 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 meters (1 foot) for every 10 meters (32.8 feet) 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 must use 600V, 75°C or 90°C wire.
Use copper wire only.

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. **Do not use THHN or similarly coated wire in wet areas**. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

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 Guidelines for PWM AC Drives," publication DRIVES-IN001A-EN-P.

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). See Table 1.C for recommendations.

The reflected wave data applies to all frequencies 2 to 10 kHz.
For 240V ratings, reflected wave effects do not need to be considered.

Table 1.C Maximum Cable Length Recommendations

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only** (1)
	1000 Vp-p	7.6 meters (25 feet)
	1200 Vp-p	22.9 meters (75 feet)
	1600 Vp-p	152.4 meters (500 feet)

(1) Longer cable lengths can be achieved by installing devices on the output of the drive. Consult factory for recommendations.

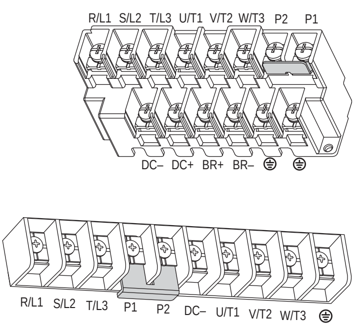
Output Disconnect

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 control run commands.

Power Terminal Block

Frame C, D, F, G and H drives utilize a finger guard over the power wiring terminals. Replace the finger guard when wiring is complete.

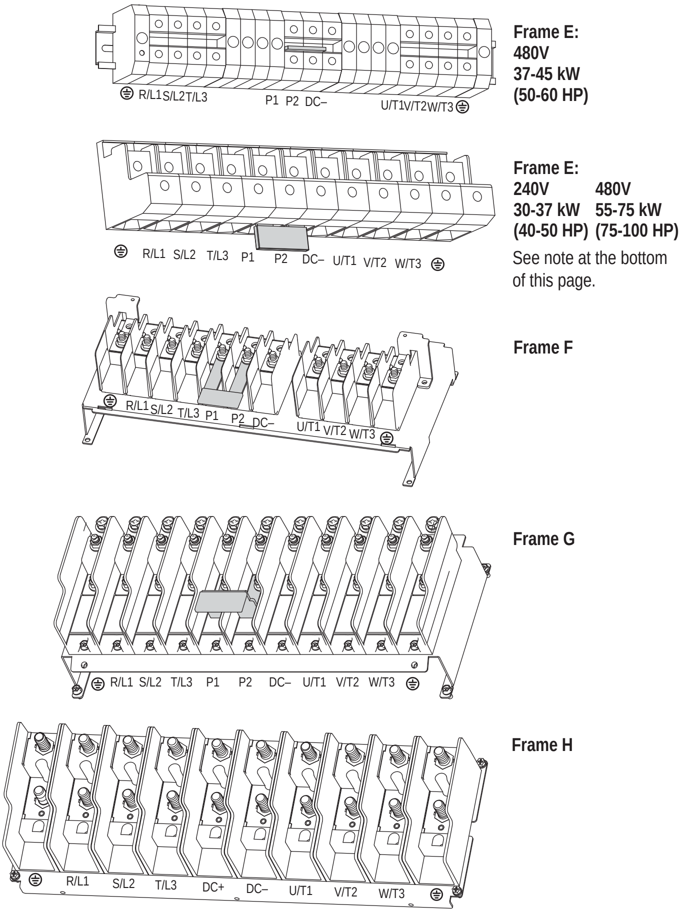
Figure 1.8 Power Terminal Blocks (Frames C through D)



Frame C

Frame D

Figure 1.9 Power Terminal Blocks (Frames E through H)



Important: For Frame E, 240V 30-37 kW (40-50 HP) and 480V 55-75 kW (75-100 HP) drives, take care to place the wire beneath the jumper and not above it when connecting to terminals P1 and P2.

Bottom view of terminal block and wire

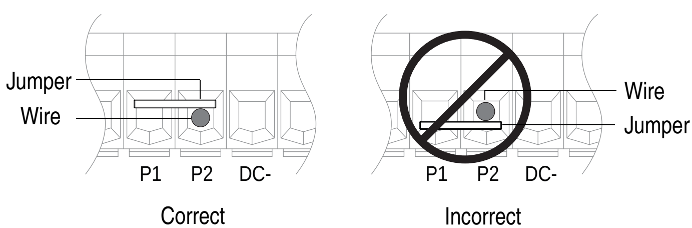
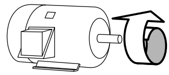
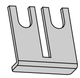


Table 1.D Power Terminal Descriptions

Terminal [1]	Description
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1
V/T2	To Motor V/T2 =  Switch any two motor leads to change forward direction.
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection Drives are shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected. 
DC–, DC+	DC Bus Connection (Frame C and H Drives)
P2, DC–	DC Bus Connection (Frame D, E, F and G Drives)
BR+, BR–	Not Used
⏚	Safety Ground - PE

(1) **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.

Table 1.E Power Terminal Block Specifications

Frame	Maximum Wire Size [1]	Minimum Wire Size [1]	Recommended Torque
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9 N-m (26 lb.-in.)
D	33.6 mm^2 (2 AWG)	8.4 mm^2 (8 AWG)	5.1 N-m (45 lb.-in.)
E 480V 37-45 kW (50-60 HP)	33.6 mm^2 (2 AWG)	3.5 mm^2 (12 AWG)	5.6 N-m (49.5 lb.-in.)
E 240V 30-37 kW (40-50 HP) 480V 55-75 kW (75-100 HP)	107.2 mm^2 (4/0 AWG)	53.5 mm^2 (1/0 AWG)	19.5 N-m (173 lb.-in.)
F	152.0 mm^2 (300 MCM)	85.0 mm^2 (3/0 AWG)	19.5 N-m (173 lb.-in.)
G	152.0 mm^2 (300 MCM)	107.2 mm^2 (4/0 AWG)	29.4 N-m (260 lb.-in.)
H	253.0 mm^2 (500 MCM)	152.0 mm^2 (300 MCM)	40.0 N-m (354 lb.-in.)

(1) Maximum/minimum sizes that the terminal block will accept - these are not recommendations. If national or local codes require sizes outside this range, lugs may be used. Some ratings will require a pair of wires.

I/O Wiring Recommendations

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.

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 meters (1 foot).

ATTENTION: Driving the 4-20mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Control Wire Types

Table 1.F Recommended Control and Signal Wire[1]

Wire Type(s)	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18 AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18 AWG), 3 conductor, shielded for remote pot only.	

(1) 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.

I/O Terminal Block

Table 1.G I/O Terminal Block Specifications

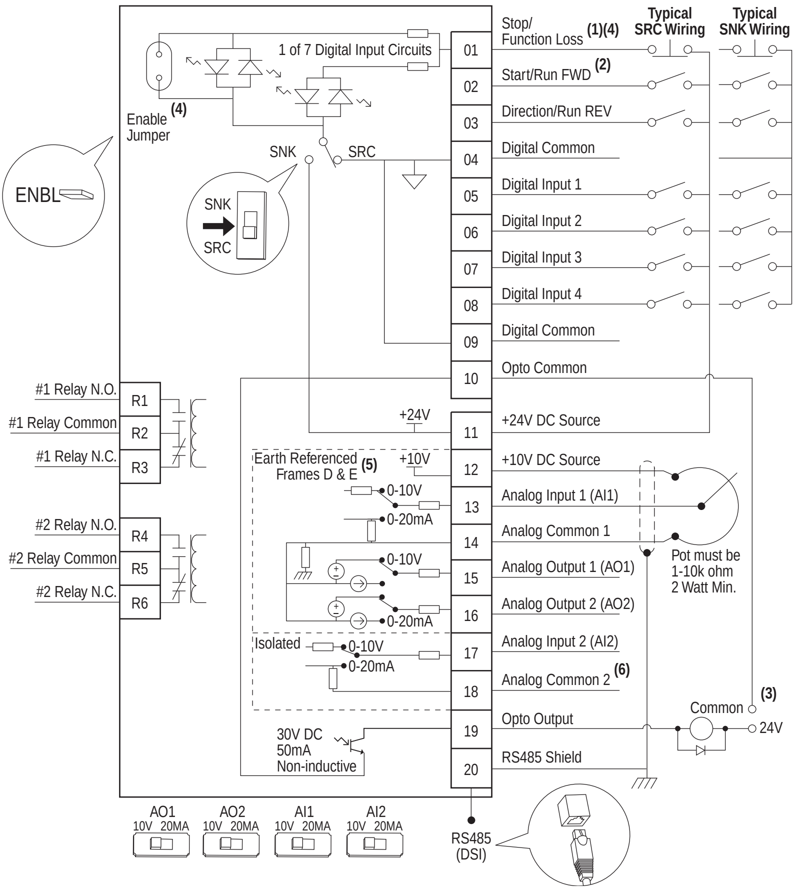
Frame	Maximum Wire Size [2]	Minimum Wire Size [2]	Torque
All	1.3 mm^2 (16 AWG)	0.13 mm^2 (26 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(2) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 meters (100 feet). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common must be connected to ground terminal/protective earth. If using the RS485 (DSI) port, I/O Terminal 20 should also be connected to ground terminal/protective earth.

Figure 1.10 Control Wiring Block Diagram



(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to option 1 “3-Wire” or 6 “2-W Lvl/Enbl”. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [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.

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037[(4)]
2-Wire	Per P037	Coast
RS485 Port	Per P037	Coast

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. If reverse is enabled by A166, 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.

(4) When the ENBL enable jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation.

(5) Most I/O terminals labeled “Common” are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference. Frame D–H drives have Analog Common 1 referenced to ground.

(6) Common for Analog Input 2 (AI2). Electronically isolated from digital I/O and opto output. Not to be used with Analog Input 1 (AI1), Analog Output 1 (AO1) or Analog Output 2 (AO2). With Analog Input 2, provides one fully isolated analog input channel.

Table 1.H Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
01	Stop [1] / Function Loss	Coast	Factory installed jumper or a normally closed input must be present for the drive to start. Program with P036 [Start Source].	P036 [1]
02	Start/Run FWD	–	HAND Mode: Command comes from Integral Keypad. AUTO Mode: I/O Terminal 02 is active. Program with P036 [Start Source].	P036, P037
03	Direction/Run REV	Rev Disabled	To enable reverse operation, program with A166 [Reverse Disable]. Program with P036 [Start Source].	P036, P037, A166
04	Digital Common	–	For digital inputs. Tied to I/O Terminal 09. Electronically isolated with digital inputs from analog I/O and opto output.	
05	Digital Input 1	Purge [2]	Program with T051 [Digital In1 Sel].	T051
06	Digital Input 2	Local	Program with T052 [Digital In2 Sel].	T052
07	Digital Input 3	Clear Fault	Program with T053 [Digital In3 Sel].	T053
08	Digital Input 4	Comm Port	Program with T054 [Digital In4 Sel].	T054
09	Digital Common	–	For digital inputs. Tied to I/O Terminal 04. Electronically isolated with digital inputs from analog I/O and opto output.	
10	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto output from analog I/O and digital inputs.	
11	+24V DC	–	Drive supplied power for digital inputs. Referenced to Digital Common. Max. Output: 100mA.	
12	+10V DC	–	Drive supplied power for 0-10V external potentiometer. Referenced to Analog Common. Max. Output: 15mA.	P038
13	Analog Input 1	0-10V	External 0-10V (unipolar), 0-20mA or 4-20mA input supply or potentiometer wiper. Default input is 0-10V. For current (mA) input, set AI1 DIP Switch to 20mA. Program with T069 [Analog In 1 Sel]. Input Impedance: 100k ohm (Voltage Mode) 250 ohm (Current Mode)	T069, T070, T071, T072
14	Analog Common 1	–	Common for Analog Input 1 and Analog Output 1 and 2. Electrically isolated from digital I/O and opto output.	
15	Analog Output 1	OutFreq 0-10	Default analog output is 0-10V. For current (mA) value, set AO1 DIP Switch to 20mA. Program with T082 [Analog Out1 Sel]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	P038, T051-T054, A152
16	Analog Output 2	OutCurr 0-10	Default analog output is 0-10V. For a current (mA) value, set AO2 DIP Switch to 20mA. Program with T085 [Analog Out2 Sel]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	T082, T084, T085, T086, T087
17	Analog Input 2	0-10V	Optically isolated external 0-10V (unipolar), ±10V (bipolar), 0-20mA or 4-20mA input supply or potentiometer wiper. Default input is 0-10V. For current (mA) input, set AI2 DIP Switch to 20mA. Program with T073 [Analog In 2 Sel]. Input Impedance: 100k ohm (Voltage Mode) 250 ohm (Current Mode)	T073, T074, T075, T076
18	Analog Common 2	–	For Analog Input 2. Electronically isolated from digital I/O and opto output. With Analog Input 2, provides one fully isolated analog input channel.	
19	Opto Output	At Frequency	Program with T065 [Opto Out Sel].	T065, T066, T068
20	RS485 (DSI) Shield	–	Terminal connected to Safety Ground - PE when using the RS485 (DSI) Communication Port.	

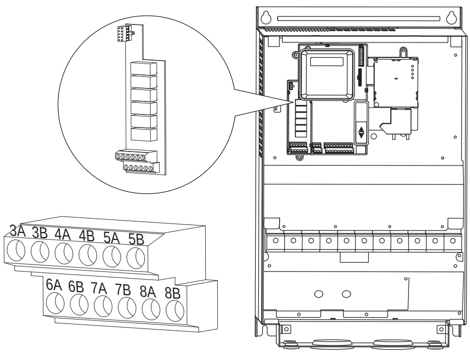
(1) See Footnotes (1) and (4) on page 1-21.

(2) **Important** information regarding Stop commands and the [Digital Inx Sel] Purge option is provided on page 3-12.

Table 1.I Relay Terminal Designations and DIP Switches

No.	Signal	Default	Description	Param.
R1	#1 Relay N.O.	Ready/Fault	Normally open contact for No. 1 output relay.	T055
R2	#1 Relay Common	–	Common for output relay.	
R3	#1 Relay N.C.	Ready/Fault	Normally closed contact for No. 1 output relay.	T055
R4	#2 Relay N.O.	Motor Running	Normally open contact for No. 2 output relay.	T060
R5	#2 Relay Common	–	Common for output relay.	
R6	#2 Relay N.C.	Motor Running	Normally closed contact for No. 2 output relay.	T060
Selection DIP Switches: Analog Input (AI1 & AI2) Analog Output (AO1 & AO2)		0-10V	Sets analog output to either voltage or current. Settings must match: AI1 & T069 [Analog In 1 Sel] AI2 & T073 [Analog In 2 Sel] AO1 & T082 [Analog Out1 Sel] AO2 & T085 [Analog Out2 Sel]	
Sink/Source DIP Switch		Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.	

Figure 1.11 User Installed Auxiliary Relay Card (Frames D, E, F, G and H Only)

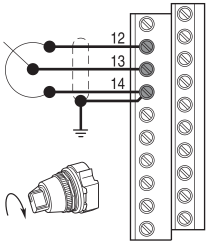
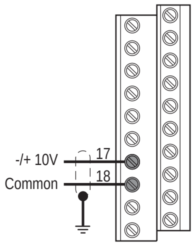
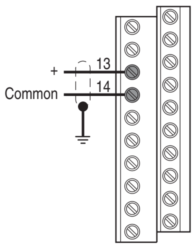
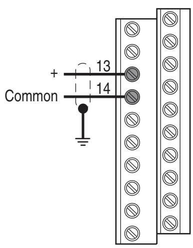
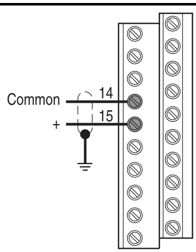


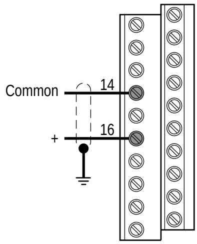
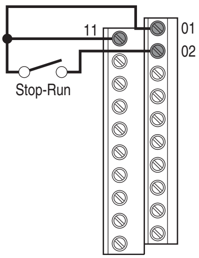
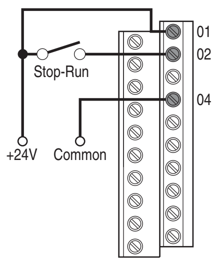
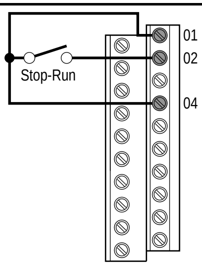
Important: If using auxiliary motor control, ensure that wiring and parameter configuration are correct before wiring contactor outputs. All relays on the Auxiliary Relay Card will energize on power-up by default. Failure to verify proper wiring and parameter configuration can result in improper motor operation or drive damage. Refer to Appendix D for more details.

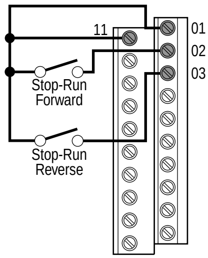
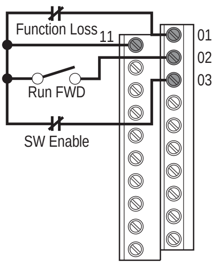
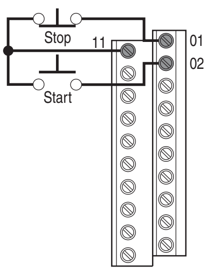
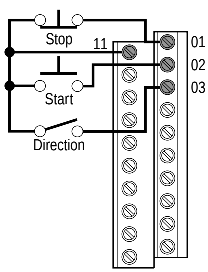
Table 1.J User Installed Relay Board Terminal Designations

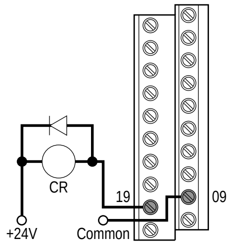
No.	Signal	Default	Description	Param.
3A	#3 Relay N.O.	Ready/Fault	Normally open contact for Number 3 Output Relay	R221
3B	#3 Relay Common	–	Common for Number 3 Output Relay	
4A	#4 Relay N.O.	Ready/Fault	Normally open contact for Number 4 Output Relay	R224
4B	#4 Relay Common	–	Common for Number 4 Output Relay	
5A	#5 Relay N.O.	Ready/Fault	Normally open contact for Number 5 Output Relay	R227
5B	#5 Relay Common	–	Common for Number 5 Output Relay	
6A	#6 Relay N.O.	Ready/Fault	Normally open contact for Number 6 Output Relay	R230
6B	#6 Relay Common	–	Common for Number 6 Output Relay	
7A	#7 Relay N.O.	Ready/Fault	Normally open contact for Number 7 Output Relay	R233
7B	#7 Relay Common	–	Common for Number 7 Output Relay	
8A	#8 Relay N.O.	Ready/Fault	Normally open contact for Number 8 Output Relay	R236
8B	#8 Relay Common	–	Common for Number 8 Output Relay	

I/O Wiring Examples

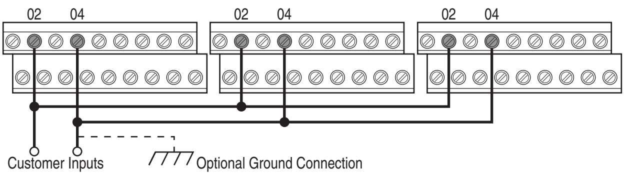
Input/Output	Connection Example	Required Settings
Potentiometer 1-10k Ohm Potentiometer Recommended (2 Watt Minimum)		DIP Switch AI1 = 10V Parameters P038 [Speed Reference] = 2 "Analog In1" T069 [Analog In 1 Sel] = 2 "0-10V" Scaling T070 [Analog In 1 Lo] T071 [Analog In 1 Hi] Check Results d305 [Analog In 1]
Analog Input Bipolar Speed Reference, ±10V Input		DIP Switch AI2 = 10V Parameters P038 [Speed Reference] = 3 "Analog In2" T073 [Analog In 2 Sel] = 3 "-10 to +10V" Scaling T074 [Analog In 2 Lo] T075 [Analog In 2 Hi] Check Results d306 [Analog In 2]
Analog Input Unipolar Speed Reference, 0 to +10V Input		DIP Switch AI1 = 10V Parameters P038 [Speed Reference] = 2 "Analog In1" T069 [Analog In 1 Sel] = 2 "0-10V" Scaling T070 [Analog In 1 Lo] T071 [Analog In 1 Hi] Check Results d305 [Analog In 1]
Analog Input Unipolar Speed Reference, 4-20 mA Input		DIP Switch AI1 = 20MA Parameters P038 [Speed Reference] = 2 "Analog In1" T069 [Analog In 1 Sel] = 1 "4-20 mA" Scaling T070 [Analog In 1 Lo] T071 [Analog In 1 Hi] Check Results d305 [Analog In 1]
Analog Output Unipolar, 0 to +10V Output • 1k Ohm Minimum		DIP Switch AO1 = 10V Parameters T082 [Analog Out1 Sel] = 0 through 6 Scaling T083 [Analog Out1 High] T084 [Analog Out1 Setpt]

Input/Output	Connection Example	Required Settings
Analog Output Unipolar, 4-20 mA Output • 525 Ohm Maximum		DIP Switch AO2 = 20MA Parameters T082 [Analog Out1 Sel] = 14 through 20 Scaling T083 [Analog Out1 High] T084 [Analog Out1 Setpt]
2 Wire Control Sourcing (SRC), Internal Supply, Non-Reversing • Input must be active for the drive to run. • When input is opened, the drive will stop as specified by P037 [Stop Mode]. • Drive will not run if I/O Terminal 01 is open. Drive will coast to stop if opened while running.		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 2, 3, 4 P037 [Stop Mode] = 0 through 7
2 Wire Control Sourcing (SRC), External Supply, Non-Reversing • Input must be active for the drive to run. • When input is opened, the drive will stop as specified by P037 [Stop Mode]. • User supplied 24V DC power source must be used. • Each digital input draws 6 mA. • Drive will not run if I/O Terminal 01 is open. Drive will coast to stop if opened while running.		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 2, 3, 4 P037 [Stop Mode] = 0 through 7
2 Wire Control Sinking (SNK), Internal Supply, Non-Reversing • Input must be active for the drive to run. • When input is opened, the drive will stop as specified by P037 [Stop Mode]. • Drive will not run if I/O Terminal 01 is open. Drive will coast to stop if opened while running.		DIP Switch SNK/SRC = SNK Parameters P036 [Start Source] = 2, 3, 4 P037 [Stop Mode] = 0 through 7

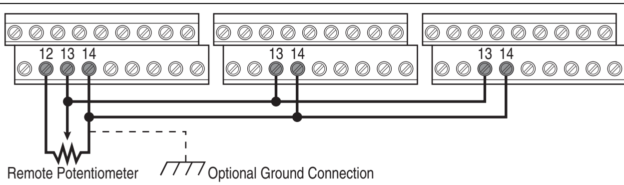
Input/Output	Connection Example	Required Settings
2 Wire Control Sourcing (SRC), Internal Supply, Run FWD/Run REV • Input must be active for the drive to run. • When input is opened, the drive will stop as specified by P037 [Stop Mode]. • If both Run FWD and Run REV inputs are closed at the same time, an undetermined state could occur. • Drive will not run if I/O Terminal 01 is open. Drive will coast to stop if opened while running.		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 2, 3, 4 P037 [Stop Mode] = 0 through 7 A166 [Reverse Disable] = 0 “Enabled”
2 Wire Control with Function Loss and SW Enable Sourcing (SRC), Internal Supply, Non-Reversing • Input must be active for the drive to run. • When input is opened, the drive will stop as specified by P037 [Stop Mode]. • Drive will not run if I/O Terminal 03 is open. Drive will coast to stop if opened while running. • Drive will fault if I/O Terminal 01 is open. Drive will coast to stop if opened while running. Requires drive reset once terminal is closed.		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 6 “2-W Lvl/Enbl” P037 [Stop Mode] = 0 through 7
3 Wire Control Sourcing (SRC), Internal Supply, Non-Reversing • A momentary input will start the drive. • A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode].		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 1 “3-Wire” P037 [Stop Mode] = 0 through 7
3 Wire Control Sourcing (SRC), Internal Supply, Reversing • A momentary input will start the drive. • A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode]. • I/O Terminal 03 determines direction.		DIP Switch SNK/SRC = SRC Parameters P036 [Start Source] = 1 “3-Wire” P037 [Stop Mode] = 0 through 7 A166 [Reverse Disable] = 0 “Rev Enabled”

<table>
<tr><th>Input/Output</th><th>Connection Example</th><th>Required Settings</th></tr>
<tr><td>Opto Output
• 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 is rated 30V DC, 50 mA (non-inductive).</td><td>
</td><td>Parameters
T065 [Opto Out Sel] = 0 through 15
T066 [Opto Out Level]
T068 [Opto Out Logic]</td></tr>
</table>

Typical Multiple Drive Connection Examples

<table>
<tr><th>Input/Output</th><th>Connection Example</th></tr>
<tr><td>Multiple Digital Input Connections
Customer Inputs can be wired per the External Supply (SRC) example on page 1-25.</td><td>

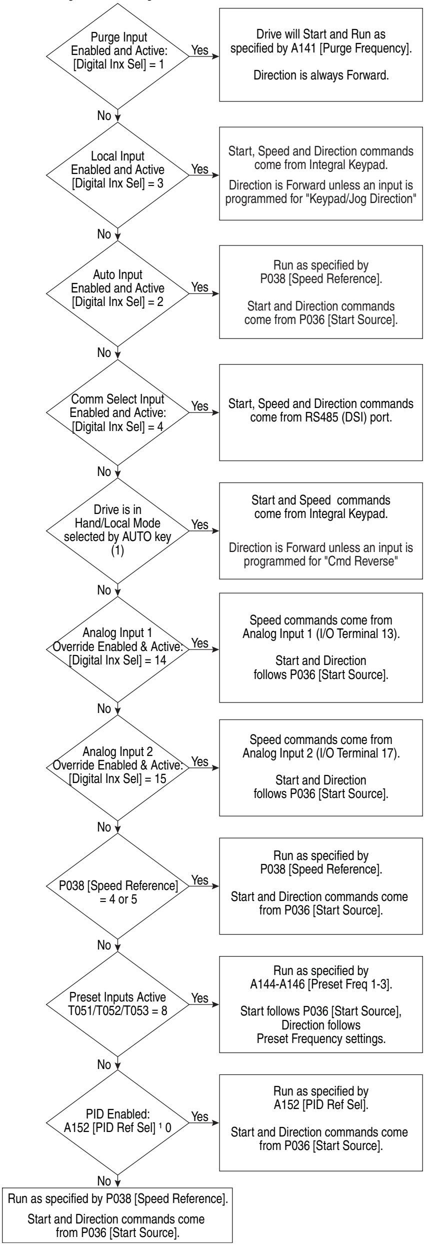
When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect I/O Terminal 04 common together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of I/O Terminal 04 should be connected.

ATTENTION: Digital inputs on multiple drives should <u>not</u> 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.</td></tr>
<tr><td>Multiple Analog Connections</td><td>

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.</td></tr>
</table>

Start and Speed Reference Control

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. The drive Start command is normally determined by P036 [Start Source]. However, the settings for these parameters can be overridden by a variety of methods. See the chart below for the override priority.



(1) Refer to page 2-6 for additional information on the operation of the Hand/Auto Mode.

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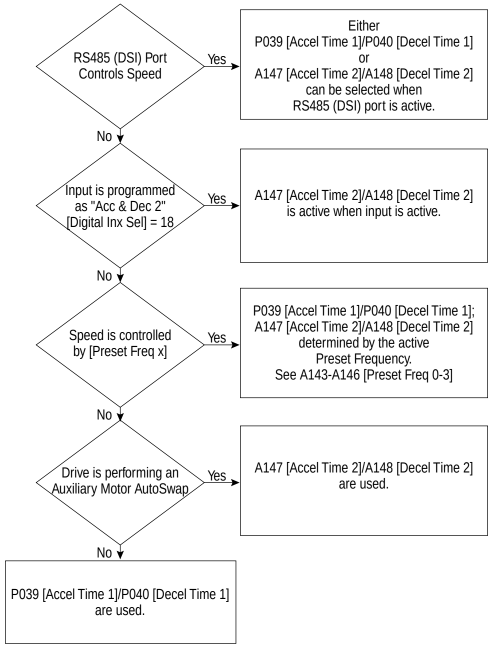
Accel/Decel Selection

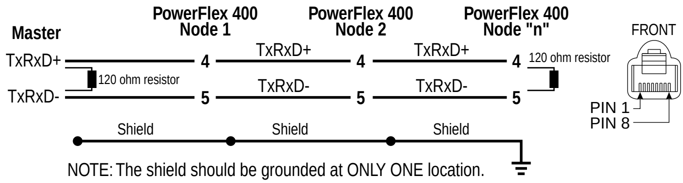
The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P039 [Accel Time 1] and P040 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, RS485 (DSI) communications and/or parameters. See the chart below for the override priority.



RS485 Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

Figure 1.12 Network Wiring Diagram



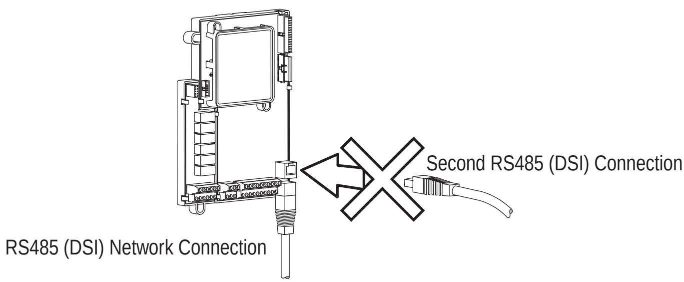
Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 400 RJ45 socket contain power, etc. for other Rockwell Automation peripheral devices and must not be connected.

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.

On Drive Connections

PowerFlex 400 Frame D, E, F, G and H drives are equipped with two RS485 (DSI) ports. One is accessible via an access door when the cover is on and one is only accessible with the cover off. When one of these ports has a Rockwell DSI device connected, the second port cannot be used.

Figure 1.13 Frame D, E, F, G and H RS485 Ports



EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User Manual.

CE Declarations of Conformity are available online at:
http://www.ab.com/certification/ce/docs.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

General Notes

All Drive Frames

- 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.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Frame C Drives Only

- If the plastic top panel is removed or the optional conduit box 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.

Essential Requirements for CE Compliance

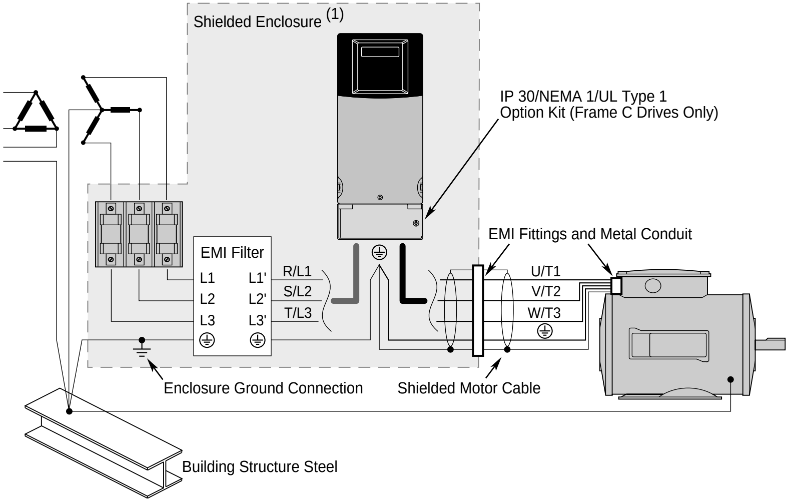
Conditions 1-4 listed below **must be** satisfied for PowerFlex drives to meet the requirements of **EN61800-3**.

1. Grounding as described in Figure 1.14. Refer to page 1-12 for additional grounding recommendations.
2. Output power, control (I/O) and signal wiring must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.
3. All shielded cables should terminate with the proper shield connector.
4. Conditions in Table 1.K.

Table 1.K PowerFlex 400 – EN61800-3 Compliance

PowerFlex 400 Drive		First Environment Restricted			First Environment Unrestricted		
kW (HP)	**Cat. No. 22C-...**	**Required Filter (Allen-Bradley)**	**Restrict Motor Cable to (Meters)**	**Install Drive and Filter in Shielded Enclosure**	**Required Filter**	**Restrict Motor Cable to (Meters)**	**Install Drive and Filter in Shielded Enclosure**
200-240 Volts							
2.2 (3.0)	B012N103	22-RF034-CS	10	No	22-RF034-CS	1	Required
3.7 (5.0)	B017N103	22-RF034-CS	10	No	22-RF034-CS	1	Required
5.5 (7.5)	B024N103	22-RF034-CS	10	No	22-RF034-CS	1	Required
7.5 (10)	B033N103	22-RF034-CS	10	No	22-RF034-CS	1	Required
11 (15)	B049A103	22-RFD070	150	Required	Deltron MIF Series	50	Required
15 (20)	B065A103	22-RFD100	150	Required	Deltron MIF Series	50	Required
18.5 (25)	B075A103	22-RFD100	150	Required	Deltron MIF Series	50	Required
22 (30)	B090A103	22-RFD150	150	Required	Deltron MIF Series	50	Required
30 (40)	B120A103	22-RFD150	150	No	Deltron MIF Series	50	Required
37 (50)	B145A103	22-RFD180	150	No	Deltron MIF Series	75	Required
380-480 Volts							
2.2 (3.0)	D6P0N103	22-RF018-CS	10	No	22-RF018-CS	1	Required
4.0 (5.0)	D010N103	22-RF018-CS	10	No	22-RF018-CS	1	Required
5.5 (7.5)	D012N103	22-RF018-CS	10	No	22-RF018-CS	1	Required
7.5 (10)	D017N103	22-RF018-CS	10	No	22-RF018-CS	1	Required
11 (15)	D022N103	22-RF026-CS	10	No	22-RF026-CS	1	Required
15 (20)	D030N103	22-RFD036	100	No	Deltron MIF Series	5	Required
18.5 (25)	D038A103	22-RFD050	150	No	Deltron MIF Series	5	Required
22 (30)	D045A103	22-RFD050	150	No	Deltron MIF Series	5	Required
30 (40)	D060A103	22-RFD070	50	No	Deltron MIF Series	5	Required
37 (50)	D072A103	22-RFD100	50	No	Deltron MIF Series	5	Required
45 (60)	D088A103	22-RFD100	50	No	Deltron MIF Series	5	Required
55 (75)	D105A103	22-RFD150	150	No	Deltron MIF Series	5	Required
75 (100)	D142A103	22-RFD180	50	No	Deltron MIF Series	5	Required
90 (125)	D170A103	22-RFD208	50	No	22-RFD208	5	Required
110 (150)	D208A103	22-RFD208	50	No	22-RFD208	5	Required
132 (200)	D260A103	22-RFD323	50	Required	22-RFD323	5	Required
160 (250)	D310A103	22-RFD480	50	Required	22-RFD480	5	Required
200 (300)	D370A103	22-RFD480	50	Required	22-RFD480	5	Required
250 (350)	D460A103	22-RFD480	50	Required	22-RFD480	5	Required

Figure 1.14 Connections and Grounding



(1) Shielded Enclosure required to meet EN61800-3 First Environment Restricted for 200-240V AC 11-22 kW (15-30 HP) PowerFlex 400 drives and to meet EN61800-3 First Environment Unrestricted for all PowerFlex 400 ratings.

FCC Instructions

FCC Compliance

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 when installed according to the User Manual. 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 User 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.

Essential Requirements for FCC Compliance

Conditions 1-4 listed below must be satisfied for PowerFlex 400 drives to meet the requirements of FCC Part 15 Subpart B.

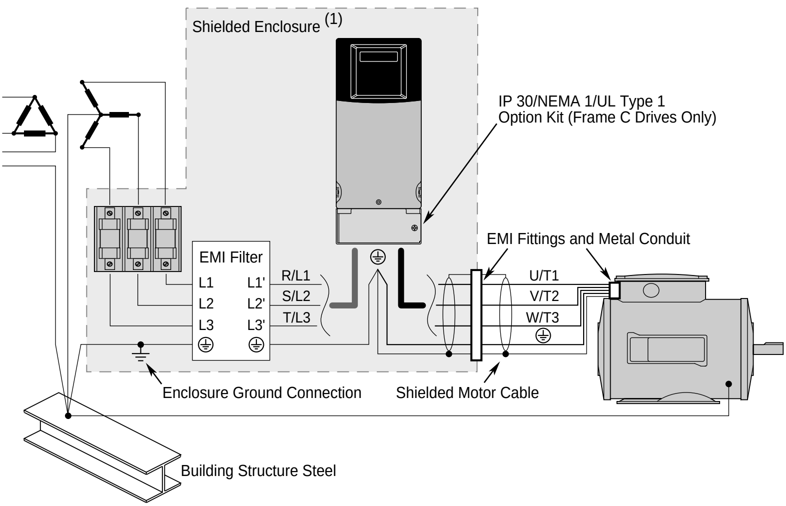
1. Grounding as described in Figure 1.14. Refer to page 1-12 for additional grounding recommendations.
2. Output power, control (I/O) and signal wiring must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.
3. All shielded cables should terminate with the proper shield connector.
4. Conditions in Table 1.L.

Table 1.L PowerFlex 400 – FCC Part 15 Subpart B Compliance

PowerFlex 400 Drive		Required Filter	Restrict Motor Cable to (Meters)	Install Drive and Filter in Enclosure
kW (HP)	**Cat. No.**			
200-240 Volts				
2.2 (3.0)	22C-B012N103	22-RF034-CS	10	No
3.7 (5.0)	22C-B017N103	22-RF034-CS	10	No
5.5 (7.5)	22C-B024N103	22-RF034-CS	10	No
7.5 (10)	22C-B033N103	22-RF034-CS	10	No
11 (15)	22C-B049A103	22-RFD070	150	Required
15 (20)	22C-B065A103	22-RFD100	150	Required
18.5 (25)	22C-B075A103	22-RFD100	150	Required
22 (30)	22C-B090A103	22-RFD150	150	Required
30 (40)	22C-B120A103	22-RFD150	150	No
37 (50)	22C-B145A103	22-RFD180	150	No
380-480 Volts				
2.2 (3.0)	22C-D6P0N103	22-RF018-CS	10	No
4.0 (5.0)	22C-D010N103	22-RF018-CS	10	No
5.5 (7.5)	22C-D012N103	22-RF018-CS	10	No

PowerFlex 400 Drive		Required Filter	Restrict Motor Cable to (Meters)	Install Drive and Filter in Enclosure
kW (HP)	Cat. No.			
7.5 (10)	22C-D017N103	22-RF018-CS	10	No
11 (15)	22C-D022N103	22-RF026-CS	10	No
15 (20)	22C-D030N103	22-RFD036	100	No
18.5 (25)	22C-D038A103	22-RFD050	150	No
22 (30)	22C-D045A103	22-RFD050	150	No
30 (40)	22C-D060A103	22-RFD070	50	No
37 (50)	22C-D072A103	22-RFD100	50	No
45 (60)	22C-D088A103	22-RFD100	50	No
55 (75)	22C-D105A103	22-RFD150	150	No
75 (100)	22C-D142A103	22-RFD180	50	No
90 (125)	22C-D170A103	22-RFD208	50	No
110 (150)	22C-D208A103	22-RFD208	50	No
132 (200)	22C-D260A103	22-RFD323	50	Required
160 (250)	22C-D310A103	22-RFD480	50	Required
200 (300)	22C-D370A103	22-RFD480	50	Required
250 (350)	22C-D460A103	22-RFD480	50	Required

Figure 1.15 Connections and Grounding



(1) Shielded Enclosure required for 200-240V AC 11-22 kW (15-30 HP) PowerFlex 400 drives.

Notes:

Start Up

This chapter describes how to start up the PowerFlex 400 Drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

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

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See Table 1.H on page 1-22 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. 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.

❑ **5.** 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.

❑ **6.** Verify that the Analog I/O DIP Switches are set to 10 volts.

Applying Power to the Drive

- ❑ **7.** Apply AC power and control voltages to the drive.
- ❑ **8.** Familiarize yourself with the integral keypad features (see page 2-3) before setting any Program Group parameters.

Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, and control speed directly from the integral keypad.

If a fault appears on power up, refer to Fault Descriptions on page 4-3 for an explanation of the fault code.

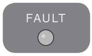
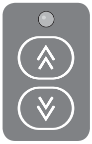
Integral Keypad

Operator Keys

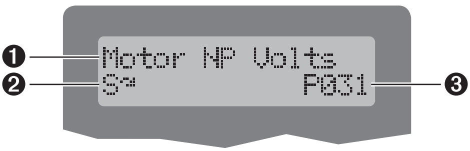
Key	Name	Description
ESC	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
SEL	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit.
	Enter	Advance one step in programming menu. Save a change to a parameter value.
	Digital Speed Increment and Decrement Arrows	Used to control speed of drive. Default is active. Control is activated by parameter P038 [Speed Reference] or P042 [Auto Mode].
HAND	Run/Start & Hand (1)	Used to start the drive. Default is Hand mode as controlled by parameter P042 [Auto Mode]. Control is activated by parameter P036 [Start Source] or P042 [Auto Mode].
AUTO AUTO	Auto (1)	Used to select Auto control mode. Controlled by parameter P042 [Auto Mode].
OFF	Stop/Off	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) **Important:** Certain digital input settings can override drive operation. Refer to Start and Speed Reference Control on page 1-28 for details.

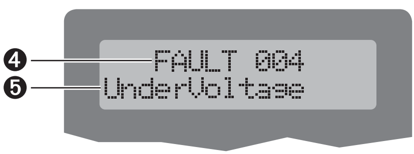
LED Status Indicators

LED		LED State	Description
Program Status		Steady Red	Indicates parameter value can be changed. Selected digit will flash.
Fault Status		Flashing Red	Indicates that the drive is faulted.
Speed Status		Steady Green	Indicates that the digital speed control keys are enabled.
Hand Status		Steady Green	Indicates that the Run/Start key is enabled.
Auto Status		Steady Yellow	Indicates that the drive is in Auto mode.

LCD Display



No.	Description
❶	Parameter Name
❷	**Run/Stop Status:** S→ & S← = Stopped / R→ & R← = Running R→ or R← flashes to indicate that the drive is stopping, but is still decelerating. R→ or R← flashes when DC Injection is commanded. **Direction Indication:** The Direction Arrow → & ← indicates the commanded direction of rotation. If the Arrow is flashing, the drive has been commanded to change direction, but is still decelerating. **Sleep Mode Indication:** R→ or R← flashes to indicate that the drive is in sleep mode.
❸	Parameter Group and Number: b = Basic Display; P = Basic Program; T = Terminal Block C = Communications; A = Advanced Program; R = Aux Relay Card d = Advanced Display



❹	Fault Indication and Fault Number
❺	Fault Name

Viewing and Editing Parameters

The last user-selected Basic Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.

The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Basic Program Group parameter.

Step	Key(s)	Example Displays
1. When power is applied, the last user-selected Basic Display Group parameter number is 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.)		Output Freq S 0.00 Hz
2. Press the Up Arrow or Down Arrow to scroll through the Basic Display Group parameters. (Only in Display Groups)	▲ or ▼	
3. Press Esc once to display the Basic Display Group parameter number shown on power-up. The parameter number will flash.	ESC	Output Freq S b001
4. Press Esc again to enter the group menu. The group menu letter will flash.	ESC	Basic Display S b001
5. Press the Up Arrow or Down Arrow to scroll through the group menu (b, P, T, C, A and d).	▲ or ▼	Basic Program S P031
6. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or SEL	Basic Program S P031
7. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	▲ or ▼	
8. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or SEL	Motor NP Volts S 230 Vac
9. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or SEL	Motor NP Volts S 230 Vac
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	Motor NP Volts S 230 Vac
11. Press the Up Arrow or Down Arrow to change the parameter value.	▲ or ▼	
12. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off.	ESC	
Or Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	↵	Motor NP Volts S 220 Vac
13. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu.	ESC	Basic Program S P031
If pressing Esc does not change the display, then b001 [Output Freq] is displayed. Press Enter or Sel to enter the last group menu viewed.		

The Basic Program Group (page 3-7) contains the most commonly changed parameters.

Keypad Hand-Off-Auto Functions

Parameter P042 [Auto Mode] defines the operation mode of the control keys on the integral keypad.

Hand-Off-Auto Mode

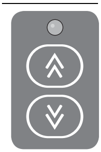
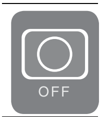
In HAND mode:

- Control keys operate as Hand-Off-Auto.
- Start command and speed reference come from the integral keypad Start/Hand and Digital Speed Increment and Decrement keys.
- Auto key switches control from HAND mode to AUTO mode in a bumpless transfer as long as there is an active Run command.

In AUTO mode:

- Auto key LED is illuminated.
- Start command is defined by P036 [Start Source].
- Speed Reference command is defined by P038 [Speed Reference].
- Start/Hand key switches control to the integral keypad in a bumpless transfer and switches the speed reference to the integral keypad.
- Stop key stops the drive and the drive switches to HAND mode.

Table 2.A P042 [Auto Mode] = 1 "Hnd-Off-Auto" (Default)
T051-T054 [Digital Inx Sel] ≠ 2 "Auto Mode" or 3 "Local"

	HAND Mode		AUTO Mode	
Key	**LED**	**Key Function**	**LED**	**Key Function**
	On	Starts drive. Runs according to Speed Increment/ Decrement keys.	On	Changes to HAND Mode and Starts drive. Runs according to Speed Increment/ Decrement keys.
	On	Changes speed.	Off	Not active. Keys are only active if P038 [Speed Source] = 0 "Drive Pot".
	Off	Changes to AUTO Mode.	On	Not active.
	N/A	Stops drive.	N/A	Changes to HAND Mode and Stops drive.

Important: Certain digital input settings can override drive operation. Refer to Start and Speed Reference Control on page 1-28 for details.

Local/Remote Mode

In Local mode:

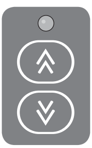
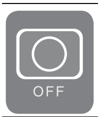
- Start command and speed reference come from the integral keypad Start/Hand and Digital Speed Increment and Decrement keys.
- Auto key stops the drive and the drive switches to Remote mode.

Important: If the drive is running and P036 [Start Source] = 3 or 6 (2-Wire Control), the drive will continue to run at reference defined by P038 [Speed Reference] if a valid start command is present.

In Remote mode:

- Auto key LED is illuminated.
- Start command is defined by P036 [Start Source].
- Speed Reference command is defined by P038 [Speed Reference].
- Auto key stops the drive and the drive switches to Local mode.

Table 2.B P042 [Auto Mode] = 2 “Local/Remote”
T051-T054 [Digital Inx Sel] ≠ 2 “Auto Mode” or 3 “Local”

	Local Mode		Remote Mode	
Key	LED	Key Function	LED	Key Function
	On	Starts drive. Runs according to Speed Increment/ Decrement keys.	Off	Not active. Only active if P036 [Start Source] = 0 “Keypad”. Starts drive.
	On	Changes speed.	Off	Not active. Keys are only active if P038 [Speed Source] = 0 “Drive Pot”.
	Off	Stops drive and changes to Remote Mode.	On	Stops drive and changes to Local Mode.
	N/A	Stops drive.	N/A	Stops drive.

Important: Certain digital input settings can override drive operation. Refer to Start and Speed Reference Control on page 1-28 for details.

Auto/Manual Mode

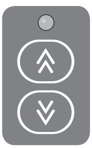
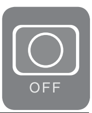
In Manual mode:

- Start command is defined by P036 [Start Source].
- Speed Reference command is defined by the Digital Speed Increment and Decrement keys.
- Auto key toggles frequency control to AUTO in a bumpless transfer.

In AUTO mode:

- Auto key LED is illuminated.
- Start command is defined by P036 [Start Source].
- Speed Reference command is defined by P038 [Speed Reference].
- Auto key switches frequency control to the integral keypad in a bumpless transfer.

Table 2.C P042 [Auto Mode] = 3 "Auto/Manual"
T051-T054 [Digital Inx Sel] ≠ 2 "Auto Mode" or 3 "Local"

	Manual Mode		AUTO Mode	
Key	**LED**	**Key Function**	**LED**	**Key Function**
	Off	Not active. Only active if P036 [Start Source] = 0 "Keypad". Starts drive. Runs according to Speed Increment/ Decrement keys.	Off	Not active. Only active if P036 [Start Source] = 0 "Keypad". Starts drive.
	On	Changes speed.	Off	Not active. Keys are only active if P038 [Speed Reference] = 0 "Drive Pot".
	Off	Changes to AUTO Mode. If running, drive will continue to run at reference defined by P038 [Speed Reference].	On	Changes to Manual Mode. If running, drive will continue to run according to Digital Speed Increment and Decrement keys.
	N/A	Stops drive.	N/A	Stops drive.

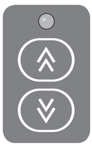
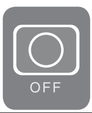
Important: Certain digital input settings can override drive operation. Refer to Start and Speed Reference Control on page 1-28 for details.

No Function Mode

In No Function mode:

- The Auto key has no function
- Start command is defined by P036 [Start Source]
- Speed Reference command is defined by P038 [Speed Reference]

Table 2.D P042 [Auto Mode] = 0 "No Function"
T051-T054 [Digital Inx Sel] ≠ 2 "Auto Mode" or 3 "Local"

Key	LED	Key Function
	Off	Not active. Only active if P036 [Start Source] = 0 "Keypad". Starts drive.
	On	Not active. Only active if P038 [Speed Reference] = 0 "Drive Pot". Changes drive speed.
	Off	Not active.
	N/A	Stops drive.

Important: Certain digital input settings can override drive operation. Refer to Start and Speed Reference Control on page 1-28 for details.

Notes:

Programming and Parameters

Chapter 3 provides a complete listing and description of the PowerFlex 400 parameters. Parameters are programmed (viewed/edited) using the integral keypad. As an alternative, programming can also be performed using DriveExplorer™ or DriveExecutive™ software, a personal computer and a serial converter module. Refer to Appendix B for catalog numbers.

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 (i.e. 0.1 Volts).
- **Bit Parameters**
  Bit parameters have four or more individual bits associated with features or conditions. If the bit is 0, the feature is off or the condition is false. If the bit is 1, the feature is on or the condition is true.

Some parameters are marked as follows.

= Stop drive before changing this parameter.

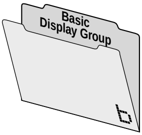
32 = 32 bit parameter. Parameters marked 32 bit will have two parameter numbers when using RS485 communications and programming software.

Parameter Organization

Refer to page 3-70 for an alphabetical listing of parameters.

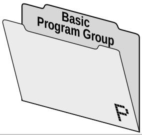
Group / **Parameters**

Basic Display



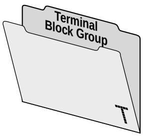
Output Freq	b001	Drive Status	b006	Elapsed MWh	b011
Commanded Freq	b002	Fault 1 Code	b007	Elapsed Run Time	b012
Output Current	b003	Process Display	b008	Torque Current	b013
Output Voltage	b004	Output Power	b010	Drive Temp	b014
DC Bus Voltage	b005			Elapsed kWh	b015

Basic Program



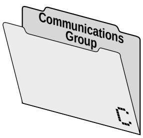
Motor NP Volts	P031	Maximum Freq	P035	Accel Time 1	P039
Motor NP Hertz	P032	Start Source	P036	Decel Time 1	P040
Motor OL Current	P033	Stop Mode	P037	Reset To Defalts	P041
Minimum Freq	P034	Speed Reference	P038	Auto Mode	P042
				Motor OL Ret	P043

Terminal Block



Digital In1 Sel	T051	Opto Out Sel	T065	Wake Level	T080
Digital In2 Sel	T052	Opto Out Level	T066	Wake Time	T081
Digital In3 Sel	T053	Opto Out Logic	T068	Analog Out1 Sel	T082
Digital In4 Sel	T054	Analog In 1 Sel	T069	Analog Out1 High	T083
Relay Out1 Sel	T055	Analog In 1 Lo	T070	Analog Out1 Setpt	T084
Relay Out1 Level	T056	Analog In 1 Hi	T071	Analog Out2 Sel	T085
Relay 1 On Time	T058	Analog In 1 Loss	T072	Analog Out2 High	T086
Relay 1 Off Time	T059	Analog In 2 Sel	T073	Analog Out2 Setpt	T087
Relay Out2 Sel	T060	Analog In 2 Lo	T074	Anlg Loss Delay	T088
Relay Out2 Level	T061	Analog In 2 Hi	T075	Analog In Filter	T089
Relay 2 On Time	T063	Analog In 2 Loss	T076	Sleep Sel	T090
Relay 2 Off Time	T064	Sleep-Wake Sel	T077	Wake Sel	T091
		Sleep Level	T078		
		Sleep Time	T079		

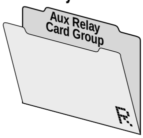
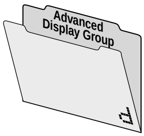
Communications



Language	C101	Comm Format	C102	Start Source 2	C108
		Comm Data Rate	C103	Speed Ref 2	C109
		Comm Node Addr	C104		
		Comm Loss Action	C105		
		Comm Loss Time	C106		
		Comm Write Mode	C107		

Advanced Program

Purge Frequency	A141	Reverse Disable	A166	Skip Frequency 1	A188
Internal Freq	A142	Flying Start En	A167	Skip Freq Band 1	A189
Preset Freq 0	A143	PWM Frequency	A168	Skip Frequency 2	A190
Preset Freq 1	A144	PWM Mode	A169	Skip Freq Band 2	A191
Preset Freq 2	A145	Boost Select	A170	Skip Frequency 3	A192
Preset Freq 3	A146	Start Boost	A171	Skip Freq Band 3	A193
Accel Time 2	A147	Break Voltage	A172	Compensation	A194
Decel Time 2	A148	Break Frequency	A173	Reset Meters	A195
S Curve %	A149	Maximum Voltage	A174	Testpoint Sel	A196
PID Trim Hi	A150	Slip Hertz @ FLA	A175	Fault Clear	A197
PID Trim Lo	A151	DC Brake Time	A176	Program Lock	A198
PID Ref Sel	A152	DC Brake Level	A177	Motor NP Poles	A199
PID Feedback Sel	A153	DC Brk Time@Strt	A178	Motor NP FLA	A200
PID Prop Gain	A154	Current Limit 1	A179	PID Invert Error	A201
PID Integ Time	A155	Current Limit 2	A180	MOP Reset Sel	A202
PID Diff Rate	A156	Motor OL Select	A181	Wake Deviation	A203
PID Setpoint	A157	Drive OL Mode	A182	ACT1 Input	A204
PID Deadband	A158	SW Current Trip	A183	ACT2 Input	A205
PID Preload	A159	Load Loss Level	A184	ACT1 Minimum	A206
Process Factor	A160	Load Loss Time	A185	ACT1 Maximum	A207
Auto Rstrt Tries	A163	Stall Fault Time	A186	ACT2 Minimum	A208
Auto Rstrt Delay	A164	Bus Reg Mode	A187	ACT2 Maximum	A209
Start At PowerUp	A165				

Group	Parameters					
Aux Relay Card 	Relay Out3 Sel	R221	Aux Motor Mode	R239	Aux Start Delay	R250
	Relay Out3 Level	R222	Aux Motor Qty	R240	Aux Stop Delay	R251
	Relay Out4 Sel	R224	Aux 1 Start Freq	R241	Aux Prog Delay	R252
	Relay Out4 Level	R225	Aux 1 Stop Freq	R242	Aux AutoSwap Tme	R253
	Relay Out5 Sel	R227	Aux 1 Ref Add	R243	Aux AutoSwap Lvl	R254
	Relay Out5 Level	R228	Aux 2 Start Freq	R244		
	Relay Out6 Sel	R230	Aux 2 Stop Freq	R245		
	Relay Out6 Level	R231	Aux 2 Ref Add	R246		
	Relay Out7 Sel	R233	Aux 3 Start Freq	R247		
	Relay Out7 Level	R234	Aux 3 Stop Freq	R248		
	Relay Out8 Sel	R236	Aux 3 Ref Add	R249		
	Relay Out8 Level	R237				
Advanced Display 	Control Source	d301	Output Powr Fctr	d318	Fault 9 Code	d335
	Contrl In Status	d302	Testpoint Data	d319	Fault 10 Code	d336
	Comm Status	d303	Control SW Ver	d320	Fault 4 Time-hr	d337
	PID Setpnt Displ	d304	Drive Type	d321	Fault 4 Time-min	d338
	Analog In 1	d305	Output Speed	d322	Fault 5 Time-hr	d339
	Analog In 2	d306	Output RPM	d323	Fault 5 Time-min	d340
	Fault 1 Code	d307	Fault Frequency	d324	Fault 6 Time-hr	d341
	Fault 2 Code	d308	Fault Current	d325	Fault 6 Time-min	d342
	Fault 3 Code	d309	Fault Bus Volts	d326	Fault 7 Time-hr	d343
	Fault 1 Time-hr	d310	Status @ Fault	d327	Fault 7 Time-min	d344
	Fault 1 Time-min	d311	PID Fdbk Display	d328	Fault 8 Time-hr	d345
	Fault 2 Time-hr	d312	DC Bus Ripple V	d329	Fault 8 Time-min	d346
	Fault 2 Time-min	d313	Fault 4 Code	d330	Fault 9 Time-hr	d347
	Fault 3 Time-hr	d314	Fault 5 Code	d331	Fault 9 Time-min	d348
	Fault 3 Time-min	d315	Fault 6 Code	d332	Fault10 Time-hr	d349
	Elapsed Time-hr	d316	Fault 7 Code	d333	Fault10 Time-min	d350
	Elapsed Time-min	d317	Fault 8 Code	d334		

Basic Display Group

b001 [Output Freq]

Related Parameter(s): b002, b008, P034, P035, P038

Output frequency present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/P035 [Maximum Freq]
	Display:	0.01 Hz

b002 [Commanded Freq]

Related Parameter(s): b001, P034, P035, P038, d302

Value of the active frequency command. Displays the commanded frequency even if the drive is not running.

Important: The frequency command can come from a number of sources. Refer to Start and Speed Reference Control on page 1-28 for details.

Values	Default:	Read Only
	Min/Max:	0.00/P035 [Maximum Freq]
	Display:	0.01 Hz

b003 [Output Current]

The output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

b004 [Output Voltage]

Related Parameter(s): P031, A170, A174

Output voltage present at terminals T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0/510
	Display:	1 VAC

b005 [DC Bus Voltage]

Present DC bus voltage level.

Values	Default:	Read Only
	Min/Max:	0/820
	Display:	1 VDC

Basic Display Group *(continued)*

b006 [Drive Status]

Related Parameter(s): A166

Present operating condition of the drive.

0000

1 = Condition True, 0 = Condition False	
Running	Bit 1
Forward	Bit 2
Accelerating	Bit 3
Decelerating	Bit 4

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

b007 [Fault 1 Code]

Related Parameter(s): A186, A197, d307-d315

A code that represents a drive fault. [Fault 1 Code] is the most recent fault. Repetitive faults will only be recorded once.

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

b008 [Process Display]

Related Parameter(s): b001, A160

32 32 bit parameter.

The output frequency scaled by A160 [Process Factor].

Output Freq x Process Factor = Process Display

Values	Default:	Read Only
	Min/Max:	0.00/9999.99
	Display:	0.01 – 1

b010 [Output Power]

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/999.9 kW
	Display:	0.1 kW

Basic Display Group *(continued)*

b011 [Elapsed MWh]

Related Parameter(s): b015, A195

Accumulated output energy of the drive.

Values	Default:	Read Only
	Min/Max:	0/3276.7 MWh
	Display:	0.1 MWh

b012 [Elapsed Run Time]

Related Parameter(s): A195

Displays the accumulated time that the drive has output power since the last A195 [Reset Meter]. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/9999 Hrs
	Display:	1 = 10 Hrs

b013 [Torque Current]

Displays the torque portion of the output current.

Values	Default:	Read Only
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

b014 [Drive Temp]

Present operating temperature of the drive power section.

Values	Default:	Read Only
	Min/Max:	0/120 degC
	Display:	1 degC

b015 [Elapsed kWh]

Related Parameter(s): b011, A195

Accumulated output energy of the drive. This parameter works in conjunction with [Elapsed MWh]. When the maximum value of this parameter is reached, this parameter resets to zero and [Elapsed MWh] is incremented.

Values	Default:	Read Only
	Min/Max:	0.0/100.0 kWh
	Display:	0.1 kWh

Basic Program Group

P031 [Motor NP Volts]

Related Parameter(s): b004, A170, A171, A172, A173

Stop drive before changing this parameter.

Set to the motor nameplate rated volts.

Values	Default:	Based on Drive Rating
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

P032 [Motor NP Hertz]

Related Parameter(s): A170, A171, A172, A173, A181, A182

Stop drive before changing this parameter.

Set to the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/320 Hz
	Display:	1 Hz

P033 [Motor OL Current]

Related Parameter(s): P042, T055, T060, T065, A175, A179, A180, A181, A183

Set to the maximum allowable motor current.

The drive will fault on an F7 Motor Overload if the value of this parameter is exceeded by 150% for 60 seconds.

Values	Default:	Drive Rated Amps
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

P034 [Minimum Freq]

Related Parameter(s): b001, b002, P035, T070, T074, A171, A172, A173, d302

Sets the lowest frequency the drive will output continuously.

Values	Default:	0.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

P035 [Maximum Freq]

Related Parameter(s): b001, b002, P034, T071, T075, T082 T083, T085, T086, A171, A172, A173, d302

Stop drive before changing this parameter.

Sets the highest frequency the drive will output.

Values	Default:	60.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Basic Program Group *(continued)*

P036 [Start Source]

Related Parameter(s): P037, P042, A166, d301

Stop drive before changing this parameter.

Sets the control scheme used to start the drive when in Auto/Remote mode.

Refer to Start and Speed Reference Control on page 1-28 for details about how other drive settings can override the setting of this parameter.

Important: For all settings except options 3 and 6, the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power or fault condition.

Options	**0**	"Keypad"	Integral keypad controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Not Used • I/O Terminal 03 = Not Used
	1	"3-Wire"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Per P037 [Stop Mode] • I/O Terminal 02 = Start • I/O Terminal 03 = Direction
	2	"2-Wire"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV
	3	"2-W Lvl Sens" (Default) See Attention Below	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV Drive will restart after a "Stop" command when: • Stop is removed and Run FWD is held active
	4	"2-W Hi Speed"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV Outputs are kept in a ready-to-run state. The drive will respond to a "Start" command within 10 ms. **Important:** There is greater potential voltage on the output terminals when using this option.
	5	"Comm Port"	Remote communications controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Not Used • I/O Terminal 03 = Not Used
	6	"2-W Lvl/Enbl" See Attention Below	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Function Loss: Fault and Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = SW Enable Drive will restart after a "Stop" command when: • Stop is removed and Run FWD is held active

ATTENTION: Hazard of injury exists due to unintended operation. When P036 [Start Source] is set to option 3 or option 6, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input or a fault clear for the drive to run again. The drive will stop only when the stop command is maintained or the drive is faulted.

Basic Program Group *(continued)*

P037 [Stop Mode]

Related Parameter(s): P036, C105, A176, A177, A178

Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below.

Important: I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].

Hardware Enable Circuitry

By default, I/O Terminal 01 is a coast to stop input. The status of the input is interpreted by drive software. If the application requires the drive to be disabled without software interpretation, a "dedicated" hardware enable configuration can be utilized. This is accomplished by removing the ENBL enable jumper on the control board. See page 1-21 for details. In this case, the drive will always coast to a stop regardless of the settings of P036 [Start Source] and P037 [Stop Mode].

Options	**0**	"Ramp, CF"[1]	Ramp to Stop. "Stop" command clears active fault.
	1	"Coast, CF"[1] (Default)	Coast to Stop. "Stop" command clears active fault.
	2	"DC Brake, CF"[1]	DC Injection Braking Stop. "Stop" command clears active fault.
	3	"DCBrkAuto,CF"[1]	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A176 [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 A176 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped.

(1) Stop input also clears active fault.

Basic Program Group *(continued)*

P038 [Speed Reference]

Related Parameter(s): b001, b002, P038, P040, P042, T051-T054, T070, T071, T073, T074, T075, C102, A141, A142, A143-A146, A152, d301

Sets the source of the speed reference to the drive.

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when T051 - T054 [Digital Inx Sel] is set to option 1, 2, 3, 4, 5, 8, 14, 15, 16, 17 and the digital input is active, or if A152 [PID Ref Sel] is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. Refer to the flowchart on page 1-28 for more information on speed reference control priority.

Options	**0**	"Drive Keypad"	Internal frequency command from the digital speed keys on the integral keypad.
	1	"InternalFreq"	Internal frequency command from A142 [Internal Freq]. Must be set when using MOP function.
	2	"Analog In 1" (Default)	External frequency command from an analog source as determined by T069 [Analog In 1 Sel] and DIP Switch AI1 on the control board. Default Dip Switch setting is 10V.
	3	"Analog In 2"	External frequency command from an analog source as determined by T073 [Analog In 2 Sel] and DIP Switch AI2 on the control board. Default Dip Switch setting is 10V.
	4	"Preset Freq"	External frequency command as defined by A143 - A146 [Preset Freq x] when T051 - T054 [Digital Inx Sel] are programmed as "Preset Frequencies" and the digital inputs are active.
	5	"Comm Port"	External frequency command from the communications port. Refer to Appendix E and Appendix G for details. Parameter C102 [Comm Format] is used to select a communications protocol.

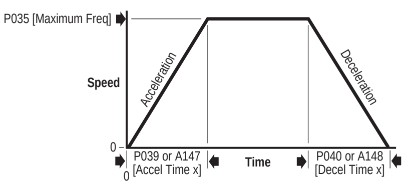
P039 [Accel Time 1]

Related Parameter(s): P038, P040, T051-T054, A141, A143-A146, A147

Sets the rate of acceleration for all speed increases.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	20.00 Secs 60.00 Secs	2.2-110 kW (3.0-150 HP) 132-250 kW (200-350 HP)
	Min/Max:	0.00/600.00 Secs	
	Display:	0.01 Secs	



Basic Program Group *(continued)*

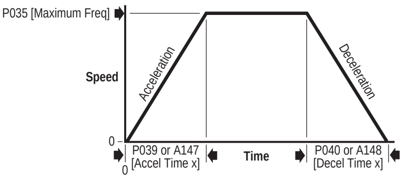
P040 [Decel Time 1]

Related Parameter(s): P038, P039, T051-T054, A141, A143-A146, A148

Sets the rate of deceleration for all speed decreases.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	20.00 Secs 60.00 Secs	2.2-110 kW (3.0-150 HP) 132-250 kW (200-350 HP)
	Min/Max:	0.00/600.00 Secs	
	Display:	0.01 Secs	



P041 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameter values to factory defaults.

Options	**0**	"Ready/Idle" (Default)	
	1	"Factory Rset"	• After the reset function is complete, this parameter will set itself back to "0". • Causes an F48 Params Defaulted fault.

Important: Drives packaged for fan and pump applications ship with custom default settings that differ from Factory Defaults. Setting this parameter to option 1 will require reprogramming of select parameters. Refer to publication 22C-IN002 for packaged drive default settings.

P042 [Auto Mode]

Related Parameter(s): P036, P038

Stop drive before changing this parameter.

Determines the operation of the "Auto" key on the integral keypad. Refer to page 2-6 for details.

Options	**0**	"No function"	LED above "Auto" key is always dark
	1	"Hnd-Off-Auto" (Default)	Toggles control start and frequency to and from keypad; starts drive.
	2	"Local/Remote"	Toggles control start and frequency to and from keypad.
	3	"Auto/Manual"	Toggles only the frequency control to and from keypad.

P043 [Motor OL Ret]

Related Parameter(s): P033, A181

Enables/disables the Motor Overload Retention function. When Enabled, the value held in the motor overload counter is saved at power-down and restored at power-up.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Terminal Block Group

T051 [Digital In1 Sel]
(I/O Terminal 05)
T052 [Digital In2 Sel]
(I/O Terminal 06)
T053 [Digital In3 Sel]
(I/O Terminal 07)
T054 [Digital In4 Sel]
(I/O Terminal 08)

Related Parameter(s): P036, P038, P039, P040, A141, A142 A143-A146, A147, A148, A166, A177, A180, d301, d302

Stop drive before changing this parameter.

Selects the function for the digital inputs. Refer to the flowchart on page 1-28 for more information on speed reference control priority.

Options	**0**	"Not Used"	Terminal has no function but can be read over network communications via d302 [Contrl In Status].
	1	"Purge" (1) (T051 Default)	Starts the drive at Purge speed regardless of the selected start source. Purge can occur, and is operational, at any time whether the drive is running or stopped. If a valid stop condition is present, other than from the Comm Port or SW Enable input (I/O Terminal 03), the drive will not start on the Purge Input Transition.

ATTENTION: A Purge command will take precedence over a stop command from the Comm Port/Network and over a SW Enable command from the terminal block. Insure that another stop method is available, such as I/O Terminal 01 of the control terminal block, if stopping is necessary during a purge.

2	"Auto Mode" (1)	When active, forces drive into "Auto" control mode. Start source determined by P036 [Start Source] and speed reference determined by P038 [Speed Reference].
3	"Local" (1) (T052 Default)	When active, sets integral keypad as start source and digital speed keys on the integral keypad as speed source.
4	"Comm Port" (1) (T054 Default)	When active, sets communication device as default start/speed command source.
5	"PID Disable"	Disables PID function. Drive uses the next valid non-PID speed reference.
6	"PID Hold"	Drive output remains at current value.The integrator for Process PID loop is also clamped at current value.
7	"PID Reset"	The integrator for the Process PID loop is reset to zero and drive output is set to Preload value.
8	"Preset Freq"	Preset speed inputs that enable the use of preset speeds.
9	"Aux Fault"	If input is enable but not active, the drive will immediately fault.
10	"Clear Fault" (T053 Default)	Clears an active fault.
11	"RampStop,CF"	The drive immediately ramps to stop. Can also be used to clear a fault.
12	"CoastStop,CF"	The drive immediately coasts to stop. Can also be used to clear a fault.

T051-T054 Options (Cont.)	**13** "DCInjStop,CF"	The drive immediately begins a DC Injection stop. Can also be used to clear a fault.
	14 "Anlg1 InCtrl" (1)	Selects Analog Input 1 control for the frequency reference.
	15 "Anlg2 InCtrl" (1)	Selects Analog Input 2 control for the frequency reference.
	16 "MOP Up"	Increases the value of A142 [Internal Freq] at the current Accel rate if P038 [Speed Reference] is set to 1 "InternalFreq". Default for A142 is 60 Hz.
	17 "MOP Down"	Decreases the value of A142 [Internal Freq] at the current Decel rate if P038 [Speed Reference] is set to 1 "InternalFreq". Default for A142 is 60 Hz.
	18 "Acc & Dec 2" (1)	• When active, A147 [Accel Time 2] and A148 [Decel Time 2] are used for all ramp rates. • Can only be tied to one input. Refer to the flowchart on page 1-29 for more information on Accel/Decel selection.
	19 "Current Lmt2"	When active, A180 [Current Limit 2] determines the drive current limit level.
	20 "Force DC"	If the drive is not running, applying this input causes the drive to apply a DC Holding current (use A177 [DC Brake Level], ignoring A176 [DC Brake Time] while the input is applied.
	21 "Mtr I-Lock 1" **22** "Mtr I-Lock 2" **23** "Mtr I-Lock 3" **24** "Mtr I-Lock 4"	Can be used as a protective motor interlock in Auxiliary Motor Control mode. When programmed but not active, input will prevent corresponding motor from operating. Refer to Appendix C for details.
	25 "Cmd Reverse"	When programmed and active the drive will run in the reverse direction when started from the integral keypad.
	31 "Logic In 1"	Input 1 used by digital output settings.
	32 "Logic In 2"	Input 2 used by digital output settings.
	36 "Damper Input"	• When active, drive is allowed to run normally. • When inactive, drive is forced into sleep mode and is prevented from accelerating to commanded speed.

(1) This function may be tied to one input only.

Terminal Block Group *(continued)*

T055 [Relay Out1 Sel]

Related Parameter(s): P033, T056, T058, T059, T069, T072, T073, T076, A163, d318

Sets the condition that changes the state of the output relay contacts.

Options	**0**	"Ready/Fault" (Default)	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Hand Active"	Active when drive is in local control.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in T056 [Relay Out1 Level]. • Use T056 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in T056 [Relay Out1 Level]. • Use T056 to set threshold. **Important:** Value for T056 [Relay Out1 Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in T056 [Relay Out1 Level]. • Use T056 to set threshold.
	9	"Above Anlg 2"	• Analog input voltage (I/O Terminal 17) exceeds the value set in T056 [Relay Out1 Level]. • Do not use if T073 [Analog In 2 Sel] is set to 3 "Voltage Mode - Bipolar". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 17) is wired to a PTC and external resistor. • Use T056 to set threshold.
	10	"Above PF Ang"	• Power Factor angle has exceeded the value set in T056 [Relay Out1 Level]. • Use T056 to set threshold.
	11	"Anlg In Loss"	Analog input loss has occurred. Program T072 [Analog In 1 Loss] and/or T076 [Analog In 2 Loss] for desired action when input loss occurs.
	12	"ParamControl"	Enables the output to be controlled over network communications by writing to T056 [Relay Out1 Level]. (0 = Off, 1 = On.)
	13	"Retries Exst"	Value set in A163 [Auto Rstrt Tries] is exceeded.
	14	"NonRec Fault"	• Number of retries for A163 [Auto Rstrt Tries] is exceeded OR • Non-resettable fault occurs OR • A163 [Auto Rstrt Tries] is not enabled.
	15	"Reverse"	Drive is commanded to run in reverse direction.
	16	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	17	"Logic In 2"	An input is programmed as "Logic In 2" and is active.

T055 Options (Cont.)	**23** "Aux Motor"	Auxiliary Motor is commanded to run. Refer to Appendix C for details.
	24 "Fault" (with FRN 7.xx and later)	Relay remains in the off state when power is applied to the drive and energizes when a fault occurs. This is inverted from Option 0, "Ready/Fault".

T056 [Relay Out1 Level]

Related Parameter(s): T055, T058, T059, d318

32 32 bit parameter.

Sets the trip point for the digital output relay if the value of T055 [Relay Out1 Sel] is 6, 7, 8, 9, 10 or 12.

T055 Setting	T056 Min/Max
6	0/320 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

T058 [Relay 1 On Time]

Related Parameter(s): T055, T056, T059

Sets delay time before Relay energizes after required condition testing.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

T059 [Relay 1 Off Time]

Related Parameter(s): T055, T056, T058

Sets delay time before Relay de-energizes after required condition testing ceases.

Important: Do not use this parameter with Auxiliary Motor Control mode AutoSwap enabled.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

Terminal Block Group *(continued)*

T060 [Relay Out2 Sel]

Related Parameter(s): P033, T061, T063, T064, T076, A163, d318

Sets the condition that changes the state of the output relay contacts.

Options	**0**	"Ready/Fault"	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning" (Default)	Motor is receiving power from the drive.
	3	"Hand Active"	Active when drive is in local control.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in T061 [Relay Out2 Level]. • Use T061 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in T061 [Relay Out2 Level]. • Use T061 to set threshold. **Important:** Value for T061 [Relay Out2 Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in T061 [Relay Out2 Level]. • Use T061 to set threshold.
	9	"Above Anlg 2"	• Analog input voltage (I/O Terminal 17) exceeds the value set in T061 [Relay Out2 Level]. • Do not use if T073 [Analog In 2 Sel] is set to 3 "Voltage Mode - Bipolar". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 17) is wired to a PTC and external resistor. • Use T061 to set threshold.
	10	"Above PF Ang"	• Power Factor angle has exceeded the value set in T061 [Relay Out2 Level]. • Use T061 to set threshold.
	11	"Anlg In Loss"	Analog input loss has occurred. Program T072 [Analog In 1 Loss] and/or T076 [Analog In 2 Loss] for desired action when input loss occurs.
	12	"ParamControl"	Enables the output to be controlled over network communications by writing to T061 [Relay Out2 Level]. (0 = Off, 1 = On.)
	13	"Retries Exst"	Value set in A163 [Auto Rstrt Tries] is exceeded.
	14	"NonRec Fault"	• Number of retries for A163 [Auto Rstrt Tries] is exceeded OR • Non-resettable fault occurs OR • A163 [Auto Rstrt Tries] is not enabled.
	15	"Reverse"	Drive is commanded to run in reverse direction.
	16	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	17	"Logic In 2"	An input is programmed as "Logic In 2" and is active.

T060 Options (Cont.)	**23** "Aux Motor"	Auxiliary Motor is commanded to run. Refer to Appendix C for details.
	24 "Fault" (with FRN 7.xx and later)	Relay remains in the off state when power is applied to the drive and energizes when a fault occurs. This is inverted from Option 0, "Ready/Fault".

T061 [Relay Out2 Level]

Related Parameter(s): T060, T063, T064, d318

32 bit parameter.

Sets the trip point for the digital output relay if the value of T060 [Relay Out2 Sel] is 6, 7, 8, 9, 10 or 12.

T060 Setting	T061 Min/Max
6	0/320 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

T063 [Relay 2 On Time]

Related Parameter(s): T060, T061, T064

Sets delay time before Relay energizes after required condition testing.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

T064 [Relay 2 Off Time]

Related Parameter(s): T060, T061, T063

Sets delay time before Relay de-energizes after required condition testing ceases.

Important: Do not use this parameter with Auxiliary Motor Control mode AutoSwap enabled.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

Terminal Block Group *(continued)*

T065 [Opto Out Sel]

Related Parameter(s): P033, T066, T068, T072, T076, A163, d318

Determines the operation of the programmable opto output.

Options	**0**	"Ready/Fault"	Opto output is active when power is applied. This indicates that the drive is ready for operation. Opto output is inactive when power is removed or a fault occurs.
	1	"At Frequency" (Default)	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Hand Active"	Active when drive is in local control.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in T066 [Opto Out Level]. • Use T066 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in T066 [Opto Out Level]. • Use T066 to set threshold. **Important:** Value for T066 [Opto Out Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in T066 [Opto Out Level]. • Use T066 to set threshold.
	9	"Above Anlg 2"	• Analog input voltage (I/O Terminal 17) exceeds the value set in T066 [Opto Out Level]. • Do not use if T073 [Analog In 2 Sel] is set to 3 "Voltage Mode - Bipolar". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 17) is wired to a PTC and external resistor. • Use T066 to set threshold.
	10	"Above PF Ang"	• Power Factor angle has exceeded the value set in T066 [Opto Out Level]. • Use T066 to set threshold.
	11	"Anlg In Loss"	Analog input loss has occurred. Program T072 [Analog In 1 Loss] and/or T076 [Analog In 2 Loss] for desired action when input loss occurs.
	12	"ParamControl"	Enables the output to be controlled over network communications by writing to T066 [Opto Out Level]. (0 = Off, 1 = On.)
	13	"Retries Exst"	Value set in A163 [Auto Rstrt Tries] is exceeded.
	14	"NonRec Fault"	• Number of retries for A163 [Auto Rstrt Tries] is exceeded OR • Non-resettable fault occurs OR • A163 [Auto Rstrt Tries] is not enabled.
	15	"Reverse"	Drive is commanded to run in reverse direction.

T065 Options (Cont.)	**16** "Logic In 1"	An input is programmed as "Logic In 1" and is active.
	17 "Logic In 2"	An input is programmed as "Logic In 2" and is active.
	24 "Fault" (with FRN 7.xx and later)	Opto output is inactive when power is applied to the drive and is active when a fault occurs. This is inverted from Option 0, "Ready/Fault".

T066 [Opto Out Level]

Related Parameter(s): T065, T068, A163, d318

32 32 bit parameter.

Determines the on/off point for the opto output when T065 [Opto Out Sel] is set to option 6, 7, 8, 9, 10 or 12.

T065 Setting	T066 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

T068 [Opto Out Logic]

Related Parameter(s): T065, T066

Determines the logic (Normally Open/NO or Normally Closed/NC) of the opto output.

T068 Option	Opto Out Logic
0	NO (Normally Open)
1	NC (Normally Closed)

Note: Setting output to NC may cause output to "glitch" on power-up. The off/reset state of all outputs is open.

Values	Default:	0
	Min/Max:	0/1
	Display:	1

Terminal Block Group *(continued)*

T069 [Analog In 1 Sel]

Related Parameter(s): T055, T070, T071, T072

Sets the analog input signal mode (0-20mA, 4-20mA, or 0-10V). This parameter must match DIP Switch AI1 setting on the control board.

T069 Option	Setting	Input Range	DIP Switch AI1 Setting
0	Current Mode	0-20 mA	20 mA
1	Current Mode	4-20 mA	20 mA
2	Voltage Mode - Unipolar	0-10V	10V
4	Current Mode (Square Root)	0-20 mA	20 mA
5	Current Mode (Square Root)	4-20 mA	20 mA
6	Voltage Mode - Unipolar (Square Root)	0-10V	10V

Values	Default:	2
	Min/Max:	0/6
	Display:	1

T070 [Analog In 1 Lo]

Related Parameter(s): P034, P038, T069, T071, T072 A152, A153

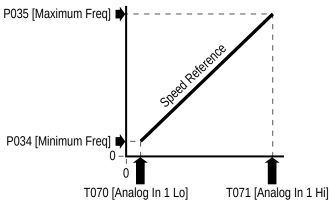
Stop drive before changing this parameter.

Sets the analog input level that corresponds to P034 [Minimum Freq].

Analog inversion can be accomplished by setting this value larger than T071 [Analog In 1 Hi].

Important: If analog inversion is implemented the drive will go to maximum frequency in the event the analog input is lost. It is strongly recommended to activate T072 [Analog In 1 Loss] to protect from this potential occurrence.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%



T071 [Analog In 1 Hi]

Related Parameter(s): P035, P038, T069, T070, T072 A152, A153

Stop drive before changing this parameter.

Sets the analog input level that corresponds to P035 [Maximum Freq].

Analog inversion can be accomplished by setting this value smaller than T070 [Analog In 1 Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Terminal Block Group *(continued)*

T072 [Analog In 1 Loss]

Related Parameter(s): T055, T060, T065, T069, T070, T071, A152

Stop drive before changing this parameter.

Selects drive action when an input signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3mA. If using a 0-10V analog input, set T070 [Analog In 1 Lo] to a minimum of 20% (i.e. 2 volts).

The drive will fault on an F29 Analog Input Loss when the analog signal is lost if this parameter is used for the PID feedback, and this parameter and A152 [PID Ref Sel] are both set to an option other than 0 "Disabled".

Options	**0**	"Disabled" (Default)	
	1	"Fault (F29)"	F29 Analog Input Loss
	2	"Stop"	Uses P037 [Stop Mode]
	3	"Zero Ref"	Drive runs at zero speed reference.
	4	"Min Freq Ref"	Drive runs at minimum frequency.
	5	"Max Freq Ref"	Drive runs at maximum frequency.
	6	"Preset Freq0"	Drive runs at A143 [Preset Freq 0].
	7	"Hold Last" (with FRN 6.xx and later)	Drive uses last frequency command from analog input prior to signal loss, or last PID reference prior to signal loss when used as a PID reference.

T073 [Analog In 2 Sel]

Related Parameter(s): P038, T055, T065, T074, T075, T076, A152

Sets the analog input signal mode (0-20mA, 4-20mA, 0-10V, -10 to +10V). This parameter must match DIP Switch AI2 setting on the control board.

T073 Option	Setting	Input Range	DIP Switch AI2 Setting
0	Current Mode	0-20 mA	20 mA
1	Current Mode	4-20 mA	20 mA
2	Voltage Mode - Unipolar	0-10V	10V
3 (1)	Voltage Mode - Bipolar	-10 to +10V	10V
4	Current Mode (Square Root)	0-20 mA	20 mA
5	Current Mode (Square Root)	4-20 mA	20 mA
6	Voltage Mode - Unipolar (Square Root)	0-10V	10V
7 (1)	Voltage Mode - Bipolar (Square Root)	-10 to +10V	10V

(1) Setting 3 is only available on [Analog In 2 Sel]. Input 2 is isolated and supports a bi-polar input, so that setting 3 determines if the voltage input is enabled for bipolar control. If bipolar is selected, P034 [Minimum Freq] and T074 [Analog In 2 Lo] are ignored. If input 2 is set up for current control, Bipolar mode is not possible. If the analog input is inverted ([Analog In 2 Lo] > [Analog In 2 Hi]), Bipolar mode is disabled and this input uses unipolar control only (negative values are treated like zero).

Values	Default:	2
	Min/Max:	0/7
	Display:	1

Terminal Block Group *(continued)*

T074 [Analog In 2 Lo]

Related Parameter(s): P034, P038, T072, T073, T075, T076, A152, A153

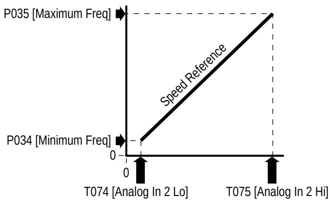
Stop drive before changing this parameter.

Sets the analog input level that corresponds to P034 [Minimum Freq].

Analog inversion can be accomplished by setting this value larger than T075 [Analog In 2 Hi].

Important: If analog inversion is implemented the drive will go to maximum frequency in the event the analog input is lost. It is strongly recommended to activate T072 [Analog In 1 Loss] to protect from this potential occurrence.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%



T075 [Analog In 2 Hi]

Related Parameter(s): P035, P038, T073, T074, T076, A152, A153

Stop drive before changing this parameter.

Sets the analog input level that corresponds to P035 [Maximum Freq].

Analog inversion can be accomplished by setting this value smaller than T074 [Analog In 2 Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Terminal Block Group *(continued)*

T076 [Analog In 2 Loss]

Related Parameter(s): T055, T060, T065, T073, T074, T075

Stop drive before changing this parameter.

Selects drive action when an input signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3mA. If using a 0-10V analog input, set T074 [Analog In 2 Lo] to a minimum of 20% (i.e. 2 volts).

The drive will fault on an F29 Analog Input Loss when the analog signal is lost if this parameter is used for the PID feedback, and this parameter and A152 [PID Ref Sel] are both set to an option other than 0 “Disabled”.

Options	**0**	“Disabled” (Default)	
	1	“Fault (F29)”	F29 Analog Input Loss
	2	“Stop”	Uses P037 [Stop Mode]
	3	“Zero Ref”	Drive runs at zero speed reference.
	4	“Min Freq Ref”	Drive runs at minimum frequency.
	5	“Max Freq Ref”	Drive runs at maximum frequency.
	6	“Preset Freq0”	Drive runs at A143 [Preset Freq 0].
	7	“Hold Last” (with FRN 6.xx and later)	Drive uses last frequency command from analog input prior to signal loss, or last PID reference prior to signal loss when used as a PID reference.

T077 [Sleep-Wake Sel]

Related Parameter(s): T078, T079, T080, T081, T090, T091

The drive “sleeps” if the appropriate analog input drops below the set [Sleep Level] for the time set in [Sleep Time] and the drive is running. When entering sleep mode the drive will ramp to zero and the run indicator (or) on the keypad display will flash indicating the drive is in “sleep” mode. When the appropriate analog input rises above the set [Sleep Level] the drive will “wake” and ramp to the commanded frequency.

Inversion can be accomplished by setting T078 [Sleep Level] to a higher setting than T080 [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 & international codes, standards, regulations or industry guidelines must be considered.

Options	**0**	“Disabled” (Default)	
	1	“Analog In 1”	Sleep and Wake enabled from Analog Input 1.
	2	“Analog In 2”	Sleep and Wake enabled from Analog Input 2.
	3	“Command Freq”	Sleep and Wake enabled based on drive commanded frequency.
	4	“Ind Slp Wake” (with FRN 7.xx and later)	Sleep and Wake enabled independently using parameters T090 [Sleep Sel] and T091 [Wake Sel].

Terminal Block Group *(continued)*

T078 [Sleep Level]

Related Parameter(s): T077, T079, T080, T081

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%

T079 [Sleep Time]

Related Parameter(s): T077, T078, T080, T081

Sets the analog input time the drive must stay below to enter sleep mode.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

T080 [Wake Level]

Related Parameter(s): T077, T078, T079, T081

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%

T081 [Wake Time]

Related Parameter(s): T077, T078, T079, T080

Sets the analog input time the drive must stay above to wake from sleep mode.

Values	Default:	0.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs

Terminal Block Group *(continued)*

T082 [Analog Out1 Sel]

Related Parameter(s): P035, T083, T084

Sets the analog output signal mode (0-20 mA, 4-20 mA, or 0-10V). The output is used to provide a signal that is proportional to several drive conditions. This parameter must match DIP Switch AO1 setting.

Setting		Output Range	Min. Output Value	Max. Output Value = [Analog Output Hi]	Filter(1)	DIP Switch AO1 Setting	Related Parameter
0	OutFreq 0-10	0-10V	0V = 0 Hz	[Maximum Freq]	None	10V	b001
1	OutCurr 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b003
2	OutTorq 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b013
3	OutVolt 0-10	0-10V	0V = 0 Volts	120% Drive Rated Output V	None	10V	b004
4	OutPowr 0-10	0-10V	0V = 0 kW	200% Drive Rated Power	Filter A	10V	b010
5	Setpnt 0-10	0-10V	0V = 0.0%	100.0% Setting	None	10V	T084
6	TstData 0-10	0-10V	0V = 0000	65535 (Hex FFFF)	None	10V	A196
7	OutFreq 0-20	0-20 mA	0 mA = 0 Hz	[Maximum Freq]	None	20 mA	b001
8	OutCurr 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
9	OutTorq 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
10	OutVolt 0-20	0-20 mA	0 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
11	OutPowr 0-20	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
12	Setpnt 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	None	20 mA	T084
13	TstData 0-20	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196
14	OutFreq 4-20	4-20 mA	4 mA = 0 Hz	[Maximum Freq]	None	20 mA	b001
15	OutCurr 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
16	OutTorq 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
17	OutVolt 4-20	4-20 mA	4 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
18	OutPowr 4-20	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
19	Setpnt 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	None	20 mA	T084
20	TstData 4-20	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196
21	MinFreq 0-10	0-10V	0V = Min. Freq	[Maximum Freq]	None	10V	b001
22	MinFreq 0-20	0-20 mA	0 mA = Min. Freq	[Maximum Freq]	None	20 mA	b001
23	MinFreq 4-20	4-20 mA	4 mA = Min. Freq	[Maximum Freq]	None	20 mA	b001
24	AnlgIn1 0-10	0-10V	0V = 0.0%	100.0% Setting	Filter A	10V	d305
25	AnlgIn1 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	Filter A	20 mA	d305
26	AnlgIn1 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	Filter A	20 mA	d305
27	AnlgIn2 0-10	0-10V	0V = 0.0%	100.0% Setting	Filter A	10V	d306
28	AnlgIn2 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	Filter A	20 mA	d306
29	AnlgIn2 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	Filter A	20 mA	d306

(1) For settings with the filter enabled, if a 0-100% step change occurs, the output will reach 95% in 500 milliseconds, 99% in 810 milliseconds and 100% in 910 milliseconds.

Values		
	Default:	0
	Min/Max:	0/29
	Display:	1

Terminal Block Group *(continued)*

T083 [Analog Out1 High]

Related Parameter(s): P035, T082, T084

Scales the Maximum Output Value for the T082 [Analog Out1 Sel] source setting.

Examples:

T083 Setting	T082 Setting	T082 Max. Output Value
50%	1 "OutCurr 0-10"	5V for 200% Drive Rated Output Current
90%	11 "OutPowr 0-20"	18mA for 200% Drive Rated Power

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

T084 [Anlg Out1 Setpt]

Related Parameter(s): T082, T083

Sets direct parameter control over the analog output. If enabled, this sets the percent value of analog output.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Terminal Block Group *(continued)*

T085 [Analog Out2 Sel]

Related Parameter(s): P035, T086, T087

Sets the analog output signal mode (0-20 mA, 4-20 mA, or 0-10V). The output is used to provide a signal that is proportional to several drive conditions. This parameter must match DIP Switch AO2 setting.

Setting		Output Range	Min. Output Value	Max. Output Value = [Analog Output Hi]	Filter[1]	DIP Switch AO2 Setting	Related Parameter
0	OutFreq 0-10	0-10V	0V = 0 Hz	[Maximum Freq]	None	10V	b001
1	OutCurr 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b003
2	OutTorq 0-10	0-10V	0V = 0 Amps	200% Drive Rated FLA	Filter A	10V	b013
3	OutVolt 0-10	0-10V	0V = 0 Volts	120% Drive Rated Output V	None	10V	b004
4	OutPowr 0-10	0-10V	0V = 0 kW	200% Drive Rated Power	Filter A	10V	b010
5	Setpnt 0-10	0-10V	0V = 0.0%	100.0% Setting	None	10V	T084
6	TstData 0-10	0-10V	0V = 0000	65535 (Hex FFFF)	None	10V	A196
7	OutFreq 0-20	0-20 mA	0 mA = 0 Hz	[Maximum Freq]	None	20 mA	b001
8	OutCurr 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
9	OutTorq 0-20	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
10	OutVolt 0-20	0-20 mA	0 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
11	OutPowr 0-20	0-20 mA	0 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
12	Setpnt 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	None	20 mA	T084
13	TstData 0-20	0-20 mA	0 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196
14	OutFreq 4-20	4-20 mA	4 mA = 0 Hz	[Maximum Freq]	None	20 mA	b001
15	OutCurr 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b003
16	OutTorq 4-20	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	Filter A	20 mA	b013
17	OutVolt 4-20	4-20 mA	4 mA = 0 Volts	120% Drive Rated Output V	None	20 mA	b004
18	OutPowr 4-20	4-20 mA	4 mA = 0 kW	200% Drive Rated Power	Filter A	20 mA	b010
19	Setpnt 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	None	20 mA	T084
20	TstData 4-20	4-20 mA	4 mA = 0000	65535 (Hex FFFF)	None	20 mA	A196
21	MinFreq 0-10	0-10V	0V = Min. Freq	[Maximum Freq]	None	10V	b001
22	MinFreq 0-20	0-20 mA	0 mA = Min. Freq	[Maximum Freq]	None	20 mA	b001
23	MinFreq 4-20	4-20 mA	4 mA = Min. Freq	[Maximum Freq]	None	20 mA	b001
24	AnlgIn1 0-10	0-10V	0V = 0.0%	100.0% Setting	Filter A	10V	d305
25	AnlgIn1 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	Filter A	20 mA	d305
26	AnlgIn1 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	Filter A	20 mA	d305
27	AnlgIn2 0-10	0-10V	0V = 0.0%	100.0% Setting	Filter A	10V	d306
28	AnlgIn2 0-20	0-20 mA	0 mA = 0.0%	100.0% Setting	Filter A	20 mA	d306
29	AnlgIn2 4-20	4-20 mA	4 mA = 0.0%	100.0% Setting	Filter A	20 mA	d306

(1) For settings with the filter enabled, if a 0-100% step change occurs, the output will reach 95% in 500 milliseconds, 99% in 810 milliseconds and 100% in 910 milliseconds.

Values		
	Default:	1
	Min/Max:	0/29
	Display:	1

Terminal Block Group *(continued)*

T086 [Analog Out2 High]

Related Parameter(s): P035, T085, T087

Scales the Maximum Output Value for the A065 [Analog Out Sel] source setting.

Examples:

T086 Setting	T085 Setting	T085 Max. Output Value
50%	1 "OutCurr 0-10"	5V for 200% Drive Rated Output Current
90%	11 "OutPowr 0-20"	18mA for 200% Drive Rated Power

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

T087 [Anlg Out2 Setpt]

Related Parameter(s): T085, T086

Sets direct parameter control over the analog output. If enabled, this sets the percent value of analog output.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

T088 [Anlg Loss Delay]

Related Parameter(s): T069, T070-T076

Sets the length of time after power-up during which the drive will not detect an analog signal loss. The drive response to an analog signal loss is set in T072 or T076 [Analog In x Loss].

Values	Default:	0.0 Secs
	Min/Max:	0.0/20.0 Secs
	Display:	0.1 Secs

T089 [Analog In Filter]

Sets 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, etc.). No additional filtering is applied when set to "0".

Values	Default:	0
	Min/Max:	0/14
	Display:	1

Terminal Block Group *(continued)*

T090 [Sleep Sel]

Related Parameter(s): T077

(with FRN 7.xx and later.)

Selects the operation of the sleep function.

Options	**0**	"AI1 > SlpLvl" (Default)	Sleep enabled from Analog Input 1 above sleep level.
	1	"AI1 < SlpLvl"	Sleep enabled from Analog Input 1 below sleep level.
	2	"AI2 > SlpLvl"	Sleep enabled from Analog Input 2 above sleep level.
	3	"AI2 < SlpLvl"	Sleep enabled from Analog Input 2 below sleep level.
	4	"OFrq>SlpLvl"	Sleep enabled based on drive output frequency above sleep level.
	5	"OFrq<SlpLvl"	Sleep enabled based on drive output frequency below sleep level.
	6	"CFrq>SlpLvl"	Sleep enabled based on drive command frequency above sleep level.
	7	"CFrq<SlpLvl"	Sleep enabled based on drive command frequency below sleep level.

Terminal Block Group *(continued)*

T091 [Wake Sel]

Related Parameter(s): T077, T080, A203, d304, d328

(with FRN 7.xx and later.)

Selects the operation of the wake function.

Options	**0**	"AI1 > WakLvl" (Default)	Wake enabled from Analog Input 1 above wake-up level.
	1	"AI1 < WakLvl"	Wake enabled from Analog Input 1 below wake-up level.
	2	"AI2 > WakLvl"	Wake enabled from Analog Input 2 above wake-up level.
	3	"AI2 < WakLvl"	Wake enabled from Analog Input 2 below wake-up level.
	4	"OFrq>WakLvl"	Wake enabled based on drive output frequency above wake-up level.
	5	"OFrq<WakLvl"	Wake enabled based on drive output frequency below wake-up level.
	6	"FB-SP>WakLvl"	PID Feedback minus PID Setpoint above wake-up level. If (d328 [PID Fdbk Display] - d304 [PID Setpnt Displ]) > T080 [Wake Level], then wake is enabled.
	7	"SP-FB>WakLvl"	PID Setpoint minus PID Feedback above wake-up level. If (d304 [PID Setpnt Displ] - d328 [PID Fdbk Display]) > T080 [Wake Level], then wake is enabled.
	8	"AI1 > WakDev"	Wake enabled from Analog Input 1 above wake deviation.
	9	"AI1 < WakDev"	Wake enabled from Analog Input 1 below wake deviation.
	10	"AI2 > WakDev"	Wake enabled from Analog Input 2 above wake deviation.
	11	"AI2 < WakDev"	Wake enabled from Analog Input 2 below wake deviation.
	12	"OFrq>WakDev"	Wake enabled based on drive output frequency above wake deviation.
	13	"OFrq<WakDev"	Wake enabled based on drive output frequency below wake deviation.
	14	"FB-SP>WakDev"	PID Feedback minus PID Setpoint above wake deviation. If (d328 [PID Fdbk Display] - d304 [PID Setpnt Displ) > A203 [Wake Deviation], then wake is enabled.
	15	"SP-FB>WakDev"	PID Setpoint minus PID Feedback above wake deviation. If (d304 [PID Setpnt Displ] - d328 [PID Fdbk Display) > A203 [Wake Deviation], then wake is enabled.

Communications Group

C101 [Language]

Selects the language displayed by the integral LCD display and remote communications option.

Options	**1**	"English" (Default)
	2	"Français"
	3	"Español"
	4	"Italiano"
	5	"Deutsch"
	6	"Reserved"
	7	"Português"
	8	"Reserved"
	9	"Reserved"
	10	"Nederlands"

C102 [Comm Format]

Related Parameter(s): d303-d306

Selects the protocol data bits (8 data bits only), parity (None, Even, Odd), and stop bits (1 or 2) used by the RS485 port on the drive.

Refer to Appendix D and Appendix E for details on using the drive communication features.

Important: Power to drive must be cycled before any changes will affect drive operation.

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"	
	6	"MetaSys N2"	
	7	"P1 8-N-1"	Floor Level Network (FLN)
	8	"P1 8-E-1"	Floor Level Network (FLN)
	9	"P1 8-O-1"	Floor Level Network (FLN)

C103 [Comm Data Rate]

Related Parameter(s): d303

Sets the serial port rate for the RS485 (DSI) port.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19.2K"
	5	"38.4K"

Communications Group *(continued)*

C104 [Comm Node Addr]

Related Parameter(s): d303

Sets the drive node address for the RS485 (DSI) port if using a network connection.

Important: Power to drive must be cycled before any changes will affect drive operation.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

C105 [Comm Loss Action]

Related Parameter(s): d303, P037, C106

Selects the drive's response to a loss of the communication connection or excessive communication errors.

Options	**0**	"Fault" (Default)	Drive will fault on an F81 Comm Loss and coast to stop.
	1	"Coast Stop"	Stops drive via coast to stop.
	2	"Stop"	Stops drive via P037 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.
	4	"Run Preset 0"	Drive will run at preset speed.
	5	"Kypd Inc/Dec"	Drive will run at keypad (digital pot) speed

C106 [Comm Loss Time]

Related Parameter(s): d303, C105

Sets the time that the drive will remain in communication loss before implementing the option selected in C105 [Comm Loss Action].

Values	Default:	5.0 Secs
	Min/Max:	0.1/60.0 Secs
	Display:	0.1 Secs

C107 [Comm Write Mode]

Determines whether parameter changes made over communication port are saved and stored in Non-Volatile Storage (NVS) or RAM only. If they are stored in RAM, the values will be lost at power-down.

Options	**0**	"Save" (Default)
	1	"RAM Only"

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless C107 [Comm Write Mode] is set to option 1.

Communications Group *(continued)*

C108 [Start Source 2]

Related Parameter(s): P037, P042, A166, d301

Stop drive before changing this parameter.

Sets the control scheme used to start the drive when in Comm Control and the communication network commands the drive to run from Local Control. This function is normally used by Point 79 of a P1-FLN. Refer to Start and Speed Reference Control on page 1-28 for details about how other drive settings can override the setting of this parameter.

Important: For all settings except options 3 and 6, the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power or fault condition.

Options	**0**	"Keypad"	Integral keypad controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Not Used • I/O Terminal 03 = Not Used
	1	"3-Wire"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Per P037 [Stop Mode] • I/O Terminal 02 = Start • I/O Terminal 03 = Direction
	2	"2-Wire"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV
	3	"2-W Lvl Sens" (Default) See Attention Below	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV Drive will restart after a "Stop" command when: • Stop is removed and Run FWD is held active
	4	"2-W Hi Speed"	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = Run REV Outputs are kept in a ready-to-run state. The drive will respond to a "Start" command within 10 ms. **Important:** There is greater potential voltage on the output terminals when using this option.
	5	"Comm Port"	Remote communications controls drive operation. • I/O Terminal 01 = Stop: Coast to Stop • I/O Terminal 02 = Not Used • I/O Terminal 03 = Not Used
	6	"2-W Lvl/Enbl" See Attention Below	I/O Terminal Block controls drive operation. • I/O Terminal 01 = Function Loss: Fault and Coast to Stop • I/O Terminal 02 = Run FWD • I/O Terminal 03 = SW Enable Drive will restart after a "Stop" command when: • Stop is removed and Run FWD is held active

ATTENTION: Hazard of injury exists due to unintended operation. When P036 [Start Source] is set to option 3 or option 6, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input or a fault clear for the drive to run again. The drive will stop only when the stop command is maintained or the drive is faulted.

Communications Group *(continued)*

C109 [Speed Ref 2]

Related Parameter(s): b001, b002, P038, P040, P042, T051-T054, T070, T071, T073, T074, T075, C102, A141, A142, A143-A146, A152, d301

Sets the source of the speed reference to the drive when in Comm Control and the communication network commands the drive to run from Local Control.

Refer to the flowchart on page 1-28 for more information on speed reference control priority.

Options	**0**	"Drive Keypad"	Internal frequency command from the digital speed keys on the integral keypad.
	1	"InternalFreq"	Internal frequency command from A142 [Internal Freq]. Must be set when using MOP function.
	2	"Analog In 1" (Default)	External frequency command from an analog source as determined by T069 [Analog In 1 Sel] and DIP Switch AI1 on the control board. Default Dip Switch setting is 10V.
	3	"Analog In 2"	External frequency command from an analog source as determined by T073 [Analog In 2 Sel] and DIP Switch AI2 on the control board. Default Dip Switch setting is 10V.
	4	"Preset Freq"	External frequency command as defined by A143 - A146 [Preset Freq x] when T051 - T054 [Digital Inx Sel] are programmed as "Preset Frequencies" and the digital inputs are active.
	5	"Comm Port"	External frequency command from the communications port. Refer to Appendix E and Appendix G for details. Parameter C102 [Comm Format] is used to select a communications protocol.

Advanced Program Group

A141 [Purge Frequency]

Related Parameter(s): P038, P039, P040, T051-T054

Provides a fixed frequency command value when T051-T054 [Digital Inx Sel] is set to 1 “Purge”. An active purge input will override speed command as shown in the flowchart on page 1-28.

Values	Default:	5.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

A142 [Internal Freq]

Related Parameter(s): P038, T051-T054

Provides the frequency command to the drive when P038 [Speed Reference] is set to 1 “Internal Freq”. When enabled, this parameter will change the frequency command in “real time” using the digital speed keys when in program mode.

Important: Once the desired command frequency is reached, the Enter key must be pressed to store this value to EEPROM memory. If the ESC key is used before the Enter key, the frequency will return to the original value following the normal accel/decel curve.

If T051 - T054 [Digital Inx Sel] is set to 16 “MOP Up” or 17 “MOP Down” this parameter acts as the MOP frequency reference if P038 [Speed Reference] is set to 1 “InternalFreq”.

Values	Default:	60.00 Hz
	Min/Max:	0.00/320.00 Hz
	Display:	0.01 Hz

A143 [Preset Freq 0][1]
A144 [Preset Freq 1]
A145 [Preset Freq 2]
A146 [Preset Freq 3]

Related Parameter(s): P038, P039, P040, T051-T052, A147, A148

Values	A143 Default:[1] A144 Default: A145 Default: A146 Default:	0.0 Hz 5.0 Hz 10.0 Hz 20.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Provides a fixed frequency command value when T051 - T052 [Digital Inx Sel] is set to 8 “Preset Freq”.

An active preset input will override speed command as shown in the flowchart on page page 1-28.

(1) To activate A143 [Preset Freq 0] set P038 [Speed Reference] to option 4 “Preset Freq”.

Input State of Digital In 1 (I/O Terminal 05 when T051 = 8)	Input State of Digital In 2 (I/O Terminal 06 when T052 = 8)	Frequency Source	Accel / Decel Parameter Used[2]
0	0	A143 [Preset Freq 0]	[Accel Time 1] / [Decel Time 1]
1	0	A144 [Preset Freq 1]	[Accel Time 1] / [Decel Time 1]
0	1	A145 [Preset Freq 2]	[Accel Time 2] / [Decel Time 2]
1	1	A146 [Preset Freq 3]	[Accel Time 2] / [Decel Time 2]

(2) When a Digital Input is set to “Accel 2 & Decel 2”, and the input is active, that input overrides the settings in this table.

Advanced Program Group *(continued)*

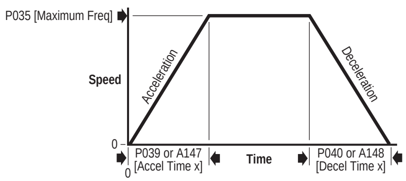
A147 [Accel Time 2]

Related Parameter(s): P039, T051-T054, A143-A146

When active, sets the rate of acceleration for all speed increases. Refer to the flowchart on page 1-29 for details.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	30.00 Secs
	Min/Max:	0.00/600.00 Secs
	Display:	0.01 Secs



A148 [Decel Time 2]

Related Parameter(s): P040, T051-T054, A143-A146

When active, sets the rate of deceleration for all speed decreases. Refer to the flowchart on page 1-29 for details.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	30.00 Secs
	Min/Max:	0.01/600.00 Secs
	Display:	0.01 Secs

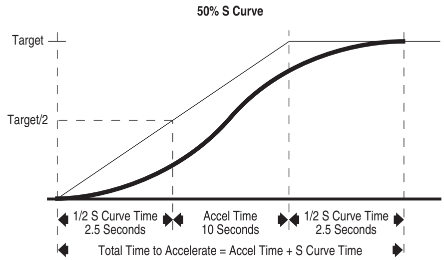
Advanced Program Group *(continued)*

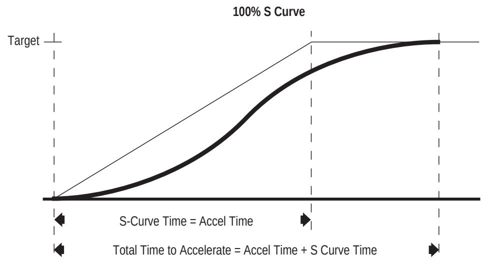
A149 [S Curve %]

Sets the percentage of acceleration or deceleration time that is applied to the ramp as S Curve. Time is added, 1/2 at the beginning and 1/2 at the end of the ramp.

Values	Default:	20%
	Min/Max:	0/100% (A setting of 0% disables this parameter.)
	Display:	1%

Example:
Accel Time = 10 Seconds
S Curve Setting = 50%
S Curve Time = 10 × 0.5 = 5 Seconds
Total Time = 10 + 5 = 15 Seconds





A150 [PID Trim Hi]

Sets the maximum positive value that is added to a PID reference when PID trim is used.

Values	Default:	60.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

A151 [PID Trim Lo]

Sets the minimum positive value that is added to a PID reference when PID trim is used.

Values	Default:	0.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A152 [PID Ref Sel]

Related Parameter(s): P038, T070, T071, T072, T074, T075

Stop drive before changing this parameter.

Enables/disables PID mode and selects the source of the PID reference. Refer to Appendix D for details.

Options	**0**	"PID Disabled" (Default)	
	1	"PID Setpoint"	
	2	"Analog In 1"	
	3	"Analog In 2"	
	4	"Comm Port"	
	5	"Setpnt, Trim"	Use PID output as Trim on [Frequency Select]
	6	"A-In 1, Trim"	Use PID output as Trim on [Frequency Select]
	7	"A-In 2, Trim" (1)	Use PID output as Trim on [Frequency Select]
	8	"Comm, Trim"	Use PID output as Trim on [Frequency Select]

(1) The PID will not function with bipolar input. It will ignore any negative voltages and treat them like zero.

Note: PID analog reference is scaled through the [Analog In x Hi/Lo] parameters. The invert operation is obtained through programming these two parameters. If A152 [PID Ref Sel] is not set to zero, PID can be disabled by programming a digital input.

A153 [PID Feedback Sel]

Related Parameter(s): T070, T071, T074, T075, A204, A205

Select the source of the PID feedback. Refer to Appendix D for details.

Options	**0**	"Analog In 1" (Default)	The PID will not function with a bipolar input. Negative voltages are treated as 0 volts.
	1	"Analog In 2" (1)	
	2	"Comm Port"	
	3	"ACT1 - ACT2" (with FRN 7.xx and later)	ACT1 minus ACT2
	4	"ACT1 + ACT2" (with FRN 7.xx and later)	ACT1 plus ACT2
	5	"ACT1 * ACT2" (with FRN 7.xx and later)	ACT1 multiplied by ACT2
	6	"ACT1 / ACT2" (with FRN 7.xx and later)	ACT1 divided by ACT2
	7	"Min A1, A2" (with FRN 7.xx and later)	The smaller of ACT1 or ACT2 is used as the feedback signal.
	8	"Max A1, A2" (with FRN 7.xx and later)	The larger of ACT1 or ACT2 is used as the feedback signal.

(1) The PID will not function with bipolar input. It will ignore any negative voltages and treat them like zero.

Note: PID analog reference is scaled through the [Analog In x Hi/Lo] parameters. The invert operation is obtained through programming these two parameters.

Advanced Program Group *(continued)*

A154 [PID Prop Gain]

Sets the value for the PID proportional component when the PID mode is enabled by A152 [PID Ref Sel].

Values	Default:	1.00
	Min/Max:	0.00/99.99
	Display:	0.01

A155 [PID Integ Time]

Sets the value for the PID integral component when the PID mode is enabled by A152 [PID Ref Sel].

Values	Default:	2.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A156 [PID Diff Rate]

Sets the value for the PID differential component when the PID mode is enabled by A152 [PID Ref Sel].

Values	Default:	0.00 (1/Secs)
	Min/Max:	0.00/99.99 (1/Secs)
	Display:	0.01 (1/Secs)

A157 [PID Setpoint]

Provides an internal fixed value for process setpoint when the PID mode is enabled by A152 [PID Ref Sel].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A158 [PID Deadband]

Sets the lower limit of the PID output.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A159 [PID Preload]

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A160 [Process Factor]

Related Parameter(s): b008

Scales the output frequency value displayed by b008 [Process Display].

Output Freq x Process Factor = Process Display

Values	Default:	30.0
	Min/Max:	0.1/999.9
	Display:	0.1

A163 [Auto Rstrt Tries]

Related Parameter(s): T055, T060, T065, T066, A164

Sets the maximum number of times the drive attempts to reset a fault and restart.

Clear a Type 1 fault and restart the drive.

1. Set A163 [Auto Rstrt Tries] to a value other than "0".
2. Set A164 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.

1. Set A163 [Auto Rstrt Tries] to a value other than "0".
2. Set A164 [Auto Rstrt Delay] to "0".

Note: If the parameter is not set to zero and [Auto Rstrt Time] is set to zero, auto fault clear is enabled. This feature automatically clears faults, but does not restart the drive.

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

A164 [Auto Rstrt Delay]

Related Parameter(s): A163

Sets the time between restart attempts when A163 [Auto Rstrt Tries] is set to a value other than zero.

Note: If the parameter is not set to zero and [Auto Rstrt Time] is set to zero, auto fault clear is enabled. This feature automatically clears faults, but does not restart the drive.

Values	Default:	1.0 Secs
	Min/Max:	0.0/160.0 Secs
	Display:	0.1 Secs

Advanced Program Group *(continued)*

A165 [Start At PowerUp]

Related Parameter(s): P036

Stop drive before changing this parameter.

Enables/disables a feature that allows a Start or Run command to automatically cause the drive to resume running at commanded speed after drive input power is restored. Requires a digital input configured for Run or Start and a valid start contact.

This parameter will not function if parameter P036 [Start Source] is set to 4 "2-W Hi Speed".

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"

A166 [Reverse Disable]

Related Parameter(s): b006, P036, T051-T054

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed. The reverse command may come from a digital or a serial command. All reverse inputs including two-wire Run Reverse will be ignored with reverse disabled.

Options	**0**	"Rev Enabled"
	1	"Rev Disabled" (Default)

A167 [Flying Start En]

Related Parameter(s): A200

Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.

Important: When this parameter is enabled, verify that A200 [Motor NP FLA] is set to the motor's actual full load amp value.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group *(continued)*

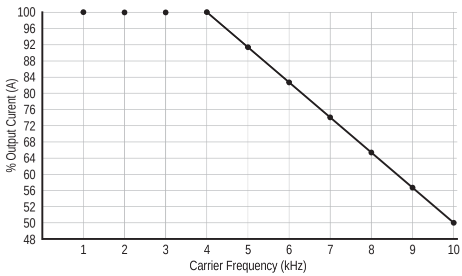
A168 [PWM Frequency]

Related Parameter(s): A169

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.

Values	Default:	4.0 kHz
	Min/Max:	2.0/10.0 kHz (Frame C and D drives) 2.0/8.0 kHz (Frame E, F, G and H drives)
	Display:	0.1 kHz



A169 [PWM Mode]

Related Parameter(s): A168

Selects the PWM algorithm used.

Options	**0**	"Space Vector"	3-Phase Modulation: Provides quiet operation and produces less motor losses.
	1	"2-Phase" (Default)	2-Phase Modulation: Provides less drive losses and best performance with long motor cable runs.

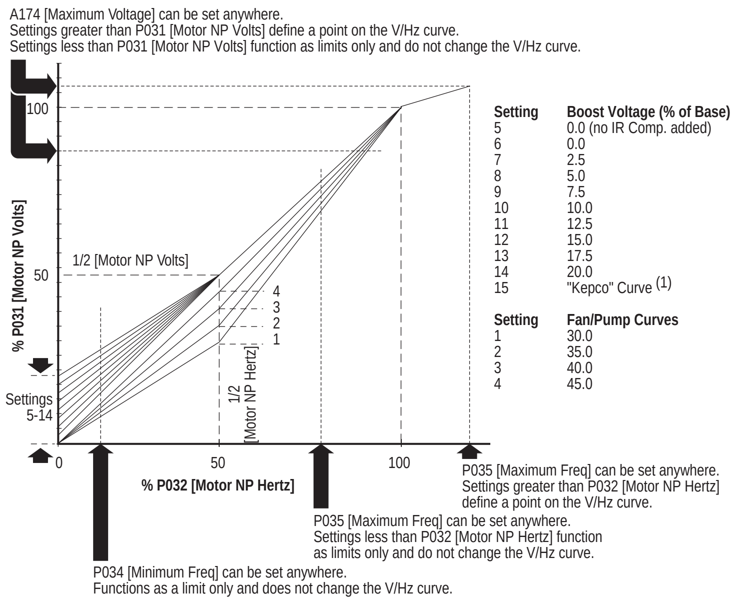
Advanced Program Group *(continued)*

A170 [Boost Select]

Related Parameter(s): b004, P031, P032, A171, A172, A173

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve.
Drive may add additional voltage unless Option 5 is selected.

	Frames C-F	Frames G-H	
Options	**0** "Custom V/Hz"	**0** "Custom V/Hz"	
	1 "30.0, VT"	**1** "30.0, VT"	Typical Fan/Pump Curves
	2 "35.0, VT"	**2** "35.0, VT"	
	3 "40.0, VT"	**3** "40.0, VT"	
	4 "45.0, VT" (Default)	**4** "45.0, VT" (Default)	
	5 "0.0 no IR"	**5** "0.0 no IR"	Boost Curves
	6 "0.0"	**6** "0.0"	
	7 "2.5"	**7** "0.2"	
	8 "5.0"	**8** "0.5"	
	9 "7.5"	**9** "0.8"	
	10 "10.0"	**10** "1.0"	
	11 "12.5"	**11** "2.0"	
	12 "15.0"	**12** "3.0"	
	13 "17.5"	**13** "4.0"	
	14 "20.0"	**14** "5.0"	
	15 "Kepco" Curve[1]	**15** "Kepco" Curve[1]	



(1) Kepco Curve is used in specific systems to meet requirements of the Korean Electric Power Company.

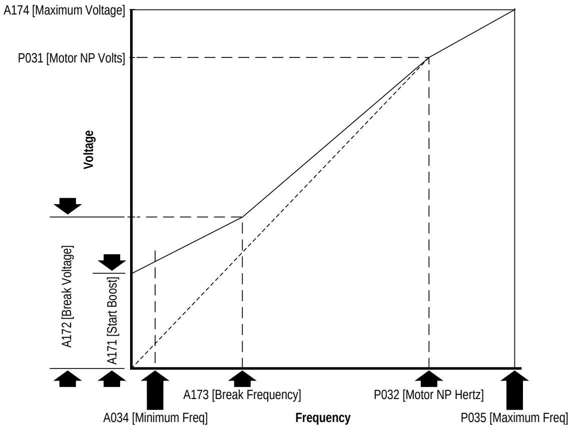
Advanced Program Group *(continued)*

A171 [Start Boost]

Related Parameter(s): P031, P032, P034, P035, A170, A172, A173, A174

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve when A170 [Boost Select] = 0 "Custom V/Hz".

Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	1.1%



A172 [Break Voltage]

Related Parameter(s): P031, P032, P034, P035, A170, A171, A173, A174

Sets the break voltage applied at the break frequency when A170 [Boost Select] = 0 "Custom V/Hz".

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A173 [Break Frequency]

Related Parameter(s): P031, P032, P034, P035, A170, A171, A172, A174

Sets the frequency where break frequency is applied when A170 [Boost Select] = 0 "Custom V/Hz".

Values	Default:	15.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A174 [Maximum Voltage]

Related Parameter(s): b004, A171, A172, A173

Sets the highest voltage the drive will output.

Values	Default:	Drive Rated Volts
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

A175 [Slip Hertz @ FLA]

Related Parameter(s): P033

Compensates for the inherent slip in an induction motor. This frequency is added to the commanded output frequency based on motor current.

Values	Default:	2.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A176 [DC Brake Time]

Related Parameter(s): P037, A177

Sets the length of time that DC brake current is "injected" into the motor when P037 [Stop Mode] is set to either 4 "Ramp" or 6 "DC Brake". Refer to parameter A177 [DC Brake Level].

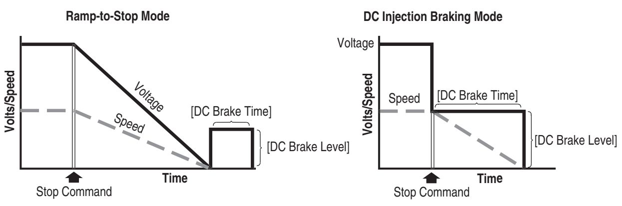
Values	Default:	0.0 Secs
	Min/Max:	0.0/99.9 Secs (A setting of 99.9 = Continuous)
	Display:	0.1 Secs

A177 [DC Brake Level]

Related Parameter(s): P037, T051-T054, A176, A178

Defines the maximum DC brake current, in amps, applied to the motor.

Values	Default:	Drive Rated Amps × 0.05
	Min/Max:	0.0/(Drive Rated Amps × 1.5)
	Display:	0.1 Amps



ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

ATTENTION: This feature should not be used with synchronous or permanent magnet motors. Motors may be demagnetized during braking.

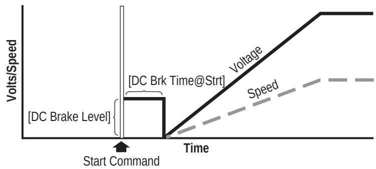
Advanced Program Group *(continued)*

A178 [DC Brk Time@Strt]

Related Parameter(s): P037, A177

Sets the length of time that DC brake current is "injected" into the motor after a valid start command is received. Parameter A177 [DC Brake Level] controls the level of braking current used.

Values	Default:	0.0 Secs
	Min/Max:	0.0/99.9 Secs (A setting of 99.9 = Continuous)
	Display:	0.1 Secs



A179 [Current Limit 1]

Related Parameter(s): P033

Maximum output current allowed before current limiting occurs.

Values	Default:	Drive Rated Amps × 1.1
	Min/Max:	0.0/(Drive Rated Amps × 1.5)
	Display:	0.1 Amps

A180 [Current Limit 2]

Related Parameter(s): P033

Maximum output current allowed before current limiting occurs.

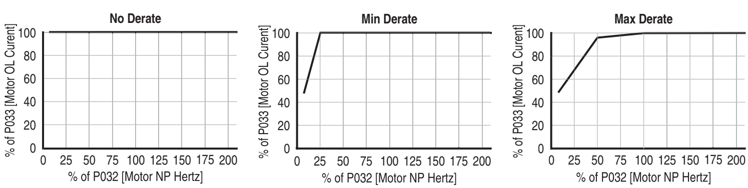
Values	Default:	Drive Rated Amps × 1.1
	Min/Max:	0.0/(Drive Rated Amps × 1.5)
	Display:	0.1 Amps

A181 [Motor OL Select]

Related Parameter(s): P032, P033, P043

Drive provides Class 10 motor 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"



Advanced Program Group *(continued)*

A182 [Drive OL Mode]

Related Parameter(s): P032, P033

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)

A183 [SW Current Trip]

Related Parameter(s): P033

Enables/disables a software instantaneous (within 100 ms) current trip.

Values	Default:	0.0 (Disabled)
	Min/Max:	0.0/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps

A184 [Load Loss Level]

Related Parameter(s): P033

Provides a software trip (Load Loss fault) when the current drops below this level for the time specified in [Load Loss Time].

Values	Default:	0.0 (Disabled)
	Min/Max:	0.0/Drive Rated Amps
	Display:	0.1 Amps

A185 [Load Loss Time]

Related Parameter(s): P033

Sets the required time for the current to be below [Load Loss Level] before a Load Loss fault occurs.

Values	Default:	0 Secs (Disabled)
	Min/Max:	0/9999 Secs
	Display:	1 Secs

A186 [Stall Fault Time]

Sets the time that the drive will remain 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"

Advanced Program Group *(continued)*

A187 [Bus Reg Mode]

Controls the operation of the drive voltage regulation, which is normally operational at decel or when the bus voltage rises.

Refer to the Attention statement on page P-3 for important information on bus regulation.

Options	**0**	"Disabled"
	1	"Enabled" (Default)

A188 [Skip Frequency 1]

Related Parameter(s): A189

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/320 Hz
	Display:	1 Hz

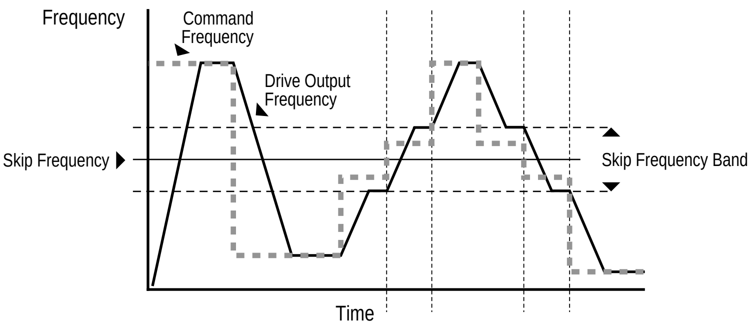
A189 [Skip Freq Band 1]

Related Parameter(s): A188

Determines the bandwidth around A188 [Skip Frequency 1]. A189 [Skip Freq Band 1] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A190 [Skip Frequency 2]

Related Parameter(s): A191

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/320 Hz
	Display:	1 Hz

Advanced Program Group *(continued)*

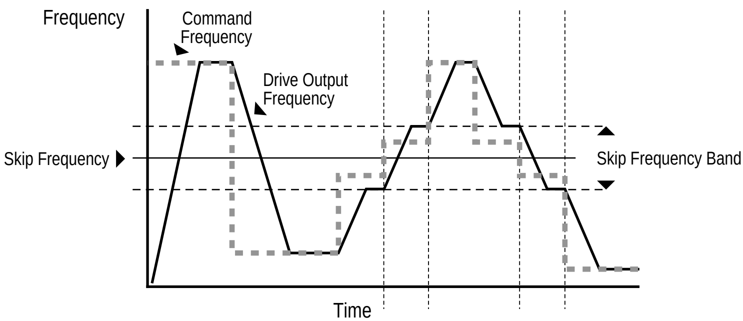
A191 [Skip Freq Band 2]

Related Parameter(s): A190

Determines the bandwidth around A190 [Skip Frequency 2]. A191 [Skip Freq Band 2] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A192 [Skip Frequency 3]

Related Parameter(s): A193

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/320 Hz
	Display:	1 Hz

Advanced Program Group *(continued)*

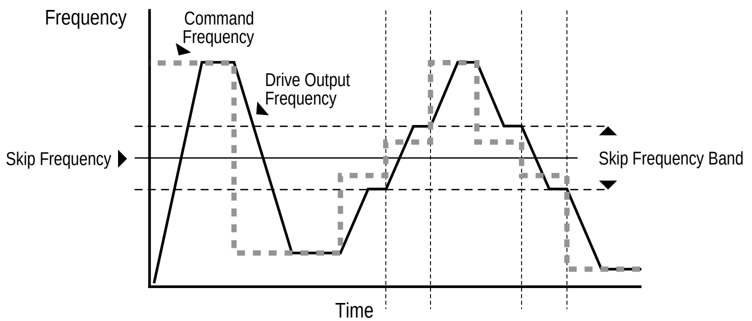
A193 [Skip Freq Band 3]

Related Parameter(s): A192

Determines the bandwidth around A192 [Skip Frequency 3]. A193 [Skip Freq Band 3] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A194 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	**0**	"Disabled"	
	1	"Electrical" (Default) (1)	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" (1)	

(1) Use "Dead Time Compensation" algorithm to minimize flat spots in motor current waveforms. Use this solution also to achieve motor stability.

A195 [Reset Meters]

Related Parameter(s): d310-d317

Resets the marker that indicates Fault Times and Energy usage.

Options	**0**	"Ready/Idle" (Default)	
	1	"Reset MWh"	Also resets kWh marker.
	2	"Reset Time"	min, hr, and x10hr

Advanced Program Group *(continued)*

A196 [Testpoint Sel]

Related Parameter(s): d319

Used by Rockwell Automation field service personnel.

Values	Default:	1024
	Min/Max:	1024/65535
	Display:	1

A197 [Fault Clear]

Related Parameter(s): b007, d307, d308, d309

Stop drive before changing this parameter.

Resets a fault and clears the fault queue. Used primarily to clear a fault over network communications.

Options	**0**	"Ready/Idle" (Default)	
	1	"Reset Fault"	
	2	"Clear Buffer"	Clears all fault buffers.

A198 [Program Lock]

Protects parameters against change by unauthorized personnel. Enter a user-selected password to lock the parameters via Option 1. Enter the same password to unlock the parameters.

Options	**0**	"Unlocked" (Default)	
	1	"Locked"	Locks all parameters.
	2	"Locked"	Parameter edits allowed over communications network.
	3	"Locked"	Locks P035 [Maximum Freq] and A170 [Boost Select].

A199 [Motor NP Poles]

Related Parameter(s): d323

Sets the motor poles. This is used to calculate d323 [Output RPM].

Values	Default:	4
	Min/Max:	2/40
	Display:	1

A200 [Motor NP FLA]

Related Parameter(s): A167

Set to the motor nameplate rated full load amps.

Values	Default:	Drive Rated Amps
	Min/Max:	0.1/(Drive Rated Amps × 2)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A201 [PID Invert Error]

(With FRN 6.xx and later.)

When set to "Inverted", changes the sign of the PID error. This causes an increase in the drive output frequency with PID Feedback greater than PID Setpoint, and a decrease in drive output frequency with PID Feedback less than PID Setpoint.

Options	**0**	"Not Inverted" (Default)
	1	"Inverted"

A202 [MOP Reset Sel]

Related Parameter(s): A142

(With FRN 6.xx and later.)

Set the drive to save the current MOP reference command.

Options	**0**	"Zero MOP Ref"	This option clamps A142 [Internal Freq] at 0.0 Hz when the drive is not running.
	1	"Save MOP Ref" (Default)	Reference is saved in A142 [Internal Freq].

A203 [Wake Deviation]

(with FRN 7.xx and later.)

Sets the deviation from PID setpoint the drive must reach to wake from sleep mode.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A204 [ACT1 Input]

Related Parameter(s): A153

(with FRN 7.xx and later.)

Defines the source of the data used as ACT1.

Options	**0**	"Analog In 1" (Default)	Use Analog Input 1
	1	"Analog In 2"	Use Analog Input 2
	2	"Current"	Use b003 [Output Current]

A205 [ACT2 Input]

Related Parameter(s): A153

(with FRN 7.xx and later.)

Defines the source of the data used as ACT2.

Options	**0**	"Analog In 1" (Default)	Use Analog Input 1
	1	"Analog In 2"	Use Analog Input 2
	2	"Current"	Use b003 [Output Current]

Advanced Program Group *(continued)*

A206 [ACT1 Minimum]

Related Parameter(s): A204

(with FRN 7.xx and later.)

Sets the minimum value of ACT1. Used with the analog input min/max settings to scale the analog input for use as the PID feedback. Can be used in a normal and inverted mode.

Values	Default:	0.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

A207 [ACT1 Maximum]

Related Parameter(s): A204

(with FRN 7.xx and later.)

Sets the maximum value of ACT1.

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

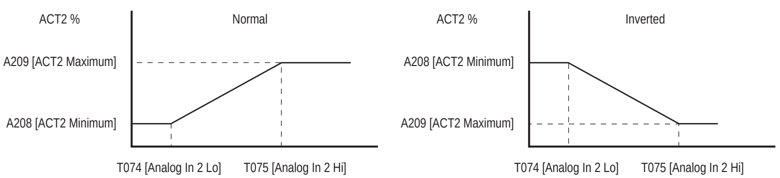
A208 [ACT2 Minimum]

Related Parameter(s): A205

(with FRN 7.xx and later.)

Sets the minimum value of ACT2. Used with the analog input min/max settings to scale the analog input for use as the PID feedback. Can be used in a normal and inverted mode.

Values	Default:	0.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%



A209 [ACT2 Maximum]

Related Parameter(s): A205

(with FRN 7.xx and later.)

Sets the maximum value of ACT2.

Values	Default:	100.0%
	Min/Max:	0.0/200.0%
	Display:	0.1%

Aux Relay Card Group

R221 [Relay Out3 Sel]
R224 [Relay Out4 Sel]
R227 [Relay Out5 Sel]
R230 [Relay Out6 Sel]
R233 [Relay Out7 Sel]
R236 [Relay Out8 Sel]

Related Parameters for the Aux Relay Card Group:
Aux Parameters
PID Parameters
Digital Inputs
Relays 1 and 2

Note: Auxiliary Relay Card option is not available for Frame C drives.

Sets the condition that changes the state of the output relay contacts.

Options	**0**	"Ready/Fault"	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Hand Active"	Active when drive is in local control.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in [Relay OutX Level]. • Use T056 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in [Relay OutX Level]. • Use T056 to set threshold. **Important:** Value for [Relay OutX Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in [Relay OutX Level]. • Use T056 to set threshold.
	9	"Above Anlg 2"	• Analog input voltage (I/O Terminal 17) exceeds the value set in [Relay OutX Level]. • Do not use if T073 [Analog In 2 Sel] is set to 3 "Voltage Mode - Bipolar". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 17) is wired to a PTC and external resistor. • Use T056 to set threshold.
	10	"Above PF Ang"	• Power Factor angle has exceeded the value set in [Relay OutX Level]. • Use T056 to set threshold.
	11	"Anlg In Loss"	Analog input loss has occurred. Program T072 [Analog In 1 Loss] and/or T076 [Analog In 2 Loss] for desired action when input loss occurs.
	12	"ParamControl"	Enables the output to be controlled over network communications by writing to [Relay OutX Level]. (0 = Off, 1 = On.)
	13	"Retries Exst"	Value set in A163 [Auto Rstrt Tries] is exceeded.
	14	"NonRec Fault"	• Number of retries for A163 [Auto Rstrt Tries] is exceeded OR • Non-resettable fault occurs OR • A163 [Auto Rstrt Tries] is not enabled.
	15	"Reverse"	Drive is commanded to run in reverse direction.
	16	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	17	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	23	"Aux Motor" (Default)	Auxiliary Motor is commanded to run. Refer to Appendix C.

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Aux Relay Card Group *(continued)*

R222 [Relay Out3 Level]
R225 [Relay Out4 Level]
R228 [Relay Out5 Level]
R231 [Relay Out6 Level]
R234 [Relay Out7 Level]
R237 [Relay Out8 Level]

Sets the trip point for the digital output relay if the value of [Relay OutX Sel] is 6, 7, 8, 9, 10 or 12.

[Relay OutX Select] Setting	[Relay OutX Level] Min/Max
6	0/320 Hz
7	0/180%
8	0/815 Volts
9	0/100%
10	1/180 degs
12	0/1

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Refer to Appendix D for details on the application of parameters R239 through R254.

R239 [Aux Motor Mode]

Enables operation of the auxiliary motor control modes when in PID mode.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Aux Relay Card Group *(continued)*

R240 [Aux Motor Qty]

Sets the number of auxiliary motors used while in Auxiliary Motor Control mode.

Options	**1**	"1 Aux Mtr" (Default)	1 Auxiliary Motor
	2	"2 Aux Mtr"	2 Auxiliary Motors
	3	"3 Aux Mtr"	3 Auxiliary Motors
	4	"1 Mtr + Swap" (1)	1 Auxiliary Motor and AutoSwap Active
	5	"2 Mtr + Swap" (1)	2 Auxiliary Motors and AutoSwap Active
	6	"3 Mtr + Swap" (1)	3 Auxiliary Motors and AutoSwap Active

R240 Option	Drive Relays		Auxiliary Relay Card Relays					
	#1 Relay	#2 Relay	#3 Relay	#4 Relay	#5 Relay	#6 Relay	#7 Relay	#8 Relay
1	Motor #2 AC Line	–	–	–	–	–	–	–
2	Motor #2 AC Line	Motor #3 AC Line	–	–	–	–	–	–
3	Motor #2 AC Line	Motor #3 AC Line	Motor #4 AC Line	–	–	–	–	–
4	Motor #1 Drive	Motor #1 AC Line	Motor #2 Drive	Motor #2 AC Line	–	–	–	–
5	Motor #1 Drive	Motor #1 AC Line	Motor #2 Drive	Motor #2 AC Line	Motor #3 Drive	Motor #3 AC Line	–	–
6	Motor #1 Drive	Motor #1 AC Line	Motor #2 Drive	Motor #2 AC Line	Motor #3 Drive	Motor #3 AC Line	Motor #4 Drive	Motor #4 AC Line

(1) **Important:** Proper wiring and parameter configuration of Aux Motor Control functions are especially important when using AutoSwap. Improper wiring or configuration could result in line power being applied to the drive outputs. Verify system operation before connecting auxiliary motor contactor outputs.

R241 [Aux 1 Start Freq]
R244 [Aux 2 Start Freq]
R247 [Aux 3 Start Freq]

Sets the frequency that causes the next available auxiliary motor to turn on.

Values	Default:	50.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

Aux Relay Card Group *(continued)*

R242 [Aux 1 Stop Freq]
R245 [Aux 2 Stop Freq]
R248 [Aux 3 Stop Freq]

Sets the frequency that causes the next running auxiliary motor to turn off.

Values	Default:	25.0 Hz
	Min/Max:	0.0/320.0 Hz
	Display:	0.1 Hz

R243 [Aux 1 Ref Add]
R246 [Aux 2 Ref Add]
R249 [Aux 3 Ref Add]

Sets the amount to add to the PID reference once the next auxiliary motor is turned on to compensate for a drop in the pipe due to the increased flow in a typical pump system.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

R250 [Aux Start Delay]

Sets the delay time before turning on the next auxiliary motor once the output frequency has risen above the value set in [Aux X Start Freq].

Values	Default:	5.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

R251 [Aux Stop Delay]

Sets the delay time before turning off the next running auxiliary motor once the output frequency has dropped below the value set in [Aux X Stop Freq].

Values	Default:	3.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

R252 [Aux Prog Delay]

Sets the time delay between connecting the drive controlled motor contactor and running the drive controlled motor and starting the auxiliary motor control.

Values	Default:	0.50 Secs
	Min/Max:	0.00/60.00 Secs
	Display:	0.01 Secs

Aux Relay Card Group *(continued)*

R253 [Aux AutoSwap Tme]

Sets the total running time between automatic motor changes.

Important: Proper wiring and parameter configuration of Aux Motor Control functions are especially important when using AutoSwap. Improper wiring or configuration could result in line power being applied to the drive outputs. Verify system operation before connecting auxiliary motor contactor outputs.

Values	Default:	0.0 Hr
	Min/Max:	0.0/999.9 Hr
	Display:	0.1 Hr

R254 [Aux AutoSwap Lvl]

Sets the maximum level allowable for an AutoSwap to occur. If the PID output is above this level, AutoSwap will be delayed until the PID output drops below this parameter setting.

Values	Default:	50.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Advanced Display Group

d301 [Control Source]

Related Parameter(s): P036, P038, T051-T054

Displays the active source of the Start Command and Speed Command which are normally defined by the settings of P036 [Start Source] and P038 [Speed Reference] but may be overridden by digital inputs. Refer to the flowcharts on pages 1-28 and 1-29 for details.

Start Command 0 = Keypad 1 = Terminal Block 2 = Communications	Digit 0
Speed Command 0 = Local Keypad Potentiometer 1 = A142 [Internal Freq] 2 = Analog Input 1 3 = Analog Input 2 4 = A143-A146 [Preset Freq x] (T051 - T053 [Digital Inx Sel] must be set to 4) 5 = Communications	Digit 1
Reserved	Digit 2
Reserved	Digit 3

Values		
	Default:	Read Only
	Min/Max:	0/99
	Display:	1

d302 [Contrl In Status]

Related Parameter(s): b002, P036, T051-T054

Status of the control terminal block control inputs.

Important: Actual control commands may come from a source other than the control terminal block.

1 = Condition True, 0 = Condition False

Bit	Input	Terminal
0	Start/FWD In	I/O Terminal 02
1	Dir/REV In	I/O Terminal 03
2	Stop Input	I/O Terminal 01
3	Digital In 1	I/O Terminal 05
4	Digital In 2	I/O Terminal 06
5	Digital In 3	I/O Terminal 07
6	Digital In 4	I/O Terminal 08
7	Not Used	

Values		
	Default:	Read Only
	Min/Max:	0/1
	Display:	1

Advanced Display Group *(continued)*

d303 [Comm Status]

Related Parameter(s): C102-C103

Status of the communications ports.

0000

1 = Condition True, 0 = Condition False

Received Good Message Packet	Digit 0
Transmitting Message	Digit 1
DSI Peripheral Connected	Digit 2
Received Bad Message Packet	Digit 3

Values	Default:	Read Only
	Min/Max:	0/1111
	Display:	1

d304 [PID Setpnt Displ]

Related Parameter(s): A152

Displays the active PID Setpoint value.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

d305 [Analog In 1]

Related Parameter(s): T069-T071

Displays the status of Analog Input 1.

Values	Default:	0.0%
	Min/Max:	0.0/120.0%
	Display:	0.1%

d306 [Analog In 2]

Related Parameter(s): T073-T075

Displays the status of Analog Input 2.

Values	Default:	0.0%
	Min/Max:	0.0/120.0%
	Display:	0.1%

Advanced Display Group *(continued)*

d307 [Fault 1 Code]

Related Parameter(s): A197

A code that represents a drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once.

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d308 [Fault 2 Code]

Related Parameter(s): A197

A code that represents the second most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 1 Code]. The value of this parameter is then moved to [Fault 3 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d309 [Fault 3 Code]

Related Parameter(s): A197

A code that represents the third most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 2 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d310 [Fault 1 Time-hr]

Related Parameter(s): A195, d316

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d311 [Fault 1 Time-min]

Related Parameter(s): A195, d317

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

Advanced Display Group *(continued)*

d312 [Fault 2 Time-hr]

Related Parameter(s): A195, d316

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d313 [Fault 2 Time-min]

Related Parameter(s): A195, d317

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d314 [Fault 3 Time-hr]

Related Parameter(s): A195, d316

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d315 [Fault 3 Time-min]

Related Parameter(s): A195, d317

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d316 [Elapsed Time-hr]

Related Parameter(s): A195, d310, d312, d314

Displays the total elapsed powered-up time (in hours) since timer reset. The timer stops when it reaches maximum.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d317 [Elapsed Time-min]

Related Parameter(s): A195, d311, d313, d315

Displays the total elapsed powered-up time (in minutes) since timer reset. The timer will increment the hour parameter when appropriate.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

Advanced Display Group *(continued)*

d318 [Output Powr Fctr]

Related Parameter(s): T055, T056, T060, T061, T065, T066

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

d319 [Testpoint Data]

Related Parameter(s): A196

The present value of the function selected in A196 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1 Hex

d320 [Control SW Ver]

Main Control Board software version.

Values	Default:	Read Only
	Min/Max:	1.00/99.99
	Display:	0.01

d321 [Drive Type]

Used by Rockwell Automation field service personnel.

d322 [Output Speed]

Related Parameter(s): P034

Displays current output frequency in percent (%). The scale is 0% at 0.00 Hz to 100.0% at P034 [Maximum Freq].

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d323 [Output RPM]

Related Parameter(s): A199

Displays current output frequency in RPM. The scale is based on A199 [Motor NP Poles].

Values	Default:	Read Only
	Min/Max:	0/24000 RPM
	Display:	1 RPM

Advanced Display Group *(continued)*

d324 [Fault Frequency]

Related Parameter(s): b001

Displays the value of b001 [Output Freq] when the last fault occurred.

Values	Default:	Read Only
	Min/Max:	0.00/320.00 Hz
	Display:	0.01 Hz

d325 [Fault Current]

Related Parameter(s): b003

Displays the value of b003 [Output Current] when the last fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

d326 [Fault Bus Volts]

Related Parameter(s): b005

Displays the value of b005 [DC Bus Voltage] when the last fault occurred.

Values	Default:	Read Only
	Min/Max:	0/820 VDC
	Display:	1 VDC

d327 [Status @ Fault]

Related Parameter(s): b006

Displays the value of b006 [Drive Status] when the last fault occurred.

Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d328 [PID Fdbk Display]

Related Parameter(s): b006

(With FRN 7.xx and later.)
Displays the active PID Feedback value.

Values	Default:	0.0%
	Min/Max:	-200.0/200.0%
	Display:	0.1%

d329 [DC Bus Ripple V]

Related Parameter(s): b006

(With FRN 6.xx and later.)
Displays the real-time value of DC bus ripple voltage.
Excessive voltage ripple will eventually result in F017 Input Phase Loss fault.
Fault ripple levels are: 30V for 230V rated drives, and 60V for 460V rated drives.

Values	Default:	Read Only
	Min/Max:	0/(410 for 230 VAC drives, 820 for 460 VAC drives) VDC
	Display:	1 VDC

Advanced Display Group *(continued)*

d330 [Fault 4 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the fourth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 3 Code]. The value of this parameter is then moved to [Fault 3 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d331 [Fault 5 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the fifth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 4 Code]. The value of this parameter is then moved to [Fault 3 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d332 [Fault 6 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the sixth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 5 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d333 [Fault 7 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the seventh most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 6 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

Advanced Display Group *(continued)*

d334 [Fault 8 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the eighth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 7 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d335 [Fault 9 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the ninth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 8 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d336 [Fault 10 Code]

Related Parameter(s): A197

(With FRN 6.xx and later.)

A code that represents the tenth most recent drive fault. The codes will appear in these parameters in the order they occur (d307 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once. As faults occur, this parameter will be overwritten by [Fault 9 Code].

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	0/122
	Display:	1

d337 [Fault 4 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

Advanced Display Group *(continued)*

d338 [Fault 4 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d339 [Fault 5 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d340 [Fault 5 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d341 [Fault 6 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d342 [Fault 6 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

Advanced Display Group *(continued)*

d343 [Fault 7 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d344 [Fault 7 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d345 [Fault 8 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d346 [Fault 8 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d347 [Fault 9 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

Advanced Display Group *(continued)*

d348 [Fault 9 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

d349 [Fault10 Time-hr]

Related Parameter(s): A195, d316

(With FRN 6.xx and later.)

Displays the value of the d316 [Elapsed Time-hr] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0/32767 Hr
	Display:	1 Hr

d350 [Fault10 Time-min]

Related Parameter(s): A195, d317

(With FRN 6.xx and later.)

Displays the value of the d317 [Elapsed Time-min] parameter when the fault occurred.

Values	Default:	Read Only
	Min/Max:	0.0/60.0 Min
	Display:	0.1 Min

Parameter Cross-Reference – by Name

Parameter Name	Number	Group	Page
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ACT1 Input	A204	Advanced Program	3-52
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Analog In 1 Loss	T072	Terminal Block	3-21
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Analog In 2 Hi	T075	Terminal Block	3-22
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Troubleshooting

Chapter 4 provides information to guide you in troubleshooting the PowerFlex 400 drive. Included is a listing and description of drive faults (with possible solutions, when applicable).

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral keypad.

LED Indications

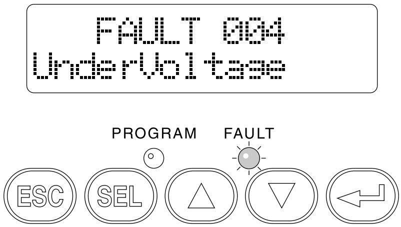
See page 2-3 for information on drive status indicators and controls.

Faults

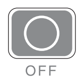
A fault is a condition that stops the drive. There are two fault types.

Type	Fault Description	
①	Auto-Reset/Run	When this type of fault occurs, and A163 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A164 [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-Resetable	This type of fault may require drive or motor repair, or is caused by wiring or programing errors. The cause of the fault must be corrected before the fault can be cleared.

Fault Indication

Condition	
Drive is indicating a fault. The integral keypad provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator Press the Escape key to regain control of the integral keypad.	

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 Table 4.A.	
3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P037 [Stop Mode] is set to a value between "0" and "3". • Cycle drive power. • Set A197 [Fault Clear] to "1" or "2". • Cycle digital input if T051-T054 [Digital Inx Sel] is set to option 10 "Clear Fault".	

Automatically Clearing Faults

Option / Step
Clear a Type 1 fault and restart the drive. 1. Set A163 [Auto Rstrt Tries] to a value other than "0". 2. Set A164 [Auto Rstrt Delay] to a value other than "0".
Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive. 1. Set A163 [Auto Rstrt Tries] to a value other than "0". 2. Set A164 [Auto Rstrt Delay] to "0".

Auto Restart (Reset/Run)

The Auto Restart feature allows 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.

Caution should be used when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Table 4.A Fault Types, Descriptions and Actions

No.	Fault	Type(1)	Description	Action
F2	Auxiliary Input	①	Auxiliary input interlock is open.	1. Check remote wiring. 2. Verify communications programming for intentional fault.
F3	Power Loss	②	FRN 5.03 and earlier only: The DC bus voltage fell below undervoltage level within 200 ms of a start command, DC bus ripple voltage is excessive, or an input phase loss has been detected.	1. Monitor the incoming AC line for low voltage or line power interruption. 2. Check input fuses.
F4	UnderVoltage	①	DC bus voltage fell below the minimum value.	1. Monitor the incoming AC line for low voltage or line power interruption. 2. Check input fuses.
F5	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 a dynamic brake chopper.
F6	Motor Stalled	①	Drive is unable to accelerate motor.	Increase P039 - A147 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A179 [Current Limit 1].
F7	Motor Overload	①	Internal electronic overload trip.	1. An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. 2. Verify A170 [Boost Select] setting
F8	Heatsink OvrTmp	①	Heatsink temperature exceeds a predefined value.	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 45°C (113°F) for IP 30/NEMA 1/UL Type 1 installations or 50°C (122°F) for IP20/Open type installations. 2. Check fan.
F12	HW OverCurrent	②	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A170 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	②	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.

(1) See page 4-1 for a description of fault types.

No.	Fault	Type(1)	Description	Action
F15	Load Loss	①	Output current has dropped below the level set in A184 [Load Loss Level].	Check for load loss (i.e., a broken belt).
F17	Input Phase Loss (FRN 6.xx and later)	②	Excessive DC bus ripple voltage detected. See d329 [DC Bus Ripple V].	Check incoming power for a missing phase or blown fuse. If drive is used intentionally with single phase input, apply output derating to 35% actual drive rating.
F29	Analog Input Loss	①	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with T072 [Analog In Loss].	1. Check parameters. 2. Check for broken/loose connections at inputs.
F32	Fan Fdbck Loss (FRN 6.xx and later)	②	A loss of cooling fan feedback has been detected. (Frames E and F only)	Make sure cooling fans are clear of debris and spinning freely. Replace fan if necessary.
F33	Auto Rstrt Tries	②	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A163 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	②	A phase to ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd			
F40	Phase W to Gnd			
F41	Phase UV Short	②	Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive if fault cannot be cleared.
F42	Phase UW Short			
F43	Phase VW Short			
F48	Params Defaulted		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
F63	SW OverCurrent	①	Programmed A183 [SW Current Trip] has been exceeded.	Check load requirements and A183 [SW Current Trip] setting.
F64	Drive Overload	②	Drive rating of 110% for 1 minute or 150% for 3 seconds has been exceeded.	Reduce load or extend Accel Time.
F70	Power Unit	②	Failure has been detected in the drive power section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.
F71	Net Loss		The communication network has faulted.	1. Cycle power. 2. Check communications cabling. 3. Check network adapter setting. 4. Check external network status.

(1) See page 4-1 for a description of fault types.

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No.	Fault	Type(1)	Description	Action
F81	Comm Loss	②	RS485 (DSI) port stopped communicating.	1. Check RS485 wiring connection. 2. Check if a communications adapter or HIM was disconnected. 3. Increase C106 [Comm Loss Time] to an appropriate time for application. 4. Change C105 [Comm Loss Action] to a value other than "0" (fault), if appropriate for the application.
F94	Function Loss	②	P036 [Start Source] is set to setting 6. The input to terminal 01 has been opened.	Close input to terminal 01 and re-start the drive.
F100	Parameter Checksum	②	The checksum read from the board does not match the checksum calculated.	Set P041 [Reset To Defalts] to option 1 "Reset Defaults".
F122	I/O Board Fail	②	Failure has been detected in the drive control and I/O section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.

(1) See page 4-1 for a description of fault types.

Common Symptoms and Corrective Actions

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 P036 [Start Source] matches your configuration. • Verify that A166 [Reverse Disable] is not prohibiting movement.
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A197 [Fault Clear] to option 1 "Clear Faults". • Cycle digital input if T051 - T054 [Digital Inx Sel] is set to option 7 "Clear Fault".

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 • Cycle power • Set A197 [Fault Clear] to option 1 "Clear Faults". • Cycle digital input if T051 - T054 [Digital Inx Sel] is set to option 7 "Clear Fault".
Incorrect programming. • P036 [Start Source] is set to option 0 "Keypad" or option 5 "RS485 (DSI) Port". • T051 - T054 [Digital Inx Sel] is set to option 5 "Local" and the input is active.	None	Check parameter settings.
Incorrect input wiring. See 1-24 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.
Incorrect Sink/Source DIP switch setting.	None	Set switch to match wiring scheme.

Drive does not Start from Integral Keypad.

Cause(s)	Indication	Corrective Action
Integral keypad is not enabled.	Green LED above Start key is not illuminated.	• Set parameter P036 [Start Source] to option 0 "Keypad". • Set parameter T051 - T054 [Digital Inx Sel] to option 5 "Local" and activate the input.
I/O Terminal 01 "Stop" input is not present.	None	Wire inputs correctly and/or install jumper.

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 d301 [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 via remote device or digital inputs.	None	• Check d301 [Control Source] for correct source. • Check d302 [Contrl In Status] to see if inputs are selecting an alternate source. Verify settings for T051 - T054 [Digital Inx Sel]. • Check P038 [Speed Reference] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 1-28.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P039 [Accel Time 1] or A147 [Accel Time 2].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	Compare b003 [Output Current] with A179 [Current Limit 1]. Remove excess load or reprogram P039 [Accel Time 1] or A147 [Accel Time 2]. Check for improper A170 [Boost Select] setting.
Speed command source or value is not as expected.	None	Verify b002 [Commanded Freq]. Check d301 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	Check P035 [Maximum Freq] to insure that speed is not limited by programming.

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 A194 [Compensation]. 3. Use A170 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Digital input is not selected for reversing control.	None	Check T051 - T054 [Digital Inx Sel] and P036 [Start Source]. Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring. (See page 1-22)
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.
Reverse is disabled.	None	Check A166 [Reverse Disable].

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.
Jumper between Power Terminals P2 and P1 not installed and/or DC Bus Inductor not connected.	None	Install jumper or connect DC Bus Inductor.

Supplemental Drive Information

Drive, Fuse & Circuit Breaker Ratings

The tables on the following pages 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 below. 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 or J must be used.[2]

Circuit Breakers

The "non-fuse" listings in the following tables 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.

(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.

(2) Typical designations include; Type CC - KTK-R, FNQ-R
Type J - JKS, LPJ
Type T - JJS, JJN

Specifications

Drive Ratings										
	Output Ratings			Input Ratings			Branch Circuit Protection			
		Amps								
Catalog Number	kW (HP)	45°C	50°C	Voltage Range	kVA	Amps	Fuses	140M Motor Protectors(1) (2)	Contactors	Min. Enclosure Volume(3) (in.3)
200 - 240V AC – 3-Phase Input, 0 - 230V 3-Phase Output										
22C-B012N103	2.2 (3.0)	12	12	180-265	6.5	15.5	20	140M-F8E-C16	100-C23	5098
22C-B017N103	3.7 (5.0)	17.5	17.5	180-265	8.8	21	30	140M-F8E-C25	100-C37	5098
22C-B024N103	5.5 (7.5)	24	24	180-265	10.9	26.1	35	140M-F8E-C32	100-C37	5098
22C-B033N103	7.5 (10)	33	33	180-265	14.4	34.6	45	140M-F8E-C45	100-C45	5098
22C-B049A103	11 (15)	49	49	180-265	21.3	51	70	–	100-C60	–
22C-B065A103	15 (20)	65	65	180-265	28.3	68	90	–	100-C85	–
22C-B075A103	18.5 (25)	75	75	180-265	32.5	78	100	–	100-D95	–
22C-B090A103	22 (30)	90	81	180-265	38.3	92	125	–	100-D110	–
22C-B120A103	30 (40)	120	120	180-265	51.6	124	175	–	100-D180	–
22C-B145A103	37 (50)	145	130	180-265	62.4	150	200	–	100-D180	–
380 - 480V AC – 3-Phase Input, 0 - 460V 3-Phase Output										
22C-D6P0N103	2.2 (3.0)	6	6	340-528	6.3	7.5	10	140M-D8E-C10	100-C09	5098
22C-D010N103	4.0 (5.0)	10.5	10.5	340-528	10.9	13	20	140M-D8E-C16	100-C16	5098
22C-D012N103	5.5 (7.5)	12	12	340-528	11.9	14.2	20	140M-D8E-C16	100-C23	5098
22C-D017N103	7.5 (10)	17	17	340-528	15.3	18.4	25	140M-D8E-C20	100-C23	5098
22C-D022N103	11 (15)	22	22	340-528	19.2	23	30	140M-F8E-C32	100-C30	5098
22C-D030N103	15 (20)	30	27	340-528	25.8	31	40	140M-F8E-C32	100-C37	5098
22C-D038A103	18.5 (25)	38	38	340-528	33.3	40	50	140M-F8E-C45	100-C60	9086
22C-D045A103	22 (30)	45.5	45.5	340-528	39.1	47	60	–	100-C60	–
22C-D060A103	30 (40)	60	54	340-528	53.3	64	80	–	100-C85	–
22C-D072A103	37 (50)	72	72	340-528	60.7	73	100	–	100-C85	–
22C-D088A103	45 (60)	88	88	340-528	74.9	90	125	–	100-D110	–
22C-D105A103	55 (75)	105	105	340-528	89	107	150	–	100-D140	–
22C-D142A103	75 (100)	142	128	340-528	124.8	150	200	–	100-D180	–
22C-D170A103	90 (125)	170	170	340-528	142	170	250	–	100-D250	–
22C-D208A103	110 (150)	208	208	340-528	167	200	250	–	100-D250	–
22C-D260A103	132 (200)	260	260	340-528	196	235	300	–	100-D300	–
22C-D310A103	160 (250)	310	290	340-528	242	290	400	–	100-D420	–
22C-D370A103	200 (300)	370	370	340-528	304	365	500	–	100-D420	–
22C-D460A103	250 (350)	460	410	340-528	387	465	600	–	100-D630	–

(1) The AIC ratings of the Bulletin 140M Motor Protector Circuit Breakers may vary. See Bulletin 140M Motor Protection Circuit Breakers Application Ratings.

(2) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/347. Not UL listed for use on 480V or 600V Delta/Delta, corner ground, or high-resistance ground systems.

(3) When using a Manual Self-Protected (Type E) Combination Motor Controller, 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.

Category	Specification	
Agency Certification		Listed to UL508C and CAN/CSA-22.2 Listed to UL508C for plenums
		Certified to AS/NZS, 1997 Group 1, Class A
		Marked for all applicable European Directives EMC Directive (89/336) EN 61800-3, EN 50081-1, EN 50082-2 Low Voltage Directive (73/23/EEC) EN 50178, EN 60204
	The drive is also designed to meet the appropriate portions of the following specifications: NFPA 70 - US National Electrical Code NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems. IEC 146 - International Electrical Code.	
Protection	Bus Overvoltage Trip:	200-240V AC Input: 405V DC bus voltage (equivalent to 290V AC incoming line) 380-460V AC Input: 810V DC bus voltage (equivalent to 575V AC incoming line)
	Bus Undervoltage Trip:	200-240V AC Input: 210V DC bus voltage (equivalent to 150V AC incoming line) 380-480V AC Input: 390V DC bus voltage (equivalent to 275V AC incoming line)
	Power Ride-Thru:	100 milliseconds
	Logic Control Ride-Thru:	0.5 seconds minimum, 2 seconds 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:	180% hardware limit, 220% instantaneous fault
	Ground Fault Trip:	Phase-to-ground on drive output
	Short Circuit Trip:	Phase-to-phase on drive output
Environment	Altitude:	1000 m (3300 ft) max. without derating. Above 1000 m (3300 ft), derate 1% for every 100 m (328 ft) up to a maximum altitude of 2000 m (6600 ft).
	Maximum Surrounding Air Temperature without derating: IP20, Open Type: IP30, NEMA Type 1, UL Type 1:	 –10 to 50 degrees C (14 to 122 degrees F) –10 to 45 degrees C (14 to 113 degrees F)
	Cooling Method:	Fan: All drive ratings
	Storage Temperature: 2.2 kW (3.0 HP) to 7.5 kW (10 HP) 11 kW (15 HP) to 250 kW (350 (HP)	 –40 to 85 degrees C (–40 to 185 degrees F) –40 to 70 degrees C (–40 to 158 degrees 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 to 95% non-condensing
	Shock (operating):	15G peak for 11 ms duration (±1.0 ms)
	Vibration (operating):	1G peak, 5 to 2000 Hz
	Seismic Rating	Meets the seismic requirements of the 2003 International Building Code as specified by AC156. (1)

(1) Drives 75 kW (100 HP) and greater have not been tested.

Category	Specification		
Electrical	Voltage Tolerance:		200-240V ±10% 380-480V ±10%
	Frequency Tolerance:		48-63 Hz
	Input Phases:		Three-phase input provides full rating. Single-phase operation provides 35% rated current.
	Displacement Power Factor:		0.98 across entire speed range
	Efficiency:		97.5% at rated amps, nominal line voltage
	Maximum Short Circuit Rating:		100,000 Amps Symmetrical (Frame C Drives) 200,000 Amps Symmetrical (Frame D–H Drives)
	Actual Short Circuit Rating:		Determined by AIC Rating of installed fuse/circuit breaker
	Transistor Type:		Isolated Gate Bipolar (IGBT)
	Internal DC Bus Choke 200-240V AC Input: 380-480V AC Input:		 11-37 kW (15-50 HP) Panel Mount Drives 18.5-160 kW (25-250 HP) Panel Mount Drives
	Internal AC Line Reactor 380-480V AC Input:		 200-250 kW (300-350 HP) Panel Mount Drives
Control	Method:		Sinusoidal PWM, Volts/Hertz
	Carrier Frequency Frames C and D: Frames E – H:		 2-10 kHz, Drive rating based on 4 kHz 2-8 kHz, Drive rating based on 4 kHz
	Frequency Accuracy Digital Input: Analog Input: Analog Output:		 Within ±0.05% of set output frequency Within 0.5% of maximum output frequency, 10-Bit resolution ±2% of full scale, 10-Bit resolution
	Speed Regulation - Open Loop with Slip Compensation:		±1% of base speed across a 60:1 speed range
	Output Frequency:		0-320 Hz (programmable)
	Stop Modes:		Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve.
	Accel/Decel:		Two independently programmable accel and decel times. Each time may be programmed from 0 - 600 seconds in 0.1 second increments.
	Drive Overload:		110% Overload capability for up to 1 minute
	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.
Control Inputs	Digital:	Quantity:	(3) Semi-programmable (4) Programmable
		Type Source Mode (SRC): Sink Mode (SNK):	 18-24V = ON, 0-6V = OFF 0-6V = ON, 18-24V = OFF
	Analog:	Quantity:	(1) Isolated, –10 to 10V or 4-20mA (1) Non-isolated, 0 to 10V or 4-20mA
		Specification Resolution: 0 to 10V DC Analog: 4-20mA Analog: External Pot:	 10-bit 100k ohm input impedance 250 ohm input impedance 1-10k ohm, 2 Watt minimum

Category	Specification		
Control Outputs	Relay:	Quantity:	(2) Programmable Form C
		Specification Resistive Rating: Inductive Rating:	 3.0A at 30V DC, 3.0A at 125V, 3.0A at 240V AC 0.5A at 30V DC, 0.5A at 125V, 0.5A at 240V AC
	Optional Relay Card:	Quantity:	(6) Optional Programmable Form A (Not available for Frame C drives.)
		Specification Resistive Rating: Inductive Rating:	 0.1A at 30V DC Class II circuits, 3.0A at 125V, 3.0A at 240V AC 0.1A at 30V DC Class II circuits, 3.0A at 125V 3.0A at 240V AC
	Opto:	Quantity:	(1) Programmable
		Specification:	30V DC, 50mA Non-inductive
	Analog:	Quantity:	(2) Non-Isolated, 0-10V or 4-20mA
		Specification Resolution: 0 to 10V DC Analog: 4-20mA Analog:	 10-bit 1k ohm minimum 525 ohm maximum
Keypad	Display:	Integral 2 line by 16 character LCD with (5) LED Indicators	
	Languages:	English, Français, Español, Italiano, Deutsch, Português, Nederlands	
Communication	Type:	Serial (RS485)	
	Supported Protocols (Standard):	Drive Serial Interface (DSI) Modbus RTU Metasys N2 P1 - Floor Level Network (FLN)	
	Supported Protocols (Optional):	BACnet DeviceNet EtherNet/IP PROFIBUS DP ControlNet LonWorks	
	Software (Optional):	Windows Based Pocket PC/Windows Mobile 2003	

PowerFlex 400 Watts Loss (Rated Load, Speed & PWM)

Voltage	kW (HP)	Panel Mount Watts	Flange Mount Watts		
		Total	External	Internal	Total
200-240V AC	2.2 (3.0)	146	119	28	146
	3.7 (5.0)	207	174	33	207
	5.5 (7.5)	266	228	39	266
	7.5 (10)	359	315	44	359
	11 (15)	488	–	–	–
	15 (20)	650	–	–	–
	18.5 (25)	734	–	–	–
	22 (30)	778	–	–	–
	30 (40)	1055	–	–	–
	37 (50)	1200	–	–	–
380-480V AC	2.2 (3.0)	105	77	28	105
	4.0 (5.0)	171	143	28	171
	5.5 (7.5)	200	161	39	200
	7.5 (10)	267	229	39	267
	11 (15)	329	285	44	329
	15 (20)	435	380	55	435
	18.5 (25)	606	–	–	–
	22 (30)	738	–	–	–
	30 (40)	764	–	–	–
	37 (50)	1019	–	–	–
	45 (60)	1245	–	–	–
	55 (75)	1487	–	–	–
	75 (100)	2043	–	–	–
	90 (125)	2617	–	–	–
	110 (150)	3601	–	–	–
	132 (200)	3711	–	–	–
	160 (250)	4208	–	–	–
	200 (300)	4916	–	–	–
	250 (350)	6167	–	–	–

Input Power Connections

Figure A.1 Frame C, D, and E Connections

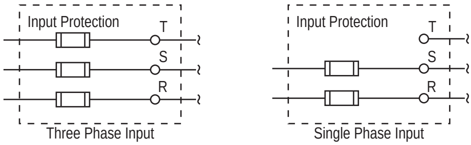
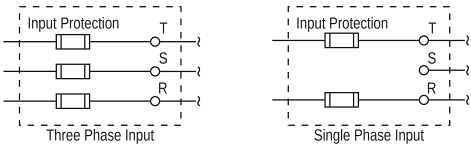


Figure A.2 Frame F Connections



Note: Frames G and H do not support single-phase operation.

Notes:

Accessories and Dimensions

Product Selection

Table B.1 Catalog Number Description

22C	-	B	024	N	1	0	3
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Comm Slot

Table B.2 PowerFlex 400 Drives

Drive Ratings						
			Output Current (Amps)			
Input Voltage	kW	HP	45°C	50°C	Catalog Number	Frame Size
240V 50/60 Hz 3-Phase	2.2	3.0	12	12	22C-B012N103	C
	3.7	5.0	17.5	17.5	22C-B017N103	C
	5.5	7.5	24	24	22C-B024N103	C
	7.5	10	33	33	22C-B033N103	C
	11	15	49	49	22C-B049A103	D
	15	20	65	65	22C-B065A103	D
	18.5	25	75	75	22C-B075A103	D
	22	30	90	81	22C-B090A103	D
	30	40	120	120	22C-B120A103	E
	37	50	145	130	22C-B145A103	E
480V 50/60 Hz 3-Phase	2.2	3.0	6	6	22C-D6P0N103	C
	4.0	5.0	10.5	10.5	22C-D010N103	C
	5.5	7.5	12	12	22C-D012N103	C
	7.5	10	17	17	22C-D017N103	C
	11	15	22	22	22C-D022N103	C
	15	20	30	27	22C-D030N103	C
	18.5	25	38	38	22C-D038A103	D
	22	30	45.5	45.5	22C-D045A103	D
	30	40	60	54	22C-D060A103	D
	37	50	72	72	22C-D072A103	E
	45	60	88	88	22C-D088A103	E
	55	75	105	105	22C-D105A103	E
	75	100	142	128	22C-D142A103	E
	90	125	170	170	22C-D170A103	F
	110	150	208	208	22C-D208A103	F
	132	200	260	260	22C-D260A103	G
	160	250	310	290	22C-D310A103	G
	200	300	370	370	22C-D370A103	H
	250	350	460	410	22C-D460A103	H

Table B.3 PowerFlex 400 Flange Mount Drives

Drive Ratings						
			Output Current			
Input Voltage	kW	HP	45°C	50°C	Catalog Number	Frame Size
240V 50/60 Hz 3-Phase	2.2	3	12A	12A	22C-B012F103	C
	3.7	5	17.5A	17.5A	22C-B017F103	C
	5.5	7.5	24A	24A	22C-B024F103	C
	7.5	10	33A	33A	22C-B033F103	C
480V 50/60 Hz 3-Phase	2.2	3	6.0A	6.0A	22C-D6P0F103	C
	4.0	5	10A	10A	22C-D010F103	C
	5.5	7.5	12A	12A	22C-D012F103	C
	7.5	10	17A	17A	22C-D017F103	C
	11	15	22A	22A	22C-D022F103 [1]	C
	15	20	30A	27A	22C-D030F103 [1]	C

[1] A DC bus inductor is required. See Table B.7 for ordering information.

Table B.4 Bulletin 1321-3R Series Line Reactors – 200-240V, 60 Hz, Three-Phase

kW	HP	Fundamental Amps	Maximum Continuous Amps	Inductance mh	Watts Loss	Catalog Number IP00 (Open Style)	Catalog Number IP11 (NEMA Type 1)
3% Impedance							
2.2	3.0	12	18	1.25	26	1321-3R12-A	1321-3RA12-A
3.7	5.0	18	27	0.8	36	1321-3R18-A	1321-3RA18-A
5.5	7.5	25	37.5	0.5	48	1321-3R25-A	1321-3RA25-A
7.5	10	35	52.5	0.4	49	1321-3R35-A	1321-3RA35-A
11	15	45	67.5	0.3	54	1321-3R45-A	1321-3RA45-A
15	20	55	82.5	0.25	64	1321-3R55-A	1321-3RA55-A
18.5	25	80	120	0.2	82	1321-3R80-A	1321-3RA80-A
22	30	80	120	0.2	82	1321-3R80-A	1321-3RA80-A
30	40	100	150	0.15	94	1321-3R100-A	1321-3RA100-A
37	50	130	195	0.1	108	1321-3R130-A	1321-3RA130-A
5% Impedance							
2.2	3.0	12	18	2.5	31	1321-3R12-B	1321-3RA12-B
3.7	5.0	18	27	1.5	43	1321-3R18-B	1321-3RA18-B
5.5	7.5	25	37.5	1.2	52	1321-3R25-B	1321-3RA25-B
7.5	10	35	52.5	0.8	54	1321-3R35-B	1321-3RA35-B
11	15	45	67.5	0.7	62	1321-3R45-B	1321-3RA45-B
15	20	55	82.5	0.5	67	1321-3R55-B	1321-3RA55-B
18.5	25	80	120	0.4	86	1321-3R80-B	1321-3RA80-B
22	30	80	120	0.4	86	1321-3R80-B	1321-3RA80-B
30	40	100	150	0.3	84	1321-3R100-B	1321-3RA100-B
37	50	130	195	0.2	180	1321-3R130-B	1321-3RA130-B

Table B.5 Bulletin 1321-3R Series Line Reactors – 380-480V, 60 Hz, Three-Phase

kW	HP	Fundamental Amps	Maximum Continuous Amps	Inductance	Watts Loss	Catalog Number IP00 (Open Style)	Catalog Number IP11 (NEMA Type 1)
3% Impedance							
2.2	3.0	8	12	5	25.3	1321-3R8-C	1321-3RA8-C
4.0	5.0	12	18	2.5	31	1321-3R12-B	1321-3RA12-B
5.5	7.5	12	18	2.5	31	1321-3R12-B	1321-3RA12-B
7.5	10	18	27	1.5	43	1321-3R18-B	1321-3RA18-B
11	15	25	37.5	1.2	52	1321-3R25-B	1321-3RA25-B
15	20	35	52.5	0.8	54	1321-3R35-B	1321-3RA35-B
18.5	25	35	52.5	0.8	54	1321-3R35-B	1321-3RA35-B
22	30	45	67.5	0.7	62	1321-3R45-B	1321-3RA45-B
30	40	55	82.5	0.5	67	1321-3R55-B	1321-3RA55-B
37	50	80	120	0.4	86	1321-3R80-B	1321-3RA80-B
45	60	80	120	0.4	86	1321-3R80-B	1321-3RA80-B
55	75	100	150	0.3	84	1321-3R100-B	1321-3RA100-B
75	100	130	195	0.2	180	1321-3R130-B	1321-3RA130-B
90	125	160	240	0.15	149	1321-3R160-B	1321-3RA160-B
110	150	200	300	0.11	168	1321-3R200-B	1321-3RA200-B
132	200	250	375	0.09	231	1321-3RB250-B	1321-3RAB250-B
160	250	320	480	0.075	264	1321-3RB320-B	1321-3RAB320-B
200	300	400	560	0.06	333	1321-3RB400-B	1321-3RAB400-B
250	350	500	700	0.05	340	1321-3R500-B	1321-3RA500-B
5% Impedance							
2.2	3.0	8	12	7.5	28	1321-3R8-D	1321-3RA8-D
4.0	5.0	12	18	4.2	41	1321-3R12-C	1321-3RA12-C
5.5	7.5	12	18	4.2	41	1321-3R12-C	1321-3RA12-C
7.5	10	18	27	2.5	43	1321-3R18-C	1321-3RA18-C
11	15	25	37.5	2.0	61	1321-3R25-C	1321-3RA25-C
15	20	35	52.5	1.2	54	1321-3R35-C	1321-3RA35-C
18.5	25	35	52.5	1.2	54	1321-3R35-C	1321-3RA35-C
22	30	45	67.5	1.2	65	1321-3R45-C	1321-3RA45-C
30	40	55	82.5	0.85	71	1321-3R55-C	1321-3RA550-C
37	50	80	120	0.7	96	1321-3R80-C	1321-3RA80-C
45	60	80	120	0.7	96	1321-3R80-C	1321-3RA80-C
55	75	100	150	0.45	108	1321-3R100-C	1321-3RA100-C
75	100	130	195	0.3	128	1321-3R130-C	1321-3RA130-C
90	125	160	240	0.23	138	1321-3R160-C	1321-3RA160-C
110	150	200	300	0.185	146	1321-3R200-C	1321-3RA200-C
132	200	250	375	0.15	219	1321-3RB250-C	1321-3RAB250-C
160	250	320	480	0.125	351	1321-3RB320-C	1321-3RAB320-C
200	300	400	560	0.105	293	1321-3RB400-C	1321-3RAB400-C
250	350	500	700	0.085	422	1321-3R500-C	1321-3RA500-C

Table B.6 Bulletin 1321 - DC Series Bus Inductors - 200-240V, 60 Hz, Three-Phase

kW	HP	DC Amps	Inductance mh	Watts Loss	Catalog Number IP00 (Open Style)
2.2	3	12	0.92	5	1321-DC12-1
3.7	5	18	0.63	5	1321-DC18-1
5.5	7.5	32	0.85	11	1321-DC32-1
7.5	10	40	0.75	15	1321-DC40-2

Table B.7 Bulletin 1321 - DC Series Bus Inductors - 380-480V, 60 Hz, Three-Phase

kW	HP	DC Amps	Inductance mh	Watts Loss	Catalog Number IP00 (Open Style)
2.2	3	9	3.68	7	1321-DC9-2
4.0	5	12	2.1	7	1321-DC12-2
5.5	7.5	18	3.75	17	1321-DC18-4
7.5	10	25	1.75	13	1321-DC25-4
11	15	32	2.68	21	1321-DC32-2 (1)
15	20	40	2.0	29	1321-DC40-4 (1)

(1) Required on 11 and 15 kW (15 and 20 HP) Frame C Flange Mount drive ratings.

Table B.8 EMC Line Filters

Drive Ratings			
Input Voltage	**kW**	**HP**	**Catalog Number**
240V 50/60 Hz 3-Phase	2.2	3.0	22-RF034-CS
	4.0	5.0	22-RF034-CS
	5.5	7.5	22-RF034-CS
	7.5	10	22-RF034-CS
	11	15	22-RFD070
	15	20	22-RFD100
	18.5	25	22-RFD100
	22	30	22-RFD150
	30	40	22-RFD150
	37	50	22-RFD180
480V 50/60 Hz 3-Phase	2.2	3.0	22-RF018-CS
	4.0	5.0	22-RF018-CS
	5.5	7.5	22-RF018-CS
	7.5	10	22-RF018-CS
	11	15	22-RF026-CS
	15	20	22-RFD036
	18.5	25	22-RFD050
	22	30	22-RFD050
	30	40	22-RFD070
	37	50	22-RFD100
	45	60	22-RFD100
	55	75	22-RFD150
	75	100	22-RFD180
	90	125	22-RFD208
	110	150	22-RFD208
	132	200	22-RFD323
	160	250	22-RFD480
	200	300	22-RFD480
	250	350	22-RFD480

Table B.9 Communication Option Kits and Accessories

Item	Description	Catalog Number
BACnet® MS/TP RS-485 Communication Adapter	Embedded communication options for use with the PowerFlex family of drives. Requires a Communication Adapter Cover when used with Frame C PowerFlex 400 drives (Ordered Separately).	22-COMM-B
ControlNet™ Communication Adapter		22-COMM-C
DeviceNet™ Communication Adapter		22-COMM-D
EtherNet/IP™ Communication Adapter		22-COMM-E
LonWorks™ Communication Adapter		22-COMM-L
PROFIBUS™ DP Communication Adapter		22-COMM-P
External DSI™ Communications Kit	External mounting kit for 22-COMM communication adapter options.	22-XCOMM-DC-BASE
External Comms Power Supply	Optional 100-240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1
Compact I/O Module	3 Channel.	1769-SM2
Communication Adapter Cover	Cover that houses the communication adapter. Frame C Drive	 22C-CCC
Serial Converter Module (RS485 to RS232)	Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive software. Includes: DSI to RS232 serial converter (one) 1203-SFC serial cable (one) 22-RJ45CBL-C20 cable (one) DriveExplorer Lite CD (one)	22-SCM-232
DSI Cable	2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 meter 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
Serial Null Cable Converter	For use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Universal Serial Bus™ (USB) Converter	Includes 2m USB, 20-HIM-H10 & 22-HIM-H10 cables.	1203-USB
Splitter Cable	RJ45 one to two port splitter cable	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
DriveExplorer Software (CD-ROM) Version 3.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online. Compatibility: Windows 95, 98, ME, NT 4.0 (Service Pack 3 or later), 2000, XP and CE[1]	9306-4EXP01ENE
DriveExecutive software (CD-ROM) Version 1.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online and offline. Compatibility: Windows 98, ME, NT 4.0 (Service Pack 3 or later), 2000 and XP	9303-4DTE01ENE
Serial Flash Firmware Kit	Use a PC to update drive firmware.	AK-U9-FLSH1

(1) See www.ab.com/drives/driveexplorer.htm for supported devices.

Table B.10 Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog Number
LCD Display, Remote Panel Mount	LCD Display Digital Speed Control CopyCat Capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.0 meter cable	22-HIM-C2S
LCD Display, Remote Handheld	LCD Display Digital Speed Control Full Numeric Keypad CopyCat Capable IP30 (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, IP30 (NEMA Type 1)	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 Meter (3.3 Feet) 2.9 Meter (9.51 Feet)	22-HIM-H10 22-HIM-H30

Table B.11 Frame C IP30/NEMA 1/UL Type 1 Kit

Item	Description	Drive Frame	Catalog Number
IP30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	C	22-JBAC
IP30/NEMA 1/UL Type 1 Kit for Communication Option	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes communication option conduit box with mounting screws and plastic top panel.	C	22-JBCC

Table B.12 Field Installed Option

Item	Description	Catalog Number
Auxiliary Relay Board	Field installed kit. Expands drive output capabilities.	AK-U9-RLB1

Product Dimensions

Table B.13 PowerFlex 400 Frames and Weights

Frame	kW (HP)	Drive Weight kg (lbs.)	Packaged Weight kg (lbs.)
240V AC – 3-Phase			
C	2.2 (3.0)	2.89 (6.4)	3.41 (7.5)
C	4.0 (5.0)	2.97 (6.5)	3.49 (7.7)
C	5.5 (7.5)	3.72 (8.2)	4.27 (9.4)
C	7.5 (10)	3.78 (8.3)	4.33 (9.5)
D	11 (15)	12.1 (26.7)	13.4 (29.5)
D	15 (20)	12.7 (28.0)	14 (30.9)
D	18.5 (25)	12.7 (28.0)	14 (30.9)
D	22 (30)	12.7 (28.0)	14 (30.9)
E	30 (40)	38 (83.8)	48.2 (106.3)
E	37 (50)	38 (83.8)	48.2 (106.3)
480V AC – 3-Phase			
C	2.2 (3.0)	2.87 (6.3)	3.39 (7.5)
C	4.0 (5.0)	3.03 (6.7)	3.55 (7.8)
C	5.5 (7.5)	3.65 (8.0)	4.2 (9.3)
C	7.5 (10)	3.75 (8.3)	4.3 (9.5)
C	11 (15)	6.41 (14.1)	7.41 (16.3)
C	15 (20)	6.47 (14.3)	7.49 (16.5)
D	18.5 (25)	12.7 (28.0)	14 (30.9)
D	22 (30)	12.7 (28.0)	14 (30.9)
D	30 (40)	14.3 (31.5)	15.6 (34.4)
E	37 (50)	36 (79.4)	46.2 (101.9)
E	45 (60)	36 (79.4)	46.2 (101.9)
E	55 (75)	41 (90.4)	51.2 (112.9)
E	75 (100)	41 (90.4)	51.2 (112.9)
F	90 (125)	78 (172.0)	88 (194.0)
F	110 (150)	78 (172.0)	88 (194.0)
G	132 (200)	89 (196.2)	106 (233.7)
G	160 (250)	89 (196.2)	106 (233.7)
H	200 (300)	157 (346.1)	177 (390.2)
H	250 (350)	157 (346.1)	177 (390.2)
240V AC – 3-Phase, Plate Drive			
C	2.2 (3.0)	2.66 (5.9)	3.26 (7.2)
C	4.0 (5.0)	2.74 (6.0)	3.34 (7.4)
C	5.5 (7.5)	3.15 (6.9)	3.75 (8.3)
C	7.5 (10)	3.21 (7.1)	3.81 (8.4)
480V AC – 3-Phase, Plate Drive			
C	2.2 (3.0)	2.63 (5.8)	3.23 (7.1)
C	4.0 (5.0)	2.77 (6.1)	3.37 (7.4)
C	5.5 (7.5)	3.04 (6.7)	3.64 (8.0)
C	7.5 (10)	3.13 (6.9)	3.73 (8.2)
C	11 (15)	3.19 (7.0)	3.79 (8.4)
C	15 (20)	3.25 (7.2)	3.85 (8.5)

Figure B.1 PowerFlex 400 Frame C Drive - *Dimensions are in millimeters and (inches)*

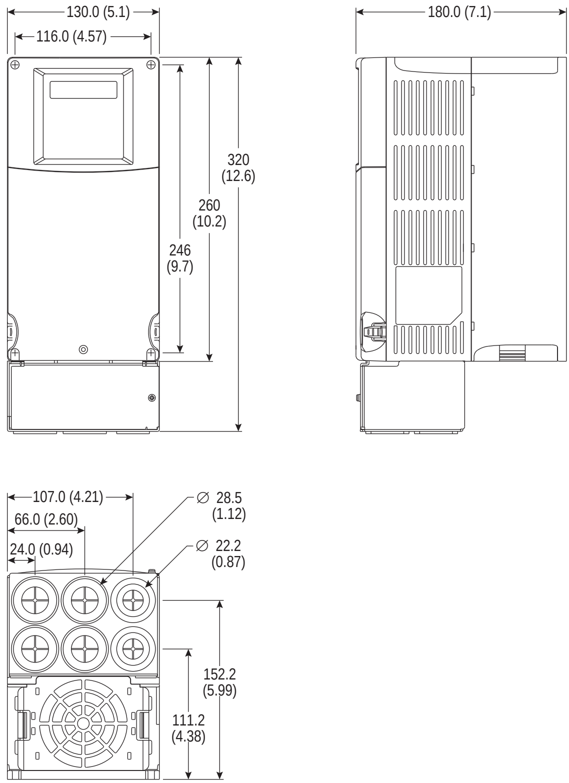


Figure B.2 PowerFlex 400 Frame D Drive - *Dimensions are in millimeters and (inches)*

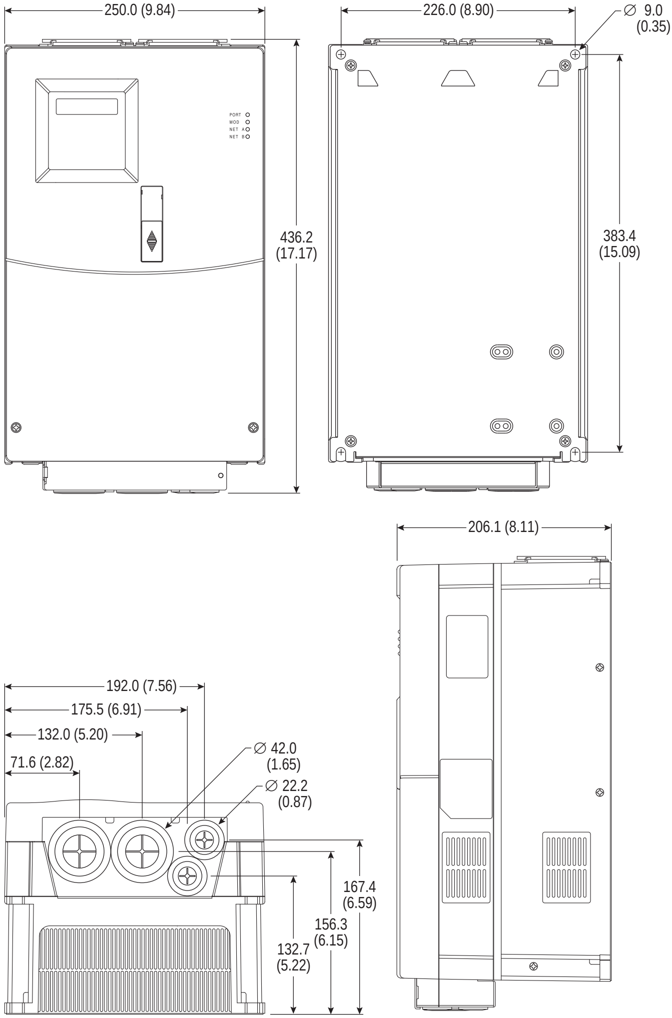


Figure B.3 PowerFlex 400 Frame E Drive - *Dimensions are in millimeters and (inches)*

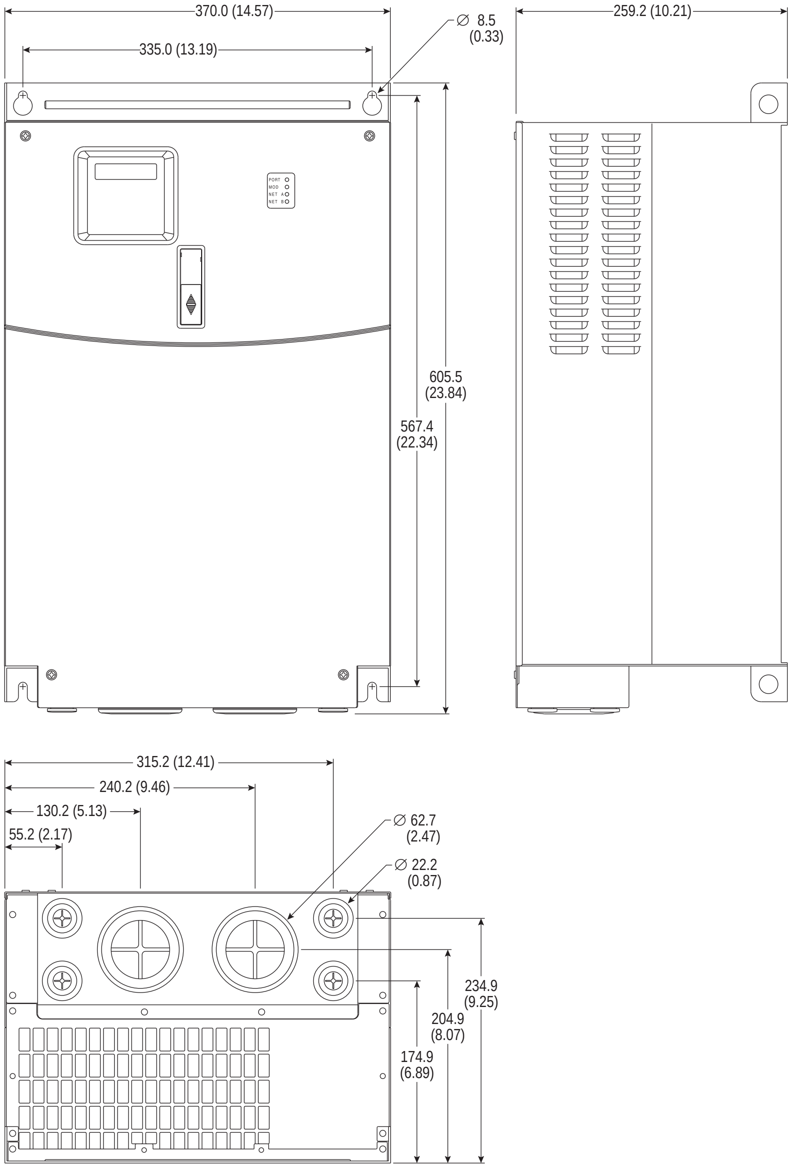


Figure B.4 PowerFlex 400 Frame F Drive - *Dimensions are in millimeters and (inches)*

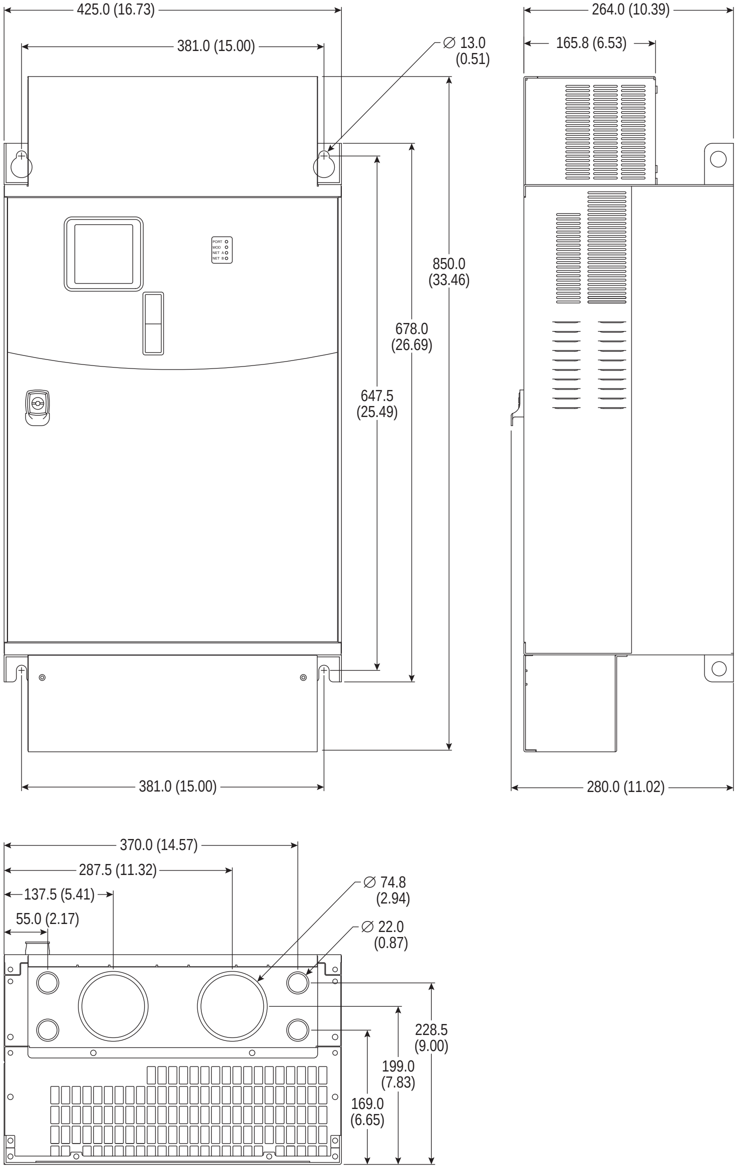


Figure B.5 PowerFlex 400 Frame G Drive - *Dimensions are in millimeters and (inches)*

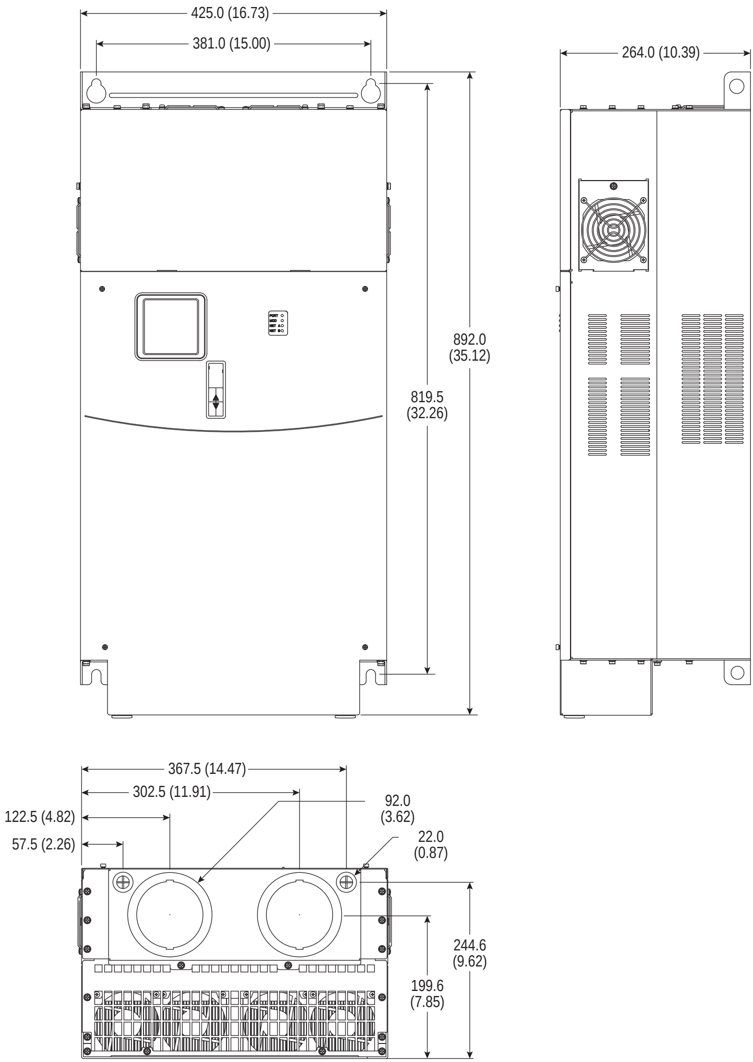


Figure B.6 PowerFlex 400 Frame H Drive - *Dimensions are in millimeters and (inches)*

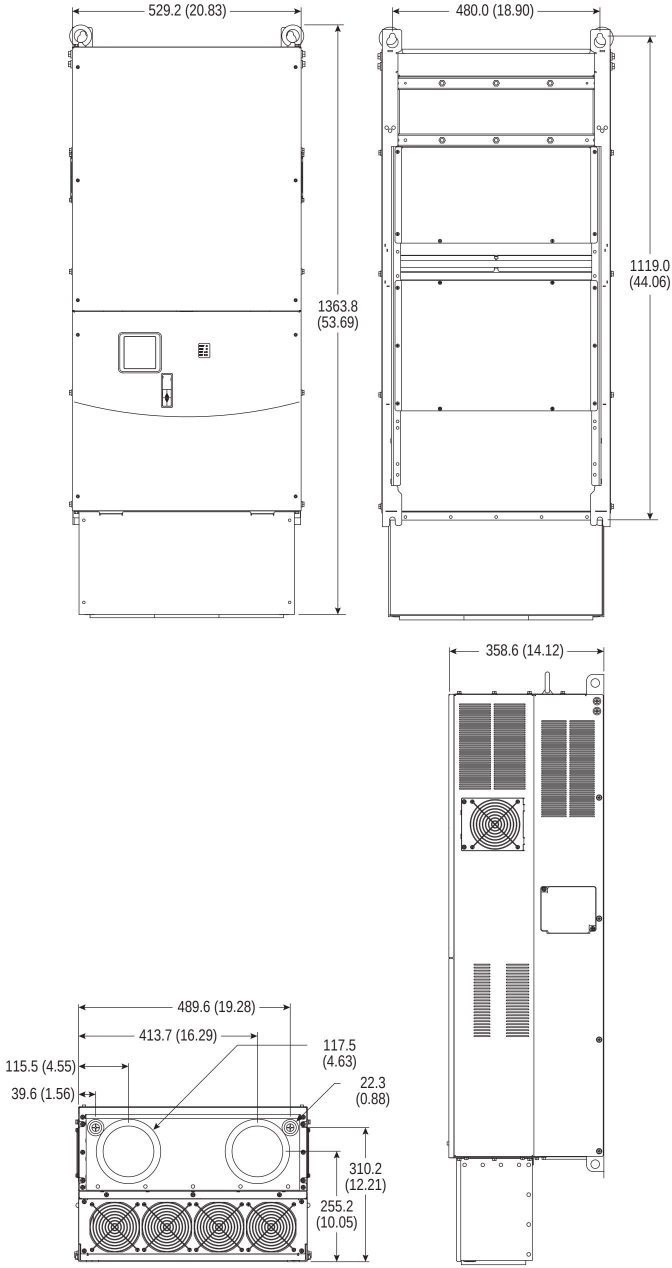
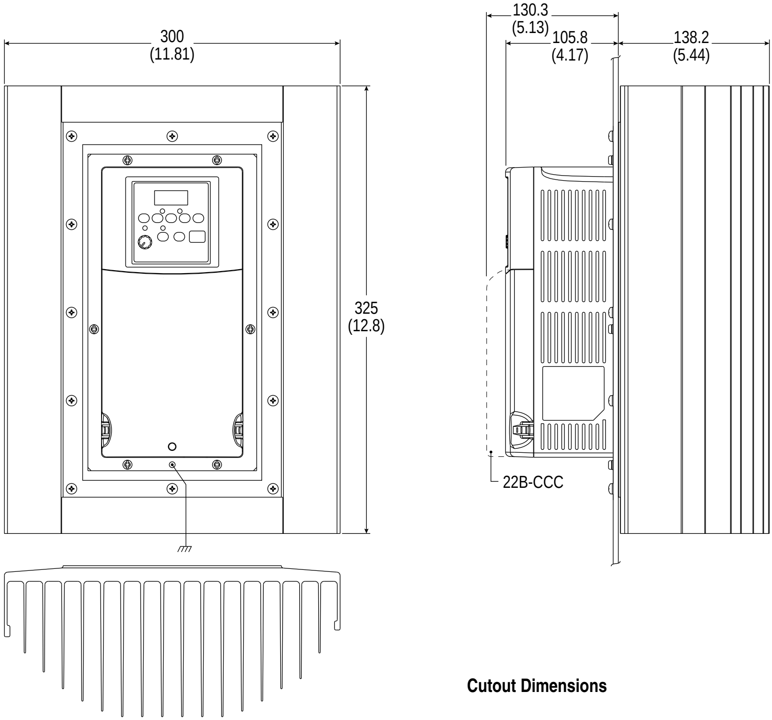


Figure B.7 PowerFlex 400 Frame C Flange Mount Drive -
Dimensions are in millimeters and (inches)



Cutout Dimensions

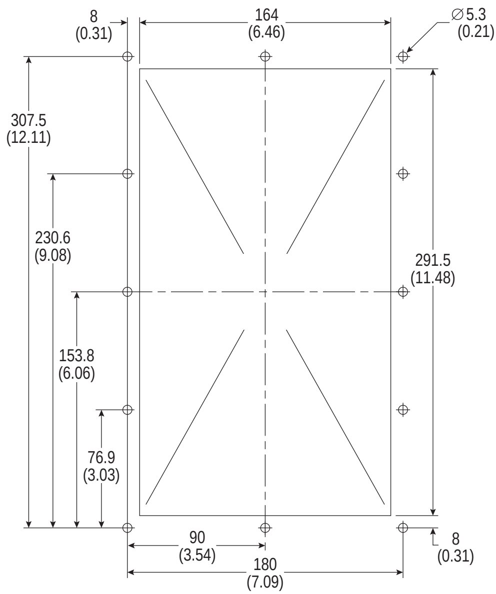
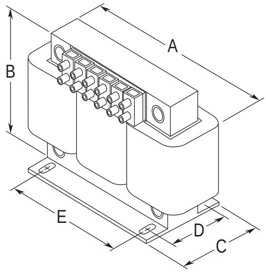
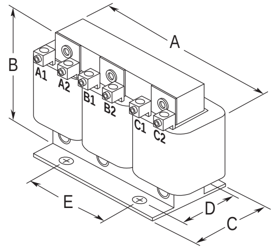


Figure B.8 Bulletin 1321-3R Series Line Reactors – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



IP00 (Open) –
45 Amps (fundamental) and Below

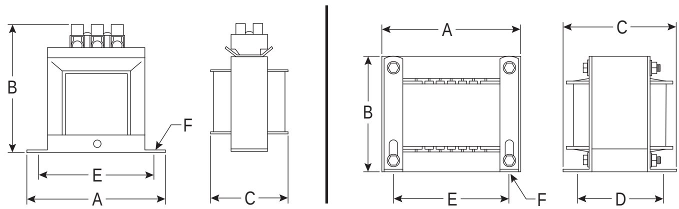


IP00 (Open) –
55 Amps (fundamental) and Above

Catalog Number	A	B	C	D	E	Weight
1321-3R8-C	152 (6.00)	122 (4.80)	86 (3.40)	67 (2.62)	51 (2.00)	5.0 (11)
1321-3R8-D	152 (6.00)	122 (4.80)	86 (3.40)	63 (2.48)	51 (2.00)	5.9 (13)
1321-3R12-A	152 (6.00)	127 (5.00)	84 (3.30)	53 (2.10)	51 (2.00)	4.1 (9)
1321-3R12-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.5 (10)
1321-3R12-C	152 (6.00)	127 (5.00)	91 (3.60)	69 (2.73)	51 (2.00)	8.2 (18)
1321-3R18-B	152 (6.00)	135 (5.30)	89 (3.50)	63 (2.48)	51 (2.00)	5.5 (12)
1321-3R18-C	183 (7.20)	146 (5.76)	92 (3.63)	66 (2.60)	76 (3.00)	7.3 (16)
1321-3R25-A	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	4.9 (11)
1321-3R25-B	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	6.3 (14)
1321-3R25-C	183 (7.20)	146 (5.76)	105 (4.10)	79 (3.10)	76 (3.00)	8.1 (18)
1321-3R35-A	193 (7.60)	146 (5.76)	91 (3.60)	66 (2.60)	76 (3.00)	6.3 (14)
1321-3R35-B	183 (7.20)	147 (5.80)	95 (3.75)	79 (3.10)	76 (3.00)	7.3 (16)
1321-3R35-C	229 (9.00)	187 (7.35)	118 (4.66)	80 (3.16)	76 (3.00)	13.6 (30)
1321-3R45-A	229 (9.00)	187 (7.35)	118 (4.66)	80 (3.16)	76 (3.00)	10.4 (23)
1321-3R45-B	229 (9.00)	187 (7.35)	118 (4.66)	80 (3.16)	76 (3.00)	12.7 (28)
1321-3R45-C	229 (9.00)	184 (7.25)	135 (5.30)	93 (3.66)	76 (3.00)	17.7 (39)
1321-3R55-A	229 (9.00)	187 (7.35)	118 (4.66)	80 (3.16)	76 (3.00)	10.9 (24)
1321-3R55-B	229 (9.00)	187 (7.35)	118 (4.66)	80 (3.16)	76 (3.00)	12.3 (27)
1321-3R55-C	229 (9.00)	184 (7.25)	142 (5.60)	99 (3.90)	76 (3.00)	18.6 (41)
1321-3R80-A	274 (10.80)	216 (8.50)	139 (5.47)	88 (3.47)	92 (3.63)	19.5 (43)
1321-3R80-B	274 (10.80)	216 (8.50)	139 (5.47)	88 (3.47)	92 (3.63)	23.1 (51)
1321-3R80-C	274 (10.80)	210 (8.26)	156 (6.16)	106 (4.16)	92 (3.63)	25.0 (55)
1321-3R100-A	274 (10.80)	217 (8.55)	139 (5.48)	84 (3.30)	92 (3.63)	21.3 (47)
1321-3R100-B	274 (10.80)	210 (8.25)	144 (5.66)	93 (3.66)	92 (3.63)	23.1 (51)
1321-3R100-C	274 (10.80)	210 (8.25)	156 (6.16)	106 (4.16)	92 (3.63)	33.6 (74)
1321-3R130-A	229 (9.00)	179 (7.04)	118 (4.66)	80 (3.16)	76 (3.00)	13.2 (29)
1321-3R130-B	274 (10.80)	213 (8.40)	144 (5.66)	93 (3.66)	92 (3.63)	25.9 (57)
1321-3R130-C	279 (11.00)	216 (8.50)	156 (6.16)	106 (4.16)	92 (3.63)	29.0 (64)
1321-3R160-A	274 (10.80)	216 (8.50)	172 (6.80)	80 (3.16)	92 (3.63)	19.0 (42)
1321-3R160-B	279 (11.00)	216 (8.50)	178 (7.00)	88 (3.47)	92 (3.63)	23.0 (51)
1321-3R160-C	287 (11.30)	216 (8.50)	229 (9.00)	118 (4.66)	92 (3.63)	33.0 (72)
1321-3R200-B	274 (10.80)	216 (8.50)	210 (8.30)	112 (4.41)	92 (3.63)	31.0 (67)
1321-3R200-C	274 (10.80)	216 (8.50)	254 (10.00)	150 (5.91)	92 (3.63)	46.0 (100)

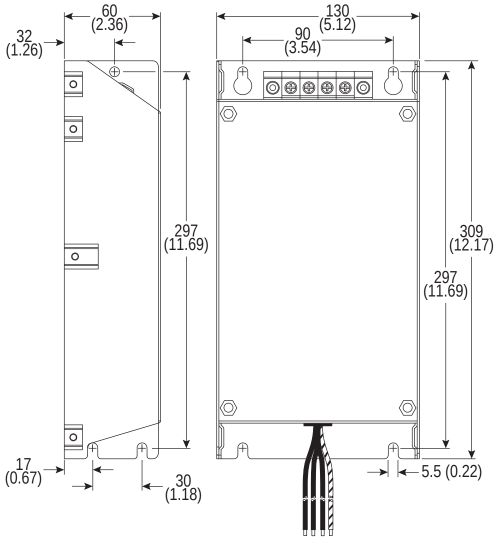
Catalog Number	A	B	C	D	E	Weight
1321-3R250-B	366 (14.40)	292 (11.50)	292 (11.50)	192 (7.56)	117 (4.60)	53.5 (118)
1321-3R250-C	366 (14.40)	286 (11.25)	260 (10.25)	167 (6.56)	117 (4.60)	57.0 (125)
1321-3R320-B	274 (10.80)	229 (9.00)	254 (10.00)	165 (6.50)	92 (3.63)	46.3 (102)
1321-3R320-C	366 (14.40)	286 (11.25)	267 (10.50)	192 (7.56)	117 (4.60)	72.6 (160)
1321-3R400-B	381 (15.00)	286 (11.25)	292 (11.50)	179 (7.06)	117 (4.60)	53.5 (118)
1321-3R400-C	366 (14.40)	286 (11.25)	318 (12.50)	192 (7.56)	117 (4.60)	67.6 (149)
1321-3R500-B	366 (14.40)	292 (11.50)	292 (11.50)	192 (7.56)	117 (4.60)	53.5 (118)
1321-3R500-C	366 (14.40)	286 (11.25)	254 (10.00)	141 (5.56)	117 (4.60)	54.4 (120)

Figure B.9 Bulletin 1321-DC Series Bus Inductors – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).

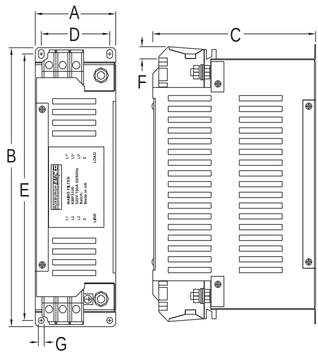


Catalog Number	Model	A	B	C	D	E	F	Weight *kg (lbs.)*
1321-DC9-2	A	95 (3.75)	83 (3.25)	51 (2.00)	–	80 (3.13)	4.7 (0.19)	
1321-DC12-1	A	95 (3.75)	83 (3.25)	44 (1.75)	–	80 (3.13)	4.7 0.19)	
1321-DC12-2	B	97 (3.81)	114 (4.50)	72 (2.82)	51 (2.00)	80 (3.13)	5x8 (.20x.33)	5.9 (13.0)
1321-DC18-1	A	95 (3.75)	83 (3.25)	51 (2.00)	–	80 (3.13)	4.7 (0.19)	
1321-DC18-4	B	118 (4.63)	133 (5.25)	102 (4.00)	64 (2.50)	95 (3.75)	5x8 (.20x.33)	3.6 (8.0)
1321-DC25-4	B	97 (3.81)	114 (4.50)	76 (3.00)	64 (2.50)	80 (3.13)	5x8 (.20x.33)	5.9 (13.0)
1321-DC32-1	B	97 (3.81)	114 (4.50)	84 (3.32)	64 (2.50)	80 (3.13)	5x8 (.20x.33)	2.3 (5.0)
1321-DC32-2	B	118 (4.63)	133 (5.25)	108 (4.25)	76 (3.00)	95 (3.75)	5x8 (.20x.33)	4.5 (10.0)
1321-DC40-2	B	97 (3.81)	114 (4.50)	95 (3.75)	76 (3.00)	80 (3.13)	5x8 (.20x.33)	3.2 (7.0)
1321-DC40-4	B	165 (6.50)	166 (6.55)	152 (6.00)	86 (3.38)	135 (5.31)	7x13 (.28x.52)	9.5 (21.0)

Figure B.10 EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF018-CS, 22-RF018-CL, 22-RF026-CS, 22-RF026-CL, 22-RF026-CL, 22-RF034-CS

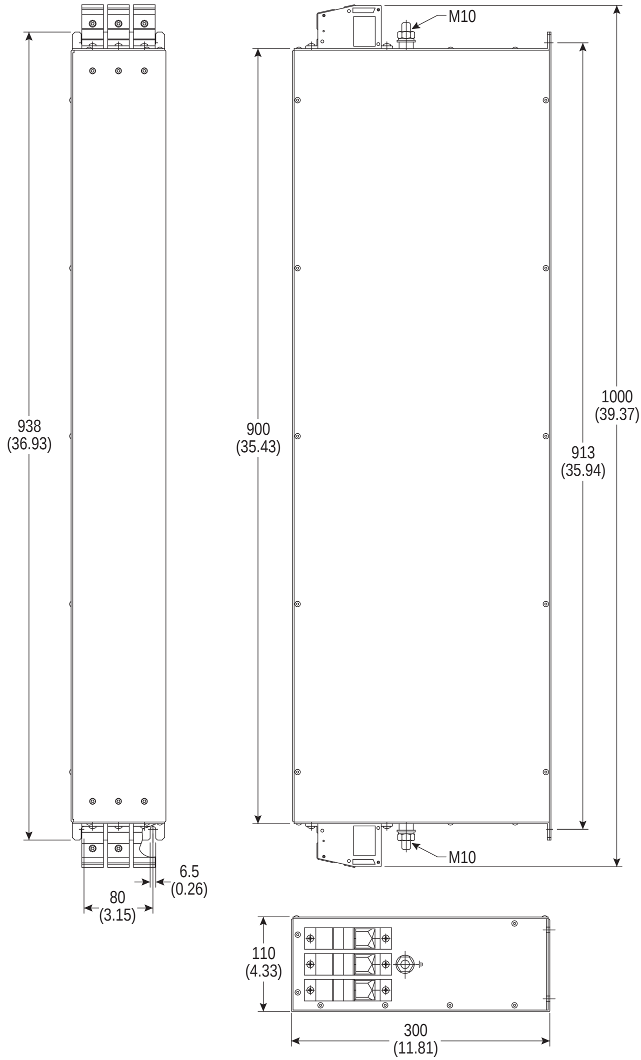


Catalog Numbers: 22-RFD036, 22-RFD050, 22-RFD070, 22-RFD100, 22-RFD150, 22-RFD180

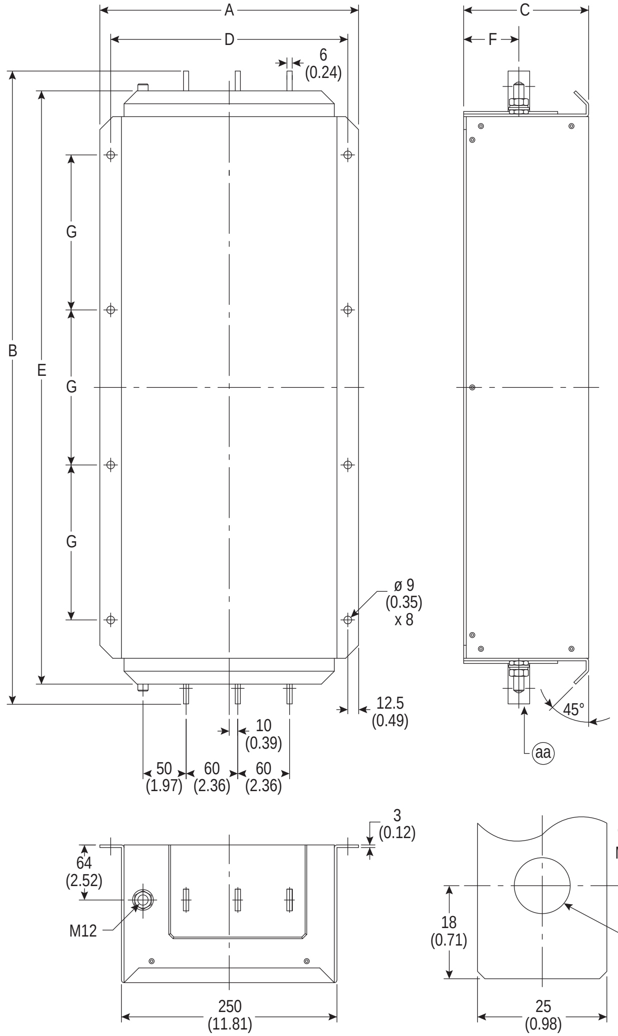


Catalog Number	A	B	C	D	E	F	G
22-RFD036	74 (2.91)	272 (10.71)	161 (6.34)	60 (2.36)	258 (10.16)	7.5 (0.30)	7 (0.28)
22-RFD050	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD070	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD100	93 (3.66)	312 (12.28)	190 (7.48)	79 (3.11)	298 (11.73)	13.5 (0.53)	7 (0.28)
22-RFD150	126 (4.96)	312 (12.28)	224 (8.82)	112 (4.41)	298 (11.73)	19.5 (0.77)	7 (0.28)
22-RFD180	126 (4.96)	312 (12.28)	224 (8.82)	112 (4.41)	298 (11.73)	27 (1.06)	7 (0.28)

Catalog Number: 22-RFD208



Catalog Numbers: 22-RFD323 and 22-RFD480



Catalog Number	A	B	C	D	E	F	G
22-RFD323	300 (11.81)	735 (28.94)	145 (5.71)	275 (10.83)	689 (27.13)	64 (2.52)	180 (7.09)
22-RFD480	300 (11.81)	882 (34.72)	145 (5.71)	275 (10.83)	836 (32.91)	64 (2.52)	240 (9.45)

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Figure B.11 Remote (Panel Mount) Small HIM – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-C2S

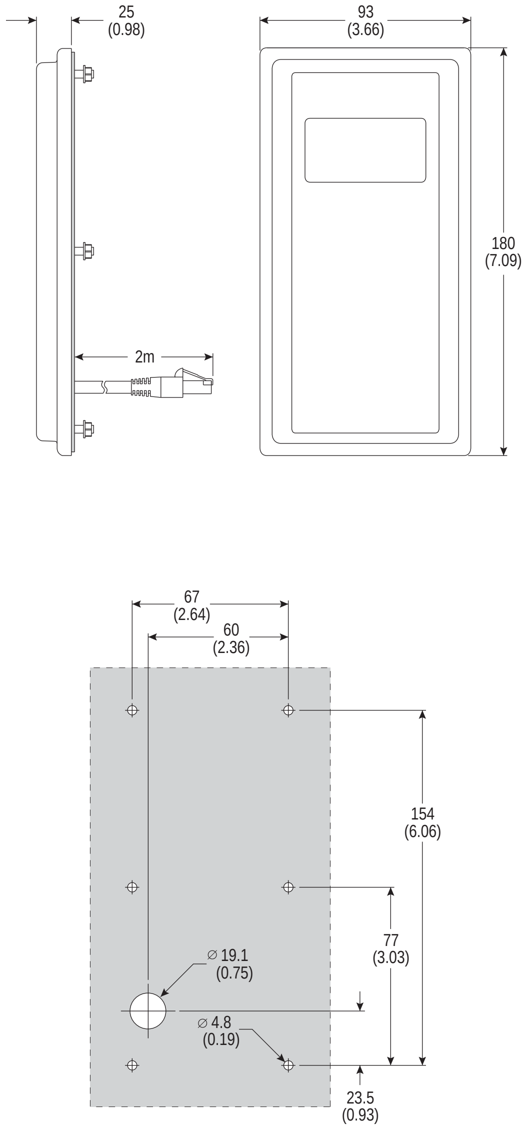
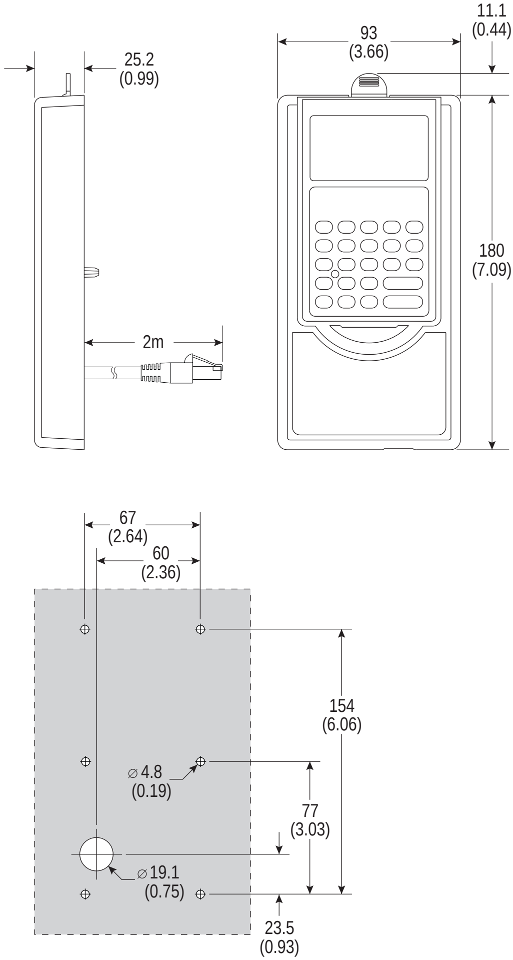


Figure B.12 NEMA Type 1 Bezel – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-B1



RJ45 DSI Splitter Cable

The PowerFlex 400 drive provides a RJ45 port to allow the connection of a single peripheral device. The RJ45 DSI Splitter Cable can be used to connect a second DSI peripheral device to the drive.

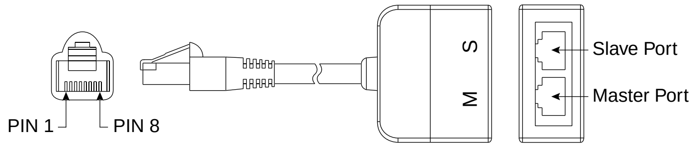
Connectivity Guidelines

ATTENTION: Risk of injury or equipment damage exists. The peripherals may not perform as intended if these Connectivity Guidelines are not followed. Precautions should be taken to follow these Connectivity Guidelines.

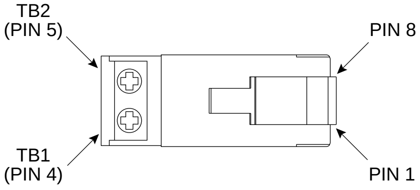
- Two peripherals maximum can be attached to a drive.
- If a single peripheral is used, it must be connected to the Master port (M) on the splitter and configured for "Auto" (default) or "Master." Parameter 9 [Device Type] on the DSI keypads and Parameter 1 [Adapter Cfg] on the Serial Converter are used to select the type (Auto / Master / Slave).
- **Do not use the RJ45 Splitter Cable with a drive that has an internal network communication adapter installed.** Since only one additional peripheral can be added, the second peripheral can be connected directly to the RJ45 port on the drive. The internal Comm is always the Master, therefore the external peripheral must be configured as "Auto" (for temporary connections) or "Slave" (for permanent connections).
- If two peripherals will be powered up at the same time, one must be configured as the "Master" and connected to the Master port (M) and the other must be connected as the "Slave" and connected to the Slave port (S).

DSI Cable Accessories

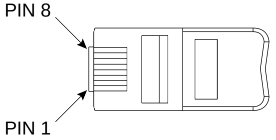
RJ45 Splitter Cable – Catalog Number: AK-U0-RJ45-SC1



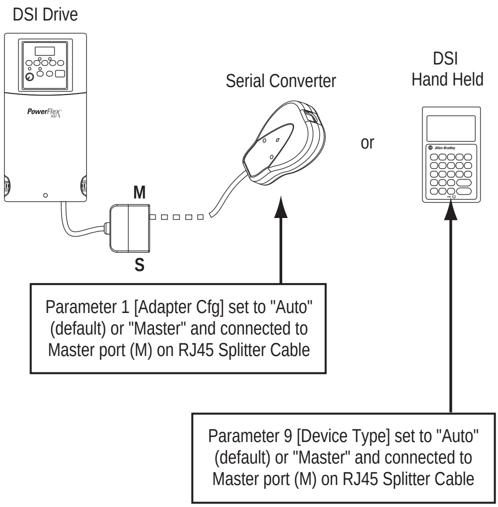
RJ45 Two-Position Terminal Block Adapter –
Catalog Number: AK-U0-RJ45-TB2P



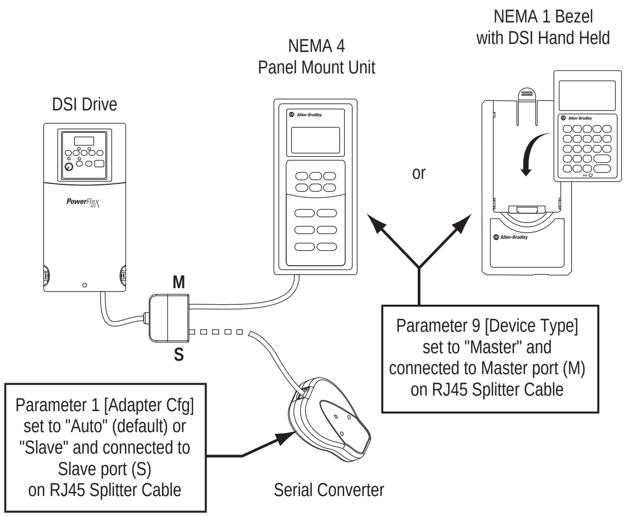
RJ45 Adapter with Integrated Termination Resistor –
Catalog Number: AK-U0-RJ45-TR1



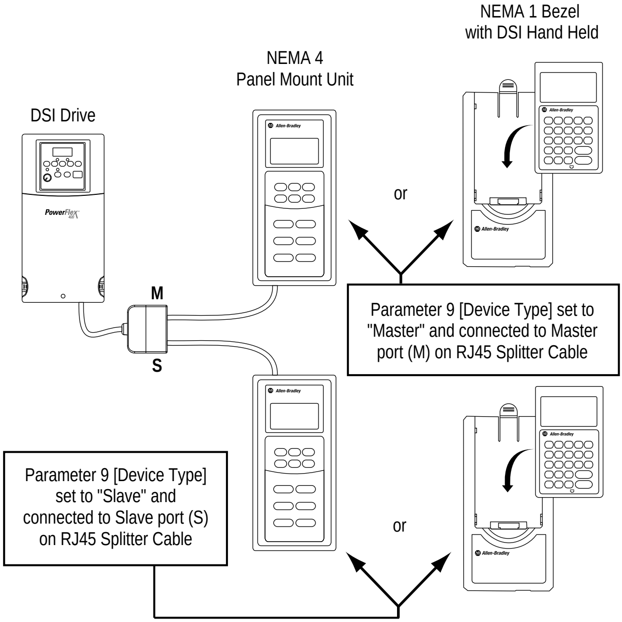
Connecting One Temporary Peripheral



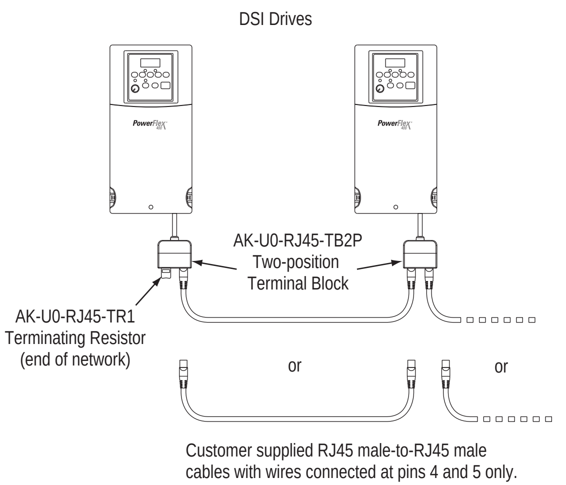
Connecting One Temporary Peripheral and One Permanent Peripheral



Connecting Two Permanent Peripherals



Connecting an RS-485 Network

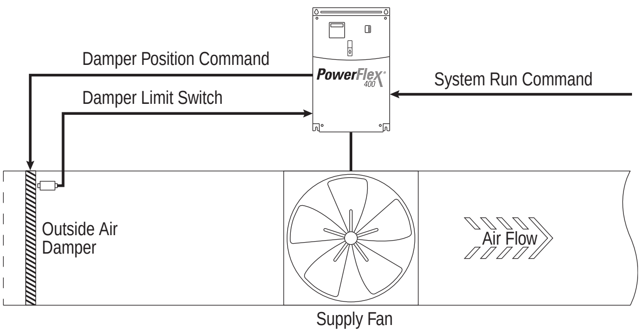


Both the Master (M) and Slave (S) ports on the RJ45 Splitter Cable operate as standard RS-485 ports in this configuration.

Application Notes

Damper Control Setup

The PowerFlex 400 allows damper control logic to be imbedded within the drive reducing cost associated with external control hardware and software. A system Run command can be wired directly into one of the drive inputs. Relay outputs can be used to energize the damper to either open or close. A damper limit switch can be wired back to the drive providing indication that the damper is in the proper position and that it is safe for the drive to run at commanded speed.



Example

- The System Run Command can come from a terminal block, integral keypad, or communication port. Configure parameter P036 [Start Source] per application requirements.
- Set one of the available digital inputs, parameter T051-T054 [Digital Inx Sel] to option 36 “Damper Input”. The damper end switch or limit switch should be wired into this input.
- Set one of the available relay outputs, parameter T055/T060 [Relay Outx Sel] to option 2 “Motor Running”. This output should be used to energize the damper to either open or close.

PID Setup

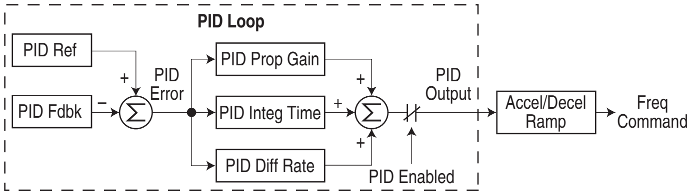
PID Control Loop

The PowerFlex 400 has a built-in PID (proportional, integral, differential) control loop. 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, parameter A152 [PID Ref Sel] must be set to an option other than 0 "PID Disabled".

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

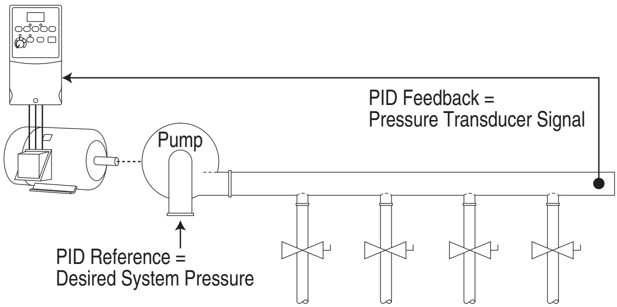
Exclusive Control

In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A152 [PID Ref Sel] is set to option 1, 2, 3 or 4. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



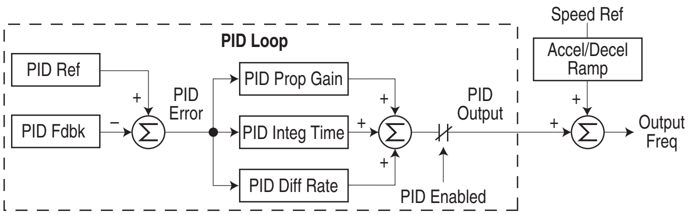
Example

- 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.



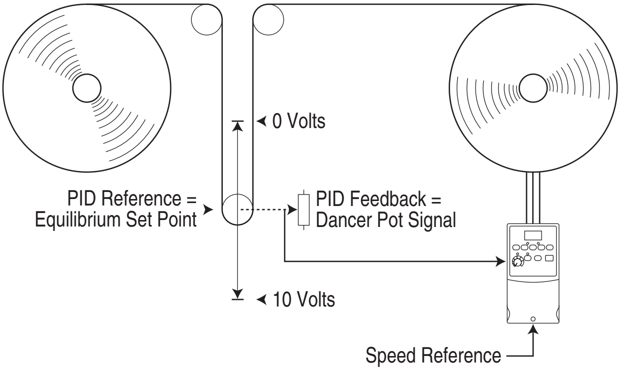
Trim Control

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 A152 [PID Ref Sel] is set to option 5, 6, 7 or 8.



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

Parameter A152 [PID Ref Sel] is used to enable the PID mode (A152 = 0 "PID Disabled") and to select the source of the PID Reference. If A152 [PID Ref Sel] is not set to 0 "PID Disabled", PID can still be disabled by select programmable digital input options (parameters T051-T054) such as "Local" or "PID Disable".

Table D.A A152 [PID Ref Sel] Options

Option	Description
0 "PID Disabled"	Disables the PID loop (default setting)
1 "PID Setpoint"	Selects Exclusive Control. A157 [PID Setpoint] will be used to set the value of the PID Reference
2 "Analog In 1"	Selects Exclusive Control. Selects the Analog In 1 Input.
3 "Analog In 2"	Selects Exclusive Control. Selects the Analog In 2 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.
4 "Comm Port"	Selects Exclusive Control. The reference word from a communication network (see Appendix E for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.
5 "Setpnt, Trim"	Selects Trim Control. A157 [PID Setpoint] will be used to set the value of the PID Reference.
6 "0-10V, Trim"	Selects Trim Control. 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.
7 "4-20mA, Trim"	Selects Trim Control. Selects the 4-20mA Input.
8 "Comm, Trim"	Selects Trim Control. The reference word from a communication network (see Appendix E for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.

A153 [PID Feedback Sel] is used to select the source of the PID feedback.

Table D.B A153 [PID Feedback Sel] Options

Option	Description
0 "Analog In 1"	Selects the Analog In 1 Input (default setting).
1 "Analog In 2"	Selects the Analog In 2 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.
2 "Comm Port"	The reference word from a communication network (see Appendix E for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Feedback. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% Feedback. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% Feedback.
3 "ACT1 - ACT2"	Selects actual inputs A204 [ACT1 Input] minus A205 [ACT2 Input] to be used as the feedback signal.
4 "ACT1 + ACT2"	Selects actual inputs A204 [ACT1 Input] plus A205 [ACT2 Input] to be used as the feedback signal.

Option	Description
5 “ACT1 * ACT2”	Selects actual inputs A204 [ACT1 Input] multiplied by A205 [ACT2 Input] to be used as the feedback signal.
6 “ACT1 / ACT2”	Selects actual inputs A204 [ACT1 Input] divided by A205 [ACT2 Input] to be used as the feedback signal.
7 “Min A1, A2”	Selects the smaller of actual inputs A204 [ACT1 Input] or A205 [ACT2 Input] to be used as the feedback signal.
8 “Max A1, A2”	Selects the larger of actual inputs A204 [ACT1 Input] or A205 [ACT2 Input] to be used as the feedback signal.

Analog PID Reference Signals

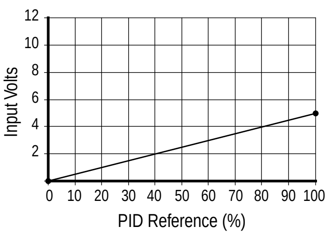
Parameters T070 [Analog In 1 Lo], T071 [Analog In 1 Hi], T074 [Analog In 2 Lo], and T075 [Analog In 2 Hi] are used to scale or invert an analog PID Reference.

Examples

Scale Function

For a 0-5 volt signal, the following parameter settings are used so that a 0 volt signal = 0% PID Reference and a 5 volt signal = 100% PID Reference.

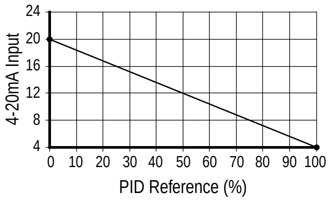
- T069 [Analog In 1 Sel] or T073 [Analog In 2 Sel] = 2 “Voltage Mode - Unipolar”.
- T070 [Analog In 1 Lo] or T074 [Analog In 2 Lo] = 0.0%
- T071 [Analog In 1 Hi] or T075 [Analog In 2 Hi] = 50.0%
- A152 [PID Ref Sel] = 0 “0-10V Input”



Invert Function

For a 4-20mA signal, the following parameter settings are used so that a 20mA signal = 0% PID Reference and a 4mA signal = 100% PID Reference.

- T069 [Analog In 1 Sel] or T073 [Analog In 2 Sel] = 1 “Current Mode 4-20 mA”
- T070 [Analog In 1 Lo] or T074 [Analog In 2 Lo] = 100.0%
- T071 [Analog In 1 Hi] or T075 [Analog In 2 Hi] = 0.0%
- A152 [PID Ref Sel] = 2 “Analog In 1” or 3 “Analog In 2”



PID Deadband

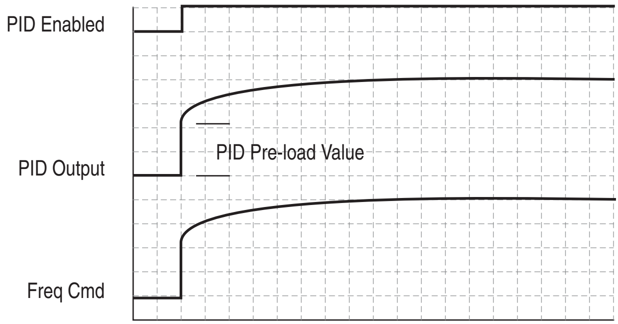
Parameter A158 [PID Deadband] is used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- [PID Deadband] is set to 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 A159 [PID Preload], in Hertz, 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 Pre-load Value > 0

PID Limits

A150 [PID Trim Hi] and A151 [PID Trim Lo] are used to limit the PID output and are only used in trim mode. [PID Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID 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.

- A154 [PID 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 Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID Prop Gain] to 0.00 disables the proportional component of the PID loop.
- A155 [PID 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 Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID Integ Time] to 0 disables the integral component of the PID loop.
- A156 [PID 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 [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID 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 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 A154 [PID Prop Gain].

– If the response is too quick and/or unstable (see Figure D.1), decrease A154 [PID Prop Gain].

– Typically, A154 [PID 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 Figure D.2), or the PID Feedback does not become equal to the PID Reference, decrease A155 [PID Integ Time].

– If there is a lot of oscillation in the PID Feedback before settling out (see Figure D.3), increase A155 [PID Integ Time].

3. At this point, the differential gain may not be needed. However, if after determining the values for A154 [PID Prop Gain] and A155 [PID Integ Time]:

– Response is still slow after a step change, increase A156 [PID Diff Rate].

– Response is still unstable, decrease A156 [PID Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

Figure D.1 Unstable

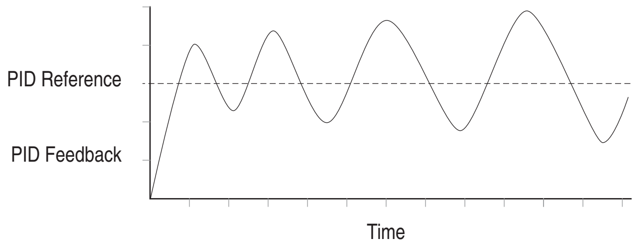


Figure D.2 Slow Response – Over Damped

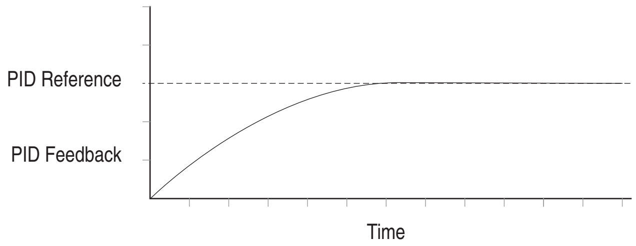


Figure D.3 Oscillation – Under Damped

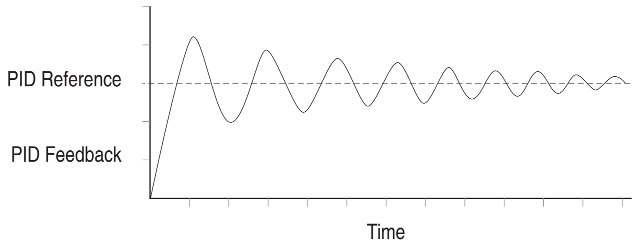
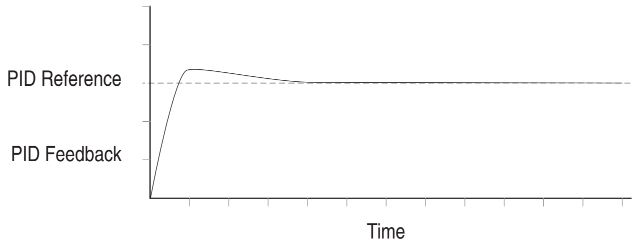


Figure D.4 Good Response – Critically Damped

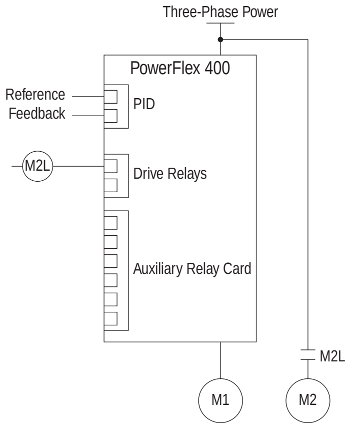


Auxiliary Motor Control Setup

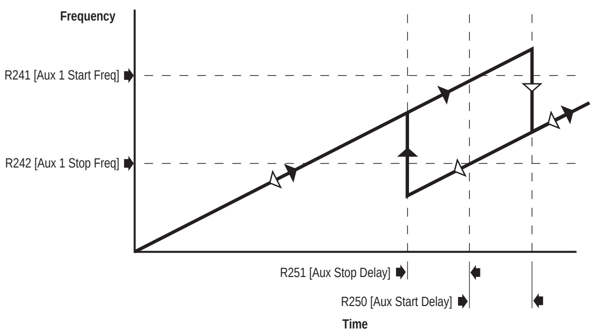
The PowerFlex 400 has a built in Auxiliary Motor Control feature. This feature allows operation of up to three (3) line-started motors in addition to the motor controlled directly by the PowerFlex 400 drive. System output can vary from 0% (auxiliary motors off and drive-controlled motor at zero speed) to 400% (3 auxiliary motors and drive-controlled motor at full speed). To enable the Auxiliary Motor Control, parameter R239 [Aux Motor Mode] must be set to an option 1 “Enabled.” When enabled, the internal PID controller in the PowerFlex 400 uses a reference and feedback signal to adjust the speed of the drive controlled motor such that the feedback signal follows the reference signal. When demand exceeds the first motors capacity, the PowerFlex 400 Auxiliary Motor Control automatically starts an auxiliary motor. The speed of the drive controlled motor is reduced to account for the auxiliary motors additional output to the system. If demand continues to increase, the PowerFlex Auxiliary Motor Control starts additional motors using the same process. When demand decreases, an auxiliary motor is stopped and the PowerFlex Auxiliary Motor Control increases the speed of the drive controlled motor to account for lost system output. A Motor Interlock input identifies motors that are out of service and causes them to skipped over to the next available motor.

An AutoSwap function also can be used which allows equal wear to be placed on each motor by periodically swapping the drive controlled and auxiliary motors. Each motor in the system will over time be connected to the PowerFlex 400 drive and also directly to the AC line. During an AutoSwap, the motor directly connected to the PowerFlex 400 drive is stopped and the contactor is opened. The contactor of the next motor that will be controlled by the PowerFlex 400 drive is opened if running across the AC line. A contactor is closed connecting this motor directly to the PowerFlex 400 drive and is started. An additional motor is line started if required.

Example 1
One External Motor without AutoSwap

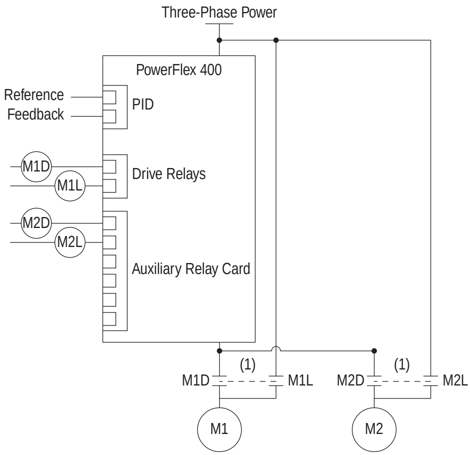


- Auxiliary Motor Control is enabled via Parameter R239 [Aux Motor Mode].
- Number of auxiliary motors is set via Parameter R240 [Aux Motor Qty].
- Relays are configured for Auxiliary Motor Control via parameters T055, T060, R222, and R225.
- The frequency of Motor #1 that Motor #2 turns on at is set via Parameter R241 [Aux 1 Start Freq].
- The time that Motor #1 is above the value set by R241 [Aux 1 Start Freq] before turning on Motor #2 is set via Parameter R250 [Aux Start Delay].
- The frequency of Motor #1 that Motor #2 turns off at is set via Parameter R242 [Aux 1 Stop Freq].
- The time that Motor #1 is below the value set by R242 [Aux 1 Stop Freq] before turning off Motor #2 is set via Parameter R251 [Aux Stop Delay].
- PID setup is done via Parameters A150 through A159. See Appendix D for additional information.



Important: If using auxiliary motor control, ensure that wiring and parameter configuration are correct before wiring contactor outputs. All relays on the Auxiliary Relay Card will energize on power-up by default. Failure to verify proper wiring and parameter configuration can result in improper motor operation or drive damage.

Example 2
One External Motor with AutoSwap



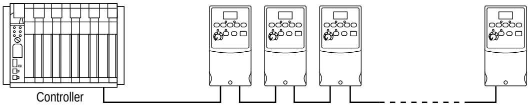
(1) Mechanically interlocked contactors are recommended to ensure that the drive contactor and the line contactor do not close at the same time. If the drive and line contactor close at the same time, drive damage may result.

- Auxiliary Motor Control is enabled via Parameter R239 [Aux Motor Mode].
- Number of auxiliary motors is set via Parameter R240 [Aux Motor Qty].
- Relays are configured for Auxiliary Motor Control via parameters T055, T060, R222, R225, R228, R231, R234, and R237.
- The frequency of Motor #1 that Motor #2 turns on at is set via Parameter R241 [Aux 1 Start Freq].
- The time that Motor #1 is above the value set by R241 [Aux 1 Start Freq] before turning on Motor #2 is set via Parameter R250 [Aux Start Delay].
- The frequency of Motor #1 that Motor #2 turns off at is set via Parameter R242 [Aux 1 Stop Freq].
- The time that Motor #1 is below the value set by R242 [Aux 1 Stop Freq] before turning off Motor #2 is set via Parameter R251 [Aux Stop Delay].
- The running time between the PowerFlex 400 switching control from Motor #1 to Motor #2 is set via R253 [Aux AutoSwap Time].
- PID setup is done via Parameters A150 through A159. See Appendix D for additional information.
- The maximum PID output level that an AutoSwap can occur is set via Parameter R254 [Aux AutoSwap Lvl]. AutoSwap will be delayed until the PID output drops below this parameter setting.

Important: If using auxiliary motor control, ensure that wiring and parameter configuration are correct before wiring contactor outputs. All relays on the Auxiliary Relay Card will energize on power-up by default. Failure to verify proper wiring and parameter configuration can result in improper motor operation or drive damage.

Modbus RTU Protocol

PowerFlex 400 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 400 drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

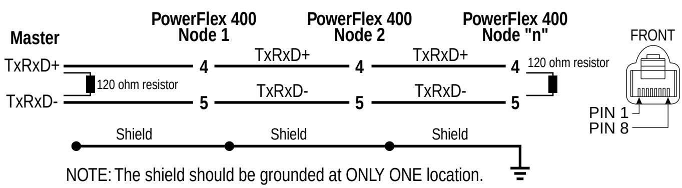


For information regarding DeviceNet or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

Figure E.1 Network Wiring Diagram



Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 400 RJ45 socket contain power, etc. for other Rockwell Automation peripheral devices and must not be connected.

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.

Parameter Configuration

The following PowerFlex 400 parameters are used to configure the drive to operate on a network.

Parameter	Details	Reference
P036 [Start Source]	Set to 5 "RS485 (DSI) Port" if Start is controlled from the network.	Page 3-8
P038 [Speed Reference]	Set to 5 "RS485 (DSI) Port" if the Speed Reference is controlled from the network.	Page 3-10
C102 [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 3-31
C103 [Comm 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 3-31
C104 [Comm Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	Page 3-32
C105 [Comm Loss Action]	Selects the drive's response to communication problems.	Page 3-32
C106 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements C105 [Comm Loss Action].	Page 3-32
C107 [Comm Write Mode]	Determines whether parameter changes made over communication port are saved or stored in RAM only. If they are stored in RAM, the values will be lost at power-down.	Page 3-31

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 400 drives supports some of the Modbus function codes.

Modbus Function Code	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 400 drive can be controlled via the network by sending Function Code 06 writes to register address 8192 (Logic Command). P036 [Start Source] must be set to 5 "Comm Port" in order to accept the commands. In addition to being written, register address 8192 can be read using Function Code 03.

<table>
<tr><th colspan="3">Logic Command</th></tr>
<tr><th>Address (Decimal)</th><th>Bit(s)</th><th>Description</th></tr>
<tr><td rowspan="26">8192</td><td>0</td><td>1 = Stop, 0 = Not Stop</td></tr>
<tr><td>1</td><td>1 = Start, 0 = Not Start</td></tr>
<tr><td>2</td><td>1 = Jog, 0 = No Jog</td></tr>
<tr><td>3</td><td>1 = Clear Faults, 0 = Not Clear Faults</td></tr>
<tr><td rowspan="4">5,4</td><td>00 = No Command</td></tr>
<tr><td>01 = Forward Command</td></tr>
<tr><td>10 = Reverse Command</td></tr>
<tr><td>11 = No Command</td></tr>
<tr><td>6</td><td>1 = Local Control[1], 0 = Comm Control</td></tr>
<tr><td>7</td><td>1 = MOP Increment, 0 = Not Increment</td></tr>
<tr><td rowspan="4">9,8</td><td>00 = No Command</td></tr>
<tr><td>01 = Accel Rate 1 Enable</td></tr>
<tr><td>10 = Accel Rate 2 Enable</td></tr>
<tr><td>11 = Hold Accel Rate Selected</td></tr>
<tr><td rowspan="4">11,10</td><td>00 = No Command</td></tr>
<tr><td>01 = Decel Rate 1 Enable</td></tr>
<tr><td>10 = Decel Rate 2 Enable</td></tr>
<tr><td>11 = Hold Decel Rate Selected</td></tr>
<tr><td rowspan="8">14,13,12</td><td>000 = No Command</td></tr>
<tr><td>001 = Freq. Source = P038 [Speed Reference]</td></tr>
<tr><td>010 = Freq. Source = A142 [Internal Freq]</td></tr>
<tr><td>011 = Freq. Source = Comms (Addr 8193)</td></tr>
<tr><td>100 = A143 [Preset Freq 0]</td></tr>
<tr><td>101 = A144 [Preset Freq 1]</td></tr>
<tr><td>110 = A145 [Preset Freq 2]</td></tr>
<tr><td>111 = A146 [Preset Freq 3]</td></tr>
<tr><td></td><td>15</td><td>1 = MOP Decrement, 0 = Not Decrement</td></tr>
</table>

(1) Local Control causes the drive to use C108 [Start Source 2] and C109 [Speed Ref 2] for start and speed reference control.

Writing (06) Reference

The Speed Reference to a PowerFlex 400 drive can be controlled via the network by sending Function Code 06 writes to register address 8193 (Reference). P038 [Speed Reference] must be set to 5 “Comm Port” in order to accept the Speed Reference. In addition to being written, register address 8192 can be read using Function Code 03.

Reference	
Address (Decimal)	**Description**
8193	A decimal value entered as xxx.xx where the decimal point is fixed. For example, a decimal “1000” equals 10.00 Hz and “543” equals 5.43 Hz.

Reading (03) Logic Status Data

The PowerFlex 400 Logic Status data can be read via the network by sending Function Code 03 reads to register address 8448 (Logic Status).

Error Codes		
Address (Decimal)	**Bit(s)**	**Description**
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 = Alarm, 0 = No Alarm
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Reference Controlled by Comm
	10	1 = Operation Cmd Controlled by 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

Reading (03) Feedback

The Feedback (Output Frequency) from the PowerFlex 400 drive can be read via the network by sending Function Code 03 reads to register address 8451 (Feedback).

Feedback[1]	
Address (Decimal)	**Description**
8451	A xxx.xx decimal value where the decimal point is fixed. For example, a decimal “1234” equals 12.34 Hz and “300” equals 3.00 Hz.

(1) Returns the same data as Reading (03) Parameter b001 [Output Freq].

Reading (03) Drive Error Codes

The PowerFlex 400 Error Code data can be read via the network by sending Function Code 03 reads to register address 8449 (Drive Error Codes).

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
8449	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	15	Load 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	Params Defaulted
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	71	Net Loss
	81	Communication Loss
	94	Function Loss
	100	Parameter Checksum Error
	122	I/O Board Fail

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 "39" is used to address Parameter P039 [Accel Time 1].

Additional Information

Refer to **http://www.ab.com/drives/** for additional information.

Notes:

Metasys N2

Appendix F provides information about controlling a PowerFlex 400 drive, setting its Reference, and accessing its parameters through configurable objects when the Metasys N2 network protocol is selected.

Understanding Metasys N2

Metasys nodes are built up by the use of several virtual objects. The Metasys N2 master performs read and write commands to these virtual objects, and the internal Metasys protocol firmware transfers/translates the data between these virtual objects and the drive.

When a read or write command occurs to a certain dedicated virtual object, data in the virtual objects is refreshed from or transferred to the drive.

The Metasys N2 master performs read and write commands to the virtual objects one at a time. The data types that are used in the virtual objects are binary input (BI), binary output (BO), analog input (AI), analog output (AO), and internal integer (ADI).

The Metasys N2 master also performs cyclic polling of all the virtual objects.

Metasys N2 Virtual Objects

A Metasys N2 node may contain up to 256 virtual objects in each of its seven different data types, called regions (Table F.1).

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless C107 [Comm Write Mode] is set to option 1.

Table F.1 Description of the Regions of a Virtual Object

Region	Type	Short	Description
Region 1	Analog Input	AI	32-bit, IEEE-standard floats
Region 2	Binary Input	BI	1-bit
Region 3	Analog Output	AO	32-bit, IEEE-standard floats
Region 4	Binary Output	BO	1-bit
Region 5	Internal Float	ADF	32-bit, IEEE-standard floats (Analog Data Float)
Region 6	Internal Integer	ADI	16-bit (Analog Data Integer)
Region 7	Internal Byte	DB	8-bit (Analog Data Byte)

Metasys N2 Data Types

Table F.2 Internal Structure of Metasys N2 Analog Input (AI)

Attribute	Type	Description
1	Byte	Object Configuration
2	Byte	Object Status
3	Float	Analog Input Value
8	Float	Low Alarm Limit
9	Float	Low Warning Limit
10	Float	High Warning Limit
11	Float	High Alarm Limit
12	Float	Differential

Table F.3 Internal Structure of Metasys N2 Binary Input (BI)

Attribute	Type	Description
1	Byte	Object Configuration
2	Byte	Object Status

Table F.4 Internal Structure of Metasys N2 Analog Output (AO)

Attribute	Type	Description
1	Byte	Object Configuration
2	Byte	Object Status
3	Float	Current Value

Table F.5 Internal Structure of Metasys N2 Binary Output (BO)

Attribute	Type	Description
1	Byte	Object Configuration
2	Byte	Object Status
3	Integer	Minimum On-Time
4	Integer	Minimum Off-Time
5	Integer	Maximum Cycle/Hour

Table F.6 Internal Structure of Metasys N2 Internal Integer (ADI)

Attribute	Type	Description
1	Byte	Object Status
2	Integer	Current Value. Signed 16-bit.

Network Points

Table F.7 Binary Inputs

Network Point Type (NPT)	Network Point Address (NPA)	Name	Description	ON ("1")	OFF ("0")
BI	1	Ready	Logic Status bit 00	Ready	Not Ready
BI	2	Active	Logic Status bit 01	Active	Not Active
BI	3	Cmd Dir	Logic Status bit 02	Forward	Reverse
BI	4	Act Dir	Logic Status bit 03	Forward	Reverse
BI	5	Accel	Logic Status bit 04	Accelerating	Not Accelerating
BI	6	Decel	Logic Status bit 05	Decelerating	Not Decelerating
BI	7	Alarm	Logic Status bit 06	Alarm	No Alarm
BI	8	Fault	Logic Status bit 07	Fault	No Fault
BI	9	At Speed	Logic Status bit 08	At Reference	Not at Reference
BI	10	Main Freq	Logic Status bit 09	Comm Controlled	Not Comm Controlled
BI	11	Oper Cmd	Logic Status bit 10	Comm Controlled	Not Comm Controlled
BI	12	Param Lock	Logic Status bit 11	Locked	Not Locked
BI	13	Digital In 1	Logic Status bit 12 (Drive Terminal #2)	On	Off
BI	14	Digital In 2	Logic Status bit 13 (Drive Terminal #3)	On	Off
BI	15	Digital In 3	Logic Status bit 14 (Drive Terminal #4)	On	Off
BI	16	Digital In 4	Logic Status bit 15 (Drive Terminal #5)	On	Off
BI	17	Digital In 5	Drive Terminal #6	On	Off
BI	18	Digital In 6	Drive Terminal #7	On	Off
BI	19	Digital In 7	Drive Terminal #8	On	Off

Table F.8 Analog Inputs

Network Point Type (NPT)	Network Point Address (NPA)	Name	Description	Units	Min/Max
AI	1	Feedback	Feedback	%	0/100
AI	2	Speed	d323 [Output RPM]	RPM	0/24000
AI	3	Current	b003 [Output Current]	A	0.00/Rated × 2
AI	4	DC Bus Volts	b005 [DC Bus Voltage]	V	0/820
AI	5	Last Fault	b307 [Fault 1 Code]	1	1/100
AI	6	2nd Fault	b308 [Fault 2 Code]	1	1/100
AI	7	Analog In 1	Drive Analog Input #1 (Drive Terminal #13)	%	–
AI	8	Analog In 2	Drive Analog Input #2 (Drive Terminal #17)	%	–
AI	9	Read Value	Read value of Param. selected by AO 10	Varies by the parameter selected.	
AI	10	User In 1	User-defined Input 1 (Param. selected via ADI 1)		
AI	11	User In 2	User-defined Input 2 (Param. selected via ADI 2)		
AI	12	User In 3	User-defined Input 3 (Param. selected via ADI 3)		
AI	13	User In 4	User-defined Input 4 (Param. selected via ADI 4)		

Table F.9 Binary Outputs

Network Point Type (NPT)	Address (NPA)	Name	Description	Values ON (“1”)	OFF (“0”)
BO	1	Run Enable	Logic Command bit 00	Enable	Stop (Coast)
BO	2	Start/Stop	Logic Command bit 00 & 01	Start	Stop (Normal)
BO	3	Jog	Logic Command bit 02	Jog	Not Jog
BO	4	Clear Faults	Logic Command bit 03	Clear Flts	Not Clear Flts
BO	5	Fwd/Rev	Logic Command bit 04 & 05	Forward	Reverse
BO	6	Not Used	Logic Command bit 06	–	–
BO	7	MOP Inc	Logic Command bit 07	Increment	Not Increment
BO	8	Accel 1	Logic Command bit 08	Accel Rate 1	Not Accel 1
BO	9	Accel 2	Logic Command bit 09	Accel Rate 2	Not Accel 2
BO	10	Decel 1	Logic Command bit 10	Decel Rate 1	Not Decel 1
BO	11	Decel 2	Logic Command bit 11	Decel Rate 2	Not Decel 2
BO BO BO	12 13 14	Ref Sel 1 Ref Sel 2 Ref Sel 3	Logic Command bit 12 Logic Command bit 13 Logic Command bit 14	BO 14 13 12 0 0 0 = No Command 0 0 1 = P038 [Speed Reference] 0 1 0 = A142 [Internal Freq] 0 1 1 = Comm - Address 8193 (1) 1 0 0 = A143 [Preset Freq 0] 1 0 1 = A144 [Preset Freq 1] 1 1 0 = A145 [Preset Freq 2] 1 1 1 = A146 [Preset Freq 3]	
BO	15	MOP Dec	Logic Command bit 15	Decrement	Not Decrement
BO	16	Pnl Lock	Lock-out Drive Front Panel	Lock	Unlock
BO	17	Digital Out 1	Relay #1 on Drive (Drive Terminal R1, R2, R3)	On	Off
BO	18	Digital Out 2	Relay #2 on Drive (Drive Terminal R4, R5, R6)	On	Off
BO	19	Opto Out	Terminal #19	On	Off

(1) See Writing (06) Reference on page E-3.

Table F.10 Analog Outputs

Network Point Type (NPT)	Address (NPA)	Name	Description	Units	Min/Max
AO	1	Reference	Reference	%	0/100
AO	2	Accel 1	P039 [Accel Time 1]	Secs	0.0/600.0
AO	3	Decel 1	P040 [Decel Time 1]	Secs	0.0/600.0
AO	4	Mtr OL Current	P033 [Motor OL Current]	A	0.0/Rated × 2
AO	5	PID Setpoint	A157 [PID Setpoint]	%	0/100
AO	6	Analog Out 1	Drive Analog Output #1 (T084)	%	–
AO	7	Analog Out 2	Drive Analog output #2 (T087)	%	–
AO	8	Write Param #	Param. number to write in AO 9	–	0 to Max Param.
AO	9	Write Value	Write value of param. selected by AO 8	Based on AO 8 selected param.	
AO	10	Read Param #	Param. number to read in AI 9	–	0 to Max Param.
AO	11	User Out 1	User-defined Output 1 (Param. selected via ADI 5)	Varies by the parameter selected.	
AO	12	User Out 2	User-defined Output 2 (Param. selected via ADI 6)		
AO	13	User Out 3	User-defined Output 3 (Param. selected via ADI 7)		
AO	14	User Out 4	User-defined Output 4 (Param. selected via ADI 8)		

Table F.11 Internal Integer

Network Point Type (NPT)	Network Point Address (NPA)	Name	Description	Min/Max	Default
ADI	1	Param# IN1	User IN 1 (AI 10) Data Source (Param#)	0/Max Drive Params.	b001 [Output Freq] (Hz)
ADI	2	Param# IN2	User IN 2 (AI 11) Data Source (Param#)	0/Max Drive Params.	b011 [Elapsed MWh]
ADI	3	Param# IN3	User IN 3 (AI 12) Data Source (Param#)	0/Max Drive Params.	b012 [Elapsed Run Time]
ADI	4	Param# IN4	User IN 4 (AI 13) Data Source (Param#)	0/Max Drive Params.	b014 [Drive Temperature]
ADI	5	Param# OUT1	User OUT 1 (AO 11) Data Source (Param#)	0/Max Drive Params.	A154 [PID Gain]
ADI	6	Param# OUT2	User OUT 2 (AO 12) Data Source (Param#)	0/Max Drive Params.	A155 [PID Integral Time]
ADI	7	Param# OUT3	User OUT 3 (AO 13) Data Source (Param#)	0/Max Drive Params.	A156 [PID Diff Rate]
ADI	8	Param# OUT4	User OUT 4 (AO 14) Data Source (Param#)	0/Max Drive Params.	A158 [PID Deadband]

Using Percent (%) for the Reference

The Reference (AO 1) for Metasys N2 is set as a percentage from 0% to +100%.

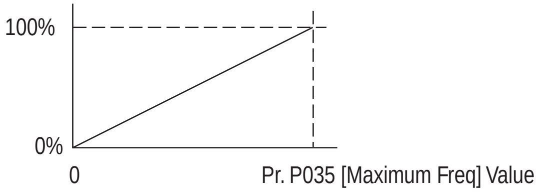


Table F.12 Example Speed Reference and Feedback for a PowerFlex 400 (P035 = 60 Hz)

Reference (AO 1)		Feedback (AI 1)	
Percent	**Speed**	**Speed**	**Percent**
100%	60 Hz	60 Hz	100%
50%	30 Hz	30 Hz	50%
25%	15 Hz	15 Hz	25%
0%	0 Hz	0 Hz	0%

Using Metasys Configurable Objects to Access Parameters

Configurable objects are inputs and outputs that let you read and write parameter values. These objects handle only 16-bit parameter values.

Reading Parameter Values

The configurable points may show any parameter in the drive by configuring the Param# for INx point. The drive reads the value of the parameter configured in the Param# for INx point and shows the result in the User INx point. The Param# for INx's default to commonly accessed parameters and can be changed if desired. A "0" disables the fetching of data and a "0" is returned in the respective User INx. See Figure F.1 and Table F.13.

Figure F.1 Configurable Input Point Operation Objects Inputs

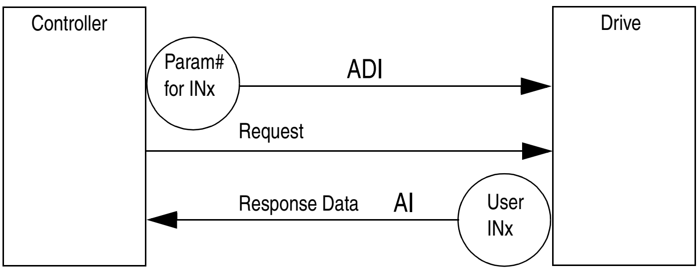


Table F.13 Configurable Objects: Inputs

Network Point Type (NPT)	Network Point Address (NPA)	Name	Description	Default
AI	10	User IN1	User-defined Input 1	0
AI	11	User IN2	User-defined Input 2	0
AI	12	User IN3	User-defined Input 3	0
AI	13	User IN4	User-defined Input 4	0
ADI	1	Param# for IN1	User IN1 (AI 10) Data Source (Param#)	b001 [Output Freq] (Hz)
ADI	2	Param# for IN2	User IN2 (AI 11) Data Source (Param#)	b011 [Elapsed MWh]
ADI	3	Param# for IN3	User IN3 (AI 12) Data Source (Param#)	b012 [Elapsed Run Time]
ADI	4	Param# for IN4	User IN4 (AI 13) Data Source (Param#)	b014 [Drive Temp]

Writing Parameter Values

ATTENTION: Risk of equipment damage exists. If configurable outputs are programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS.

These outputs are written each time the User OUTx point is written from the network.

The Param# for OUTx's default to commonly accessed parameters and can be changed if desired. A value of "0" in the Param# for OUTx field disables the writing of data for that specific point.

Figure F.2 Configurable Objects: Outputs

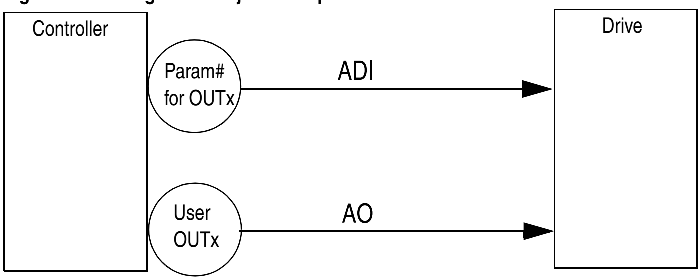


Table F.14 Configurable Objects: Outputs

Network Point Type (NPT)	Network Point Address (NPA)	Description	Range	Default
AO	6	User OUT1	Varies by the parameter selected by Param# for OUTx.	0
AO	7	User OUT2		0
AO	8	User OUT3		0
AO	9	User OUT4		0
ADI	5	User OUT1 (A06) Destination (Param#)	0 (not in use), 1 to maximum # of drive parameters	A154 [PID Prop Gain]
ADI	6	User OUT2 (A07) Destination (Param#)	0 (not in use), 1 to maximum # of drive parameters	A155 [PID Integ Time]
ADI	7	User OUT3 (A08) Destination (Param#)	0 (not in use), 1 to maximum # of drive parameters	A156 [PID Diff Rate]
ADI	8	User OUT4 (A09) Destination (Param#)	0 (not in use), 1 to maximum # of drive parameters	A158 [PID Deadband]

Notes:

P1 – Floor Level Network (FLN)

Appendix G provides information about controlling a PowerFlex 400 drive, setting its Reference, and accessing its parameters through configurable points when the P1-FLN protocol is selected. The P1-FLN protocol is a serial communication protocol used by the Siemens APOGEE® system.

Understanding P1-FLN

The P1-FLN master performs read and write commands to certain points, and the internal P1-FLN protocol firmware transfers/translates the data between these points and the drive.

When a read or write command occurs to a certain point, data in the point is refreshed from or transferred to the drive.

The P1-FLN master also performs cyclic polling of all the virtual objects.

P1-FLN Points

A P1-FLN node may contain up to 99 points.

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless C107 [Comm Write Mode] is set to option 1.

Network Points

Table G.1 Point Database for Application 2735

Point Number	Point Type	Subpoint Name	Factory Default (SI Units)	Engineering Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	LAO	CTLR ADDRESS	99	–	1	0	–	–
02	LAO	APPLICATION	2735	–	1	0	–	–
{03}	LAI	FREQ OUTPUT	0	HZ	0.01	0	–	–
{04}	LAI	PCT OUTPUT	0	PCT	0.1	0	–	–
{05}	LAI	SPEED	0	RPM	1	0	–	–
{06}	LAI	CURRENT	0	AMPS	0.1	0	–	–
{07}	LAI	TORQUE	0	AMPS	0.1	0	–	–
{08}	LAI	POWER	0	HP (KW)	0.1333 (0.1)	0 (0)	–	–
{09}	LAI	DRIVE TEMP	0	DEG F (DEG C)	1.8 (1)	32 (0)	–	–
{11}	LAI	DRIVE MWH	0	MWH	0.1	0	–	–
{12}	LAI	RUN TIME	0	HRS	10	0	–	–
{13}	LAI	DC BUS VOLT	0	VOLTS	1	0	–	–
20	LAO	OVRD TIME	1	HRS	1	0	–	–
{21}	LDI	FWD.REV MON	FWD	–	1	0	REV	FWD
{22}	LDO	CMD FWD.REV	FWD	–	1	0	REV	FWD
{23}	LDI	RUN.STOP MON	STOP	–	1	0	RUN	STOP
{24}	LDO	CMD RUN.STOP	STOP	–	1	0	RUN	STOP
{25}	LDI	READY	READY	–	1	0	READY	NOTRDY
{26}	LDO	RUN ENABLE	STOP	–	1	0	ENABLE	STOP
{29}	LDO	DAY NGT	DAY	–	1	0	NIGHT	DAY
30	LAO	CURRENT LIMT	***1**	AMPS	0.1	0	–	–
31	LAO	ACCEL TIME	20	SEC	0.02	0	–	–
32	LAO	DECEL TIME	20	SEC	0.02	0	–	–
33	LDO	KEYPAD LOCK	UNLOCK	–	1	0	LOCK	UNLOCK
{36}	LAO	READ PARAM	0	–	1	0	–	–
{37}	LAI	READ VALUE	0	–	1	0	–	–
{38}	LAO	WRITE PARAM	0	–	1	0	–	–
{39}	LAO	WRITE VALUE	0	–	1	0	–	–
{40}	LDO	DIGITAL OUT1	OFF	–	1	0	ON	OFF
{41}	LDO	DIGITAL OUT2	OFF	–	1	0	ON	OFF
{42}	LDO	DIGITAL OUT3	OFF	–	1	0	ON	OFF
{43}	LDO	OPT RELAY 1	OFF	–	1	0	ON	OFF
{44}	LDO	OPT RELAY 2	OFF	–	1	0	ON	OFF
{45}	LDO	OPT RELAY 3	OFF	–	1	0	ON	OFF
{46}	LDO	OPT RELAY 4	OFF	–	1	0	ON	OFF
{47}	LDO	OPT RELAY 5	OFF	–	1	0	ON	OFF
{48}	LDO	OPT RELAY 6	OFF	–	1	0	ON	OFF
{49}	LDI	DIGITAL IN 1	OFF	–	1	0	ON	OFF
{50}	LDI	DIGITAL IN 2	OFF	–	1	0	ON	OFF
{51}	LDI	DIGITAL IN 3	OFF	–	1	0	ON	OFF
{52}	LDI	DIGITAL IN 4	OFF	–	1	0	ON	OFF
{53}	LDI	DIGITAL IN 5	OFF	–	1	0	ON	OFF
{54}	LDI	DIGITAL IN 6	OFF	–	1	0	ON	OFF
{55}	LDI	DIGITAL IN 7	OFF	–	1	0	ON	OFF
{60}	LAI	INPUT REF 1	0	***3**	0.1	0	–	–
{61}	LAI	INPUT REF 2	0	***3**	0.1	0	–	–
{62}	LAO	ANALOG OUT 1	0	PCT	0.1	0	–	–
{63}	LAO	ANALOG OUT 2	0	PCT	0.1	0	–	–
{64}	LAI	LAST FAULT	0	–	1	0	–	–

Table G.1 Point Database for Application 2735

Point Number	Point Type	Subpoint Name	Factory Default (SI Units)	Engineering Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
65	LAO	PID GAIN	1	PTC	0.01	0	–	–
66	LAO	PID INT TIME	2	SEC	0.1	0	–	–
67	LAO	PID DIF RATE	0	PERSEC ***2**	0.01	0	–	–
68	LAO	PID SETPOINT	0	PTC	0.1	0	–	–
{70}	LDI	CMD DIR MON	FWD	–	1	0	REV	FWD
{71}	LDI	ACCELERATING	OFF	–	1	0	ON	OFF
{72}	LDI	DECELERATING	OFF	–	1	0	ON	OFF
{73}	LDI	ALARM	NORMAL	–	1	0	ALARM	NORMAL
{74}	LDI	AT SPEED	OFF	–	1	0	ON	OFF
{75}	LDI	MAIN FREQ	OFF	–	1	0	ON	OFF
{76}	LDI	OPER CMD	OFF	–	1	0	ON	OFF
{77}	LDI	PARAM LOCK	UNLOCK	–	1	0	LOCK	UNLOCK
{78}	LDO	JOG	OFF	–	1	0	ON	OFF
{79}	LDO	LOCAL CNTRL ***4**	OFF	–	1	0	ON	OFF
{80}	LDO	MOP INC	OFF	–	1	0	ON	OFF
{81}	LDO	ACCEL RATE 1	OFF	–	1	0	ON	OFF
{82}	LDO	ACCEL RATE 2	OFF	–	1	0	ON	OFF
{83}	LDO	DECEL RATE 1	OFF	–	1	0	ON	OFF
{84}	LDO	DECEL RATE 2	OFF	–	1	0	ON	OFF
{85}	LDO	REF SELECT 1	OFF	–	1	0	ON	OFF
{86}	LDO	REF SELECT 2	OFF	–	1	0	ON	OFF
{87}	LDO	REF SELECT 3	OFF	–	1	0	ON	OFF
{88}	LDO	MOP DEC	OFF	–	1	0	ON	OFF
{92}	LAO	REFERENCE	0	PCT	0.01	0	–	–
{93}	LDI	OK.FAULT	OK	–	1	0	FAULT	OK
{94}	LDO	RESET FAULT	NORMAL	–	1	0	RESET	NORMAL
{99}	LAO	ERROR STATUS	0	–	1	0	–	–

a. Points not listed are not used in this application.
b. A single value in a column means that the value is the same in English units and in SI units.
c. Point numbers that appear in brackets { } may be unbundled at the field panel.
*1 Depends on drive model.
*2 1 / Secs
*3 Depending on configuration, units can be volts or milliamperes.
*4 Local Control causes the drive to use C108 [Start Source 2] and C109 [Speed Ref 2] for start and speed reference control.

Table G.2 Point Database for Application 2735

Point Number	Subpoint Name	Parameter
01	CTLR ADDRESS	C104
02	APPLICATION	–
03	FREQ OUTPUT	b001
04	PCT OUTPUT	d322
05	SPEED	d323
06	CURRENT	b003
07	TORQUE	b013
08	POWER	b010
09	DRIVE TEMP	b014
11	DRIVE MWH	b011
12	RUN TIME	b012
13	DC BUS VOLT	b005
20	OVRD TIME	–
21	FWD.REV MON	–
22	CMD FWD.REV	–
23	RUN.STOP MON	b066, bit 1 (Running)
24	CMD RUN.STOP	–
25	READY	d302, bit 2 (I/O Terminal 01)
26	RUN ENABLE	–
29	DAY NGT	–
30	CURRENT LIMIT	P033
31	ACCEL TIME 1	P039
32	DECEL TIME 1	P040
33	KEYPAD LOCK	A198
36	READ PARAM #	–
37	READ VALUE	–
38	WRITE PARAM #	–
39	WRITE VALUE	–
40	DIGITAL OUT 1	T055, T056
41	DIGITAL OUT 2	T060, T061
42	DIGITAL OUT 3	T065, T066
43	OPT RELAY 1	R221, R222 ***1**
44	OPT RELAY 2	R224, R225 ***1**
45	OPT RELAY 3	R227, R228 ***1**
46	OPT RELAY 4	R230, R231 ***1**
47	OPT RELAY 5	R233, R234 ***1**
48	OPT RELAY 6	R236, R237 ***1**
49	DIGITAL IN 1	d302, bit 0 (I/O Terminal 02)
50	DIGITAL IN 2	d302, bit 1 (I/O Terminal 03)
51	DIGITAL IN 3	d302, bit 2 (I/O Terminal 01)
52	DIGITAL IN 4	d302, bit 3 (I/O Terminal 05)
53	DIGITAL IN 5	d302, bit 4 (I/O Terminal 06)
54	DIGITAL IN 6	d302, bit 5 (I/O Terminal 07)
55	DIGITAL IN 7	d302, bit 6 (I/O Terminal 08)
60	INPUT REF 1	d305
61	INPUT REF 2	d306
62	ANALOG OUT 1	T082
63	ANALOG OUT 2	T085
64	LAST FAULT	b007
65	PID GAIN	A154
66	PID INT TIME	A155
67	PID DIFF RATE	A156
68	PID SETPOINT	A157

Table G.2 Point Database for Application 2735

Point Number	Subpoint Name	Parameter
70	CMD DIR MON	b006, bit 2 (Forward)
71	ACCELERATING	b006, bit 3 (Accelerating)
72	DECELERATING	b006, bit 4 (Decelerating)
73	ALARM	–
74	AT SPEED	–
75	MAIN FREQ	d301 (Digit 0)
76	OPER CMD	d301 (Digit 1)
77	PARAM LOCK	–
78	JOG	–
79	LOCAL CNTRL	–
80	MOP INC	–
81	ACCEL RATE 1	–
82	ACCEL RATE 2	–
83	DECEL RATE 1	–
84	DECEL RATE 2	–
85	REF SELECT 1	–
86	REF SELECT 2	–
87	REF SELECT 3	–
88	MOP DEC	–
92	REFERENCE	b022
93	OK.FAULT	–
94	RESET FAULT	–
99	ERROR STATUS	–

*1 These parameters affect the operation of an optional auxiliary relay board.

Using Percent (%) for the Reference

The Reference (Point 92) for P1 is set as a percentage from 0% to +100%.

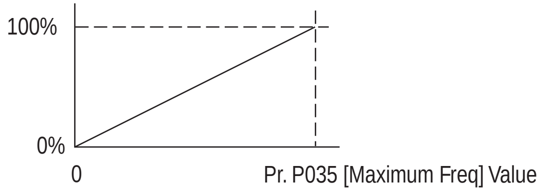


Table G.3 Example Speed Reference and Feedback for a PowerFlex 400 (P035 = 60 Hz)

Reference (Point 92)		PCT Output (Point 4)	
Percent	**Speed**	**Speed**	**Percent**
100%	60 Hz	60 Hz	100%
50%	30 Hz	30 Hz	50%
25%	15 Hz	15 Hz	25%
0%	0 Hz	0 Hz	0%

Using P1 Configurable Points to Access Parameters

Configurable points are inputs and outputs that let you read and write parameter values. These objects handle only 15-bit parameter values (0 – 32767).

Important: If a parameter has a decimal point, the value must be properly scaled by the user. For example, Accel Time has two decimal places. To use the value 60.00, the scaled value 6000 must be communicated to the drive. The scaled value 6000 will be returned.

Reading Parameter Values

The configurable points may show any parameter in the drive by configuring the Param# in the Read Param point. The drive reads the value of the parameter configured in the Param# for the Read Param point and shows the result in the Read Value point. The Param# for the Read Param point default to commonly accessed parameters and can be changed if desired. A "0" disables the fetching of data and a "0" is returned in the Read Value point. See Figure G.1 and Table G.4.

Figure G.1 Configurable Input Point Operation

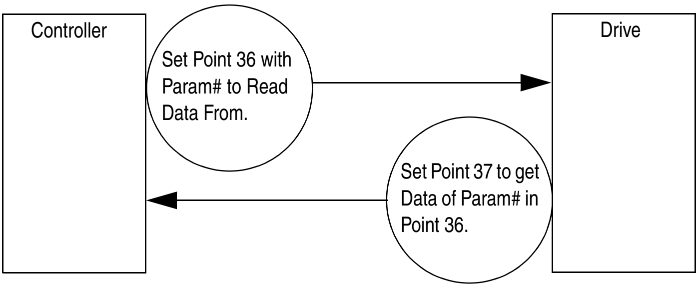


Table G.4 Configurable Points: Inputs

Point	Name	Description	Default
36	Read Param	Param# to read value	0
37	Read Value	Value of parameter specified by Point 36	0

Writing Parameter Values

These outputs are written each time the Write Value point is written from the network.

The Param# for Write Param point's default to commonly accessed parameters and can be changed if desired. A value of "0" in the Param# for Write Param point field disables the writing of data.

Figure G.2 Configurable Output Point Operation

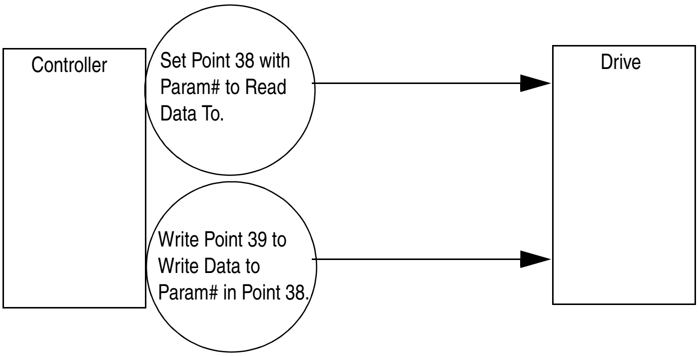


Table G.5 Configurable Points: Outputs

Point	Name	Description	Default
38	Write Param	Param# to write value	0
39	Write Value	New value of parameter specified by Point 38	0

S

T

U

W

5011625906-T306

U.S. Allen-Bradley Drives Technical Support
Tel: (1) 262.512.8176, Fax: (1) 262.512.2222, Email: support@drives.ra.rockwell.com, Online: www.ab.com/support/abdrives

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication 22C-UM001I-EN-P – January 2014 PN-143041
Supersedes 22C-UM001H-EN-P – June 2013

Level control

➜ ENRM filling or emptying with adjustable time delay

- **Regulation of one or two levels (min./max.)**
- **Monitoring filling (UP) or emptying (DOWN) selected by a switch on the front panel.**
- **Probes supplied with AC current.**
- **Sensitivity adjustable on front panel from 250 Ω to 1 M Ω.**
- **Time delay preventing wave effect adjustable from 0.1 to 5s.**

Specifications

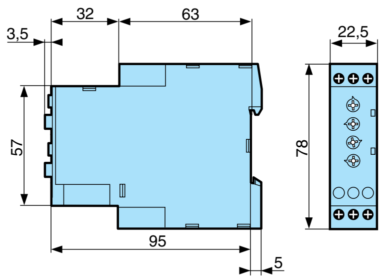
Type	Characteristics	Voltages	Code
ENRM	Monitoring filling (UP)	24 V AC	84 870 211
	Monitoring emptying (DOWN)	~~48 V AC~~	~~84 870 212~~
		120 V AC	84 870 213
		~~230 V AC~~	~~84 870 214~~

General characteristics

Operating range	0.85 → 1.10 x Un
Maximum power consumption	3 VA
Adjustable sensitivity	250 Ω → 1 MΩ
Measurement accuracy (at maximum sensitivity)	± 30 %
Electrode voltage (max)	24 V AC (50/60 Hz)
Electrode current (maximum)	1 mA (50/60 Hz)
Maximum cable capacity	10 nF
Response time high level	300 ms
Response time low level	500 ms
Output relay (according to AC1 resistive load)	1 AgNi changeover relay 8 A AC max.
Galvanic isolation via transformer (4 kV, 8 mm creepage distance)	Class II VDE 0551
Isolation of contacts and electrodes from power supply	2.5 kV AC
Operating temperature range (°C)	-20 → +50°C
Storage temperature range (°C)	-40 → +70°C
Weight (g)	150

Dimensions

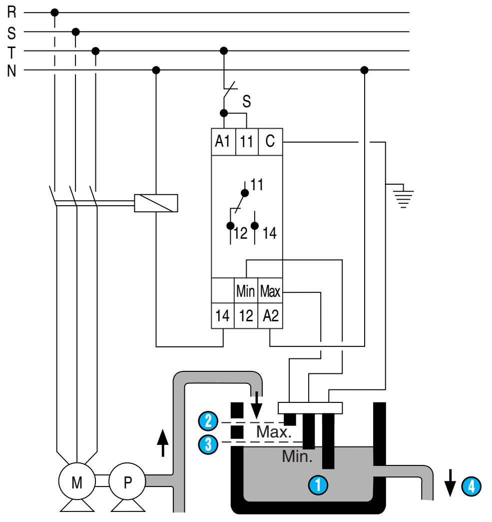
ENRM



To order, see page 6

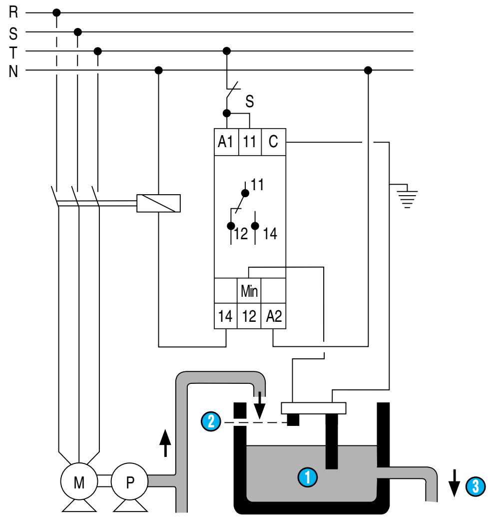
Connections

Adjusting two levels
Monitoring filling "Up"



1 Common
2 Off
3 On
4 Output
A1-A2 : power supply

Monitoring emptying "Down"



1 Common
2 Off
3 Output
A1-A2 : power supply

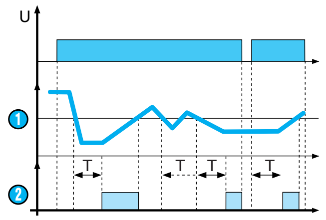
Principles

Operating principle

General principle :
The ENRM monitors the levels of conductive liquids. The principle is based on measuring the apparent resistance of the liquid between two submerged probes. When this value is lower than the preset threshold displayed on the unit's front panel, the relay changes state. To prevent any occurrences of electrolysis, an AC current is passed through the probes. A rotary switch on the front panel can be used to select the desired function and sensitivity range. A level can be monitored using the 2nd rotary switch.
In this instance, the max. probe remains above the liquid and an adjustable time delay prevents the wave effect.

A green LED indicates that the supply voltage is present.
A yellow LED indicates the output relay's state.
When the green and yellow LEDs are flashing, this indicates an incompatible adjustment position.

Rotary switch in mode 2 - Activation time - Filling function



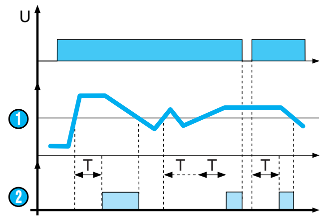
1 Level
2 Relay

Monitoring a level, filling function, activation time
(level : 1 - on delay, function Up LS (Low Sensitivity : 250 Ω to 5 kΩ) , Up St (Standard Sensitivity : 5 kΩ to 100 kΩ) , Up HS (High Sensitivity : 50 kΩ to 1 MΩ).

When the level of liquid drops below the probe for a period exceeding the value of time delay T set on the front panel, the relay energises and remains on until the level of liquid reaches the probe again.
If the level of liquid returns above the level set before the time delay elapses, the relay does not come on.

Note
When the power returns after a power break, the output relay only energises after time delay T if the level of liquid is below the threshold.

Rotary switch in mode 2 - Activation time - Emptying function



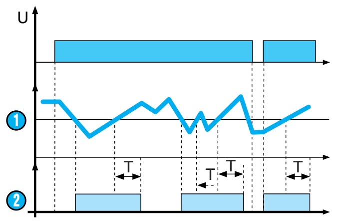
1 Level
2 Relay

Monitoring a level, emptying function, activation time
(level : 1 - on delay, function Dwn LS (Low Sensitivity : 250 Ω to 5 kΩ) , Dwn St (Standard Sensitivity : 5 kΩ to 100 kΩ) , Dwn HS (High Sensitivity : 50 kΩ to 1 MΩ).

When the level of liquid rises above the probe for a period exceeding the value of time delay T set on the front panel, the relay energises and remains on until the level of liquid drops back below the probe.
If the level of liquid drops back below the level set before the time delay elapses the relay does not come on.

Note
When the power returns after a power break, the output relay only energises after delay time T if the level of liquid is above the threshold.

Rotary switch in mode 3 - Deactivation time - Filling function



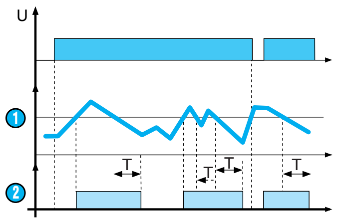
1. Level
2. Relay

Monitoring a level, filling function, deactivation time
(level : 1 - off delay, function Up LS (Low Sensitivity : 250 Ω to 5 kΩ) or Up St (Standard Sensitivity : 5 kΩ to 100 kΩ) or Up HS (High Sensitivity : 50 kΩ to 1 MΩ).

When the liquid level drops below the probe the relay energises immediately and remains on until the level of liquid reaches the probe again and remains above it for a period exceeding time delay T set on the front panel.
If the level of liquid drops back below the level set before the time delay elapses, the relay remains on.

Note
When the power returns after a power break, the output relay energises immediately if the liquid level is below the threshold.

Rotary switch in mode 3 - Deactivation time - Emptying function



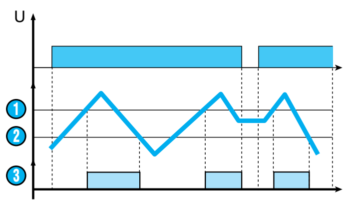
1. Level
2. Relay

Monitoring a level, emptying function, deactivation time
(level : 1 - off delay, function Dwn LS (Low Sensitivity : 250 Ω to 5 kΩ) or Dwn St (Standard Sensitivity : 5 kΩ to 100 kΩ) or Dwn HS (High Sensitivity : 50 kΩ to 1 MΩ).

When the level of liquid rises above the probe the relay energises immediately and remains on until the level of liquid drops back below the probe for a period exceeding the value of time delay T set on the front panel.
If the level of liquid returns above the level set before the time delay elapses the relay remains on.

Note
When the power returns after a power break, the output relay energises immediately if the level of liquid is above the threshold.

Monitoring two levels, emptying function



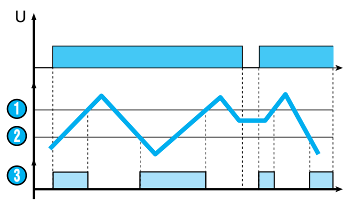
1. Maximum level
2. Minimum level
3. Output relay : Down

Monitoring two levels, emptying function
(level : 2, function Dwn LS (Low Sensitivity : 250 Ω to 5 kΩ) , Dwn St (Standard Sensitivity : 5 kΩ to 100 kΩ) , Dwn HS (High Sensitivity : 50 kΩ to 1 MΩ).

The output relay remains open as long as the level of liquid has not reached the maximum probe. Once the maximum level is reached the contact closes and the tank can then be emptied (valve opened, pump started, etc). When the level drops below the minimum level the contact opens and interrupts the emptying process.
Note : when monitoring two levels the time delay preventing the wave effect is not in operation.

Note
When the power returns after a power break, the output relay energises immediately if the level of liquid is above the threshold.

Monitoring two levels, filling function



1. Maximum level
2. Minimum level
3. Output relay : Up

Monitoring two levels, filling function
(level : 2, function Up LS (Low Sensitivity : 250 Ω to 5 kΩ) or Up St (Standard Sensitivity : 5 kΩ to 100 kΩ) or Up HS (High Sensitivity : 50 kΩ to 1 MΩ).

The output relay remains on as long as the level of liquid has not reached the maximum probe. As soon as the maximum level is reached the contact opens and pumping stops. When the level drops below the minimum level the contact closes again and pumping restarts to bring the level of liquid back up.
Note : When monitoring the two levels the time delay preventing the wave effect is not in operation.

Note
When the power returns after a power break, the output relay energises immediately if the level of liquid is below the threshold.

Other information

The probe cable (maximum length 100 metres) does not have to be screened, but avoid mounting it in parallel with the power supply cables. A screened cable can be used with the screening connected to the common terminal.

MODEL 257

3-Phase Monitor

- **Detects phase loss, low voltage, phase reversal**
- **50 Hz, 60 Hz and 400 Hz models**
- **Automatic or manual reset**
- **Five year unconditional warranty**

DESCRIPTION

The **Model 257** continuously monitors 3-phase power lines for abnormal conditions. When properly adjusted, the Model 257 monitor will detect phase loss on a loaded motor even when regenerated voltage is present.

This device consists of a solid-state voltage and phase-angle sensing circuit, driving an electro-mechanical relay. When correct voltage and phase rotation are applied, the internal relay will energize. A fault condition will de-energize the relay. When the fault is corrected, the monitor will automatically reset *(a manual reset version is also available)*.

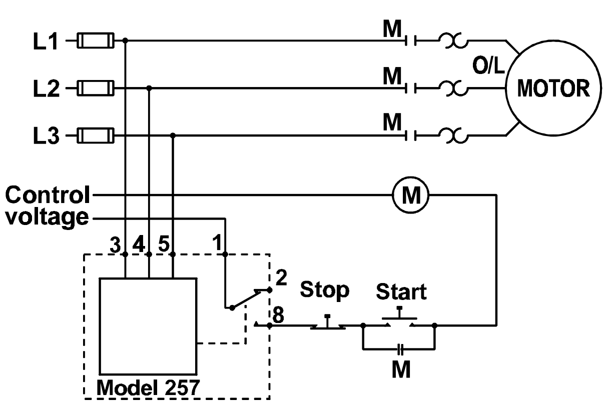
The Model 257 does not require a neutral connection and can be used with Wye or Delta systems. Voltage ranges are sufficiently wide to allow for proper adjustment to existing conditions. Both “TRIP” and “NORM” condition indicators are provided to aid in adjustment and system trouble-shooting.

SPECIFICATIONS

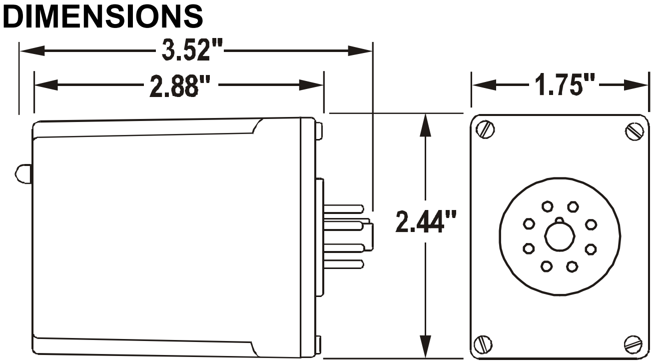
AUTO Reset MANUAL Reset	B257B B257BM	257B 257BM	A257B A257BM	EX257B EX257BM	B257B-400 B257BM-400	257B-400 257BM-400
Nominal AC voltage (phase to phase)	120 vac	208/240 vac	480 vac	380 vac	120 vac	208/240 vac
Case Color	Gray	Red	Yellow	Yellow	Gray	Red
Adjustment range	85-120vac	160-240vac	380-480vac	300-400vac	85-120vac	160-240vac
Frequency	60 Hz	60 Hz	60 Hz	50 Hz	400 Hz	400 Hz
Power consumption	0.75W	1.5W	4.5W	3.75W	0.75W	1.5W
Transient protection	2500 VAC for 10msec					
Repeat accuracy	± 0.1% of set point (fixed conditions)					
Response time	50 msec (set or reset)					
Dead band	Approximately 2%					
Output contacts	SPDT 10 amps at 240 VAC resistive					
Expected relay life	Mechanical: 10 million operations Electrical: 100,000 operations at rated load					
Operating temp	-40° to +131° F					
Humidity tolerance	0 - 97% w/o condensation					
Enclosure material	Dust cover: ABS plastic					
Mounting	8-pin socket (**sold separately)					
Weight	5 ounces					
Agency approvals	UL Recognized* and CSA Certified ***condition of acceptability:** the 380V and 480V versions must be used with a UL Recognized 600 VAC socket					

** Order 8-pin socket number **51X120**

TYPICAL APPLICATION



DIMENSIONS



(dimensions have tolerance of ± 0.06)

TIME MARK CORPORATION

Graphic Terminals

2711P PanelView Plus CE

2711P PanelView Plus CE 700

2711P PanelView Plus CE 1000

2711P PanelView Plus CE 1250

2711P PanelView Plus CE 1500

PanelView Plus CE 1250 Terminals

The PanelView™ Plus CE 1250 Graphic Terminals have a 12.1 in. flat-panel color display with 800 x 600 resolution and 18-bit graphics. These terminals support operator input via keypad (40 keys), via touch screen or via keypad and touch screen.

Quick Links

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Overview **Software** **Documentation** **Resources** **Accessories** **Applications**

Features

- Modular design includes logic, display and communication modules
- High-bright, conformal-coated and marine-certified display modules available for stringent environmental conditions
- Supports real-time monitoring of a terminal's displays from a web browser
- Built-in Ethernet and RS-232 communication ports
- Internal CompactFlash containing the Windows® CE operating system, FactoryTalk® View Machine Edition software and flash memory
- Viewers for Microsoft® Office, HTML, MPEG/JPEG and CAD files (including Microsoft Internet Explorer)

Products

- 2711P PanelView™ Plus CE 1250 Graphic Terminals

Certifications

- C-UL certified; UL listed; CE marked; Class I Div 2, Groups A, B, C, D; Class II Div 2, Groups F, G; Class III, Div I; C-Tick

Certifications apply when product is marked. See our Product Certification site for Declarations of Conformity, certificates and other certification details.

PanelView Plus CE 1250 Terminals

The PanelView™ Plus CE 1250 Graphic Terminals have a 12.1 in. flat-panel color display with 800 x 600 resolution and 18-bit graphics. These terminals support operator input via keypad (40 keys), via touch screen or via keypad and touch screen.

Frequently Viewed Publications

- PanelView Plus and PanelView Plus CE Product Profile [PDF]
- FactoryTalk View ME and PanelView Plus Product Profile [PDF]
- Visualization Platforms Selection Guide [PDF]
- PanelView Plus Terminal User Manual [PDF]
- More PanelView Plus CE documents in Literature Library

Certifications

See our Product Certification site for Declarations of Conformity, certificates and other certification details.

Can't Find What You Need?

Browse our Literature Library where you can search for additional publications. You can also use the Advanced Search feature to search by catalog number, publication type, title, or keywords to narrow your results.

1769 Compact I/O Modules Specifications

Catalog Numbers 1769 series

The 1769 Compact I/O modules can be used with a CompactLogix controller, as well as for expansion I/O in a MicroLogix 1500 controller assembly or in an assembly with a 1769-ADN DeviceNet adapter module. Unless connected to a MicroLogix 1500 base, each bank of I/O modules must include its own power supply.

Install the I/O modules on a panel with two mounting screws or on a DIN rail. The modules mechanically lock together by means of a tongue-and-groove design and have an integrated communication bus that is connected from module to module by a moveable bus connector.

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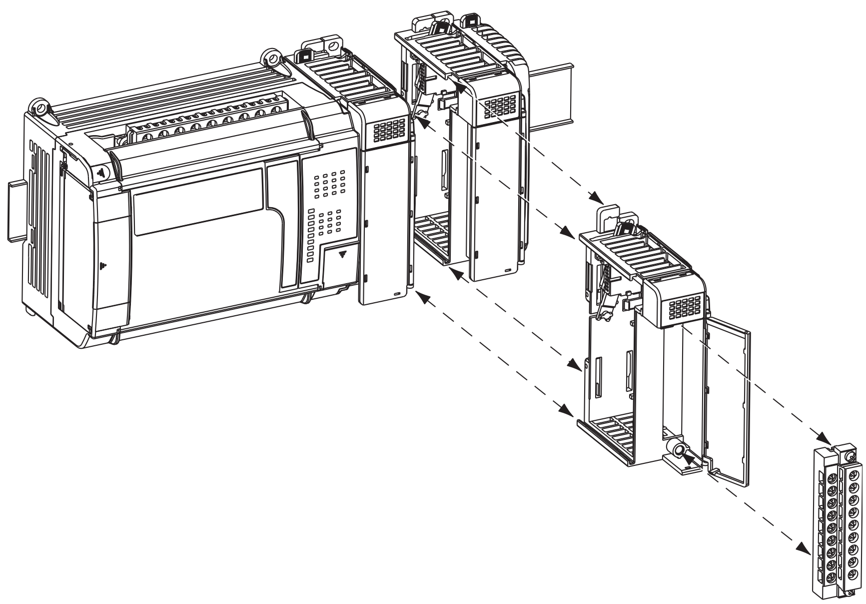
Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

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.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
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.

Each I/O module includes a built-in removable terminal block with finger-safe cover for connections to I/O sensors and actuators. The terminal block is behind a door at the front of the module. I/O wiring can be routed from beneath the module to the I/O terminals.



- Once the modules are locked together, the system becomes a rugged assembly.
- Upper and lower tongue-and-groove slots guide the module during installation and secure the module within the system.
- Removable terminal blocks help ease the wiring task.
- Self-lifting, field-wire pressure plates cut installation time.
- The patented bus connector with locking function enables reliable module and system communication.
- A color bar is provided on the front of the module.
- Digital and field circuits are optically isolated.

Available 1769 I/O Modules

I/O Type	Cat. No.	Page	Cat. No.	Page
AC digital	1769-IA8I 1769-IA16 1769-IM12	9 11 42	1769-OA8 1769-OA16	65 68
DC digital	1769-IG16 1769-IQ16 1769-IQ16F 1769-IQ32 1769-IQ32T 1769-IQ6XOW4	40 44 46 48 50 52	1769-OB8 1769-OB16 1769-OB16P 1769-OB32 1769-OB32T 1769-OG16 1769-OV16 1769-OV32T	71 73 76 79 82 102 104 107
Contact	1769-OW8 1769-OW8I	109 111	1769-OW16	113
Analog	1769-IF4 1769-IF4I 1769-IF4XOF2 1769-IF4FXOF2F 1769-IF8 1769-IF16C 1769-IF16V 1769-IR6 1769-IT6	13 16 20 25 30 34 37 55 61	1769-OF2 1769-OF4 1769-OF4CI 1769-OF4VI 1769-OF8C 1769-OF8V	84 87 90 93 96 99
Specialty	1769-ARM 1769-ASCII	115 116	1769-BOOLEAN 1769-HSC	118 123

Environmental Specifications - 1769 I/O Modules

Attribute	1769-IA8I, 1769-IA16, 1769-IM12, 1769-OA8, 1769-OA16, 1769-IQ16, 1769-IQ16F, 1769-IQ32, 1769-IQ6XOW4, 1769-OB8, 1769-OB16, 1769-OB16P, 1769-OB32, 1769-OV16, 1769-OW8, 1769-OW8I, 1769-OW16 1769-IF4, 1769-IF4XOF2, 1769-IR6, 1769-IT6 1769-ARM, 1756-HSC	1769-IG16, 1769-IQ32T, 1769-OB32T, 1769-OG16, 1769-OV32T 1769-IF4I, 1769-IF8, 1769-IF16C, 1769-IF16V, 1769-OF2, 1769-OF4CI, 1769-OF4VI, 1769-OF8C, 1769-OF8V, 1769-IF4FXOF2F 1769-ASCII, 1769-BOOLEAN
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	0…60 °C (32…140 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5…95% noncondensing	5…95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	Operating: 5 g @ 10…500 Hz Relay operating: 2 g	5 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	Panel mount 30 g DIN rail mount 20 g	Panel mount 30 g DIN rail mount 20 g
Shock, relay operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	Panel mount 7.5 g DIN rail mount 5 g	—
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	Panel mount 40 g DIN rail mount 30 g	Panel mount 40 g DIN rail mount 30 g

Place Compact I/O Modules

You can DIN-rail or panel mount the controller and I/O modules. The number of local I/O modules supported depends on the controller.

This Controller	Supports	Location	Considerations
1769-L23E-QB1B 1769-L23E-QBFC1B 1769-L23-QBFC1B	2 local modules	Right side of the packaged controller	The additional modules are connected directly to the packaged controller. There are no additional banks of local I/O.
1769-L35CR 1769-L35E	30 local modules	3 separate banks	Each module uses a set amount of backplane memory, in addition to the data that the module stores or transfers. The additional banks are powered by standard 1769 power supplies and connect to the main rack by using standard 1769 expansion cables.
1769-L32C 1769-L32E 1769-L31	16 local modules	3 separate banks	
1768-L43	16 local modules	3 separate banks	As many as eight 1769 local modules can be attached to the 1768 backplane. The remaining modules can be in one or two additional I/O banks. The additional banks are powered by standard 1769 power supplies and connect to the main rack by using standard 1769 expansion cables.
1768-L45	30 local modules	3 separate banks	

Each 1769 I/O module has a distance rating. In 1769 systems, the distance rating is the number of modules between the specific module and the 1769 power supply. In a 1768 system, the distance rating is the number of modules between the specific I/O module and the 1768 controller.

Digital I/O Modules

Choose digital I/O modules when you need these features.

Type	Description
Input	An input module responds to an input signal in the following manner: • Input filtering limits the effect of voltage transients caused by contact bounce and/or electrical noise. If not filtered, voltage transients could produce false data. All input modules use input filtering. • Optical isolation shields logic circuits from possible damage due to electrical transients. • Logic circuits process the signal. • An input indicator turns on or off indicating the status of the corresponding input device.
Output	An output module controls the output signal in the following manner: • Logic circuits determine the output status. • An output indicator displays the status of the output signal. • Optical isolation separates module logic and bus circuits from field power. • The output driver turns the corresponding output on or off.

Most output modules have built-in surge suppression to reduce the effects of high-voltage transients. Use an additional suppression device if an output is being used to control inductive devices, such as relays, motor starters, solenoids, or motors.

Additional suppression is especially important if your inductive device is in series with or parallel to hard contacts, such as pushbuttons or selector switches. Add a suppression device directly across the coil of an inductive device to reduce the effects of voltage transients caused by interrupting the current to that device and to prolong the life of the switch contacts.

Analog I/O Modules

Choose analog, thermocouple, or RTD modules for these features:

- Individually configurable channels
- Ability to individually enable and disable channels
- On-board scaling
- Autocalibration of inputs
- Online configuration
- Selectable input filters
- Over-range and under-range detection and indication
- Selectable response to a broken input sensor
- Selectable power source
- Input modules offer both single-ended or differential inputs
- Ability to direct output device operation during an abnormal condition
- High accuracy ratings

The data can be configured on board each module as:

- Engineering Units in volts or milliamps.
- Scaled-for-PID.
- Percent of range.
- Raw/Proportional Data for maximum resolution.

Specialty I/O Modules

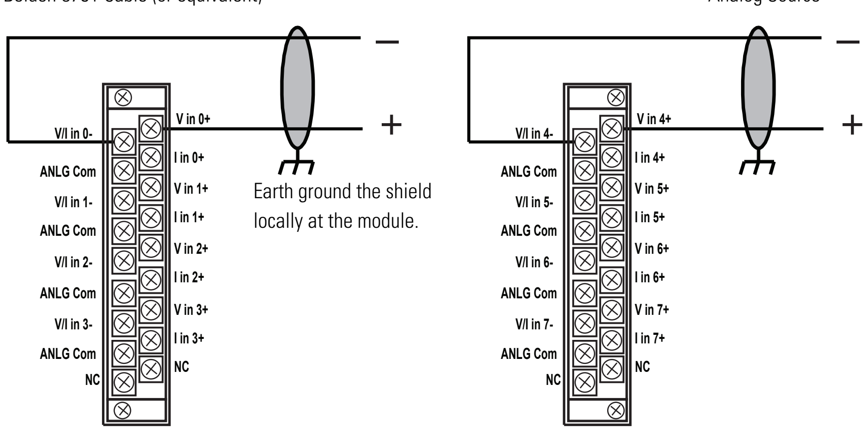
These specialty modules are available.

Cat. No.	Description
1769-ARM	Use a 1769-ARM address reserve module to reserve module slots. After creating an I/O configuration and user program, you can remove and replace any I/O module in the system with a 1769-ARM module once you inhibit the removed module in RSLogix 5000 programming software.
1769-ASCII	The 1769-ASCII module, a general purpose two-channel ASCII interface, provides a flexible network interface to a wide variety of RS-232, RS-485, and RS-422 ASCII devices. The module provides the communication connections to the ASCII device.
1769-BOOLEAN	Use the 1769-BOOLEAN module in applications that require repeatability, such as material handling and packaging, when there is a requirement to activate an output based on an input's transition. If the Boolean expression is true, the output is directed to the ON state. If the Boolean expression is false, the output channel is directed to the OFF state. There are four operators that you can configure as OR, AND, XOR, or none.
1769-HSC	Use the 1769-HSC module when you need: • a counter module that is capable of reacting to high-speed input signals. • to generate rate and time-between-pulses (pulse interval) data. • as many as two channels of quadrature or four channels of pulse/count inputs.
1769-SM1	The Compact I/O to DPI/SCANport module connects to PowerFlex 7-class drives, other DPI-based host devices, and SCANport-based host devices such as 1305 and 1336 PLUS II drives.
1769-SM2	The Compact I/O to DSI/Modbus module connects to PowerFlex 4-class drives and to other Modbus RTU slave devices, such as PowerFlex 7-class drives with 20-COMM-H RS485 HVAC adapters.

1769-IF8

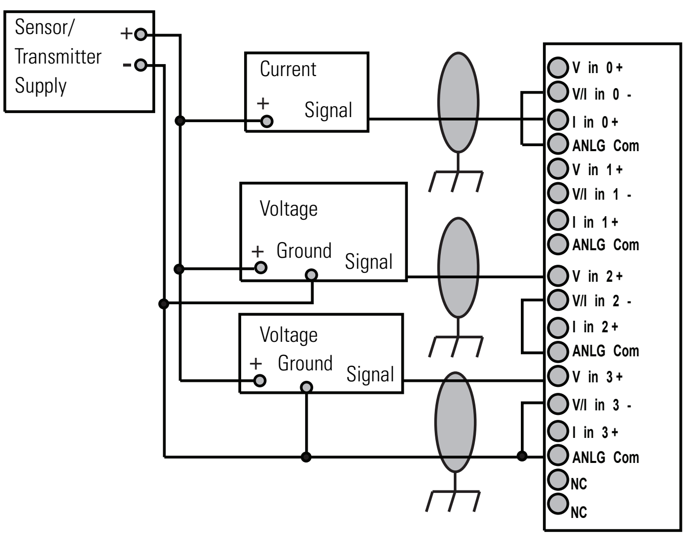
Compact voltage/current analog input module

1769-IF8 Differential Inputs



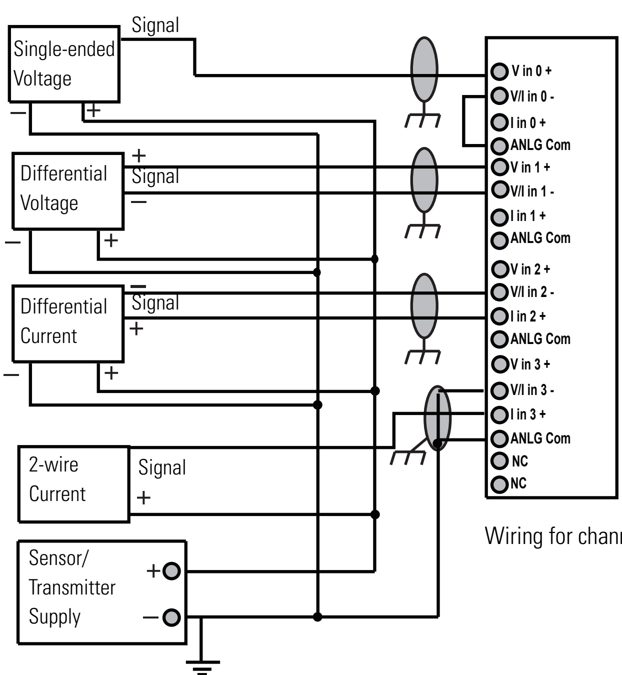
1769-IF8 Single-ended Sensor/Transmitter Inputs

The sensor power supply must be rated Class 2.



Wiring for channels 4...7 are identical.

1769-IF8 Mixed Transmitter Inputs



The sensor power supply must be rated Class 2.

Wiring for channels 4-7 are identical.

Technical Specifications - 1769-IF8

Attribute	1769-IF8
Inputs	8 differential or single-ended
Input range	±10V 0...10V 0...5V 1...5V 0…20 mA 4...20 mA
Full scale range(1)	±10.5V -0.5...10.5V -0.5...5.25V 0.5...5.25V 0…21 mA 3.2...21 mA
Current draw @ 5.1V	120 mA
Current draw @ 24V	70 mA
Converter type	Delta Sigma
Heat dissipation, max	3.24 W
Resolution (2)	16 bits (unipolar) 15 bits plus sign (bipolar)
Rated working voltage(3)	30V AC/30V DC
Common mode voltage range(4)	±10V DC max per channel
Common mode rejection	> 60 dB @ 50 and 60 Hz with the 10 Hz filter selected
Normal mode rejection ratio	-50 dB @ 50 and 60 Hz with the 10 Hz filter selected

Technical Specifications - 1769-IF8

Attribute	1769-IF8
Input impedance	Voltage: 220 kΩ Current: 250 Ω
Accuracy[5]	Voltage: ±0.2% full scale @ 25 °C (77 °F) Current: ±0.35% full scale @ 25 °C (77 °F)
Accuracy drift with temperature	Voltage: ±0.003% per °C Current: ±0.0045% per °C
Nonlinearity	±0.03%
Repeatability[6]	±0.03%
Module error	Voltage: ±0.3% Current: ±0.5%
Overload at input terminals, max[7]	Voltage: ±30V DC continuous, 0.1 mA Current: ±32 mA continuous, ±7.6V DC
Isolation voltage	500V AC or 710V DC for 1 minute (qualification test), group to bus 30V AC/30V DC working voltage (IEC Class 2 reinforced insulation)
Weight, approx.	450 g (0.99 lb)
Dimensions (HxWxD), approx.	118 x 52.5 x 87 mm (4.65 x 2.07 x 3.43 in.) Height with mounting tabs 138 mm (5.43 in.)
Slot width	1.5
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Power supply distance rating	8 modules
Terminal screw torque	0.68 N•m (6 lb•in)
Retaining screw torque	0.46 N•m (4.1 lb•in)
Wire size	(22…14 AWG) solid (22…16 AWG) stranded
Wire type	Cu-90 °C (194 °F)
Replacement terminal block	1769-RTBN18 (1 per kit)
Replacement door label	1769-RL2 series B (2 per kit)
Replacement door	1769-RD (2 per kit)
Vendor ID code	1
Product type code	10
Product code	38
Enclosure type rating	None (open-style)

(1) The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog input up to the maximum full scale range. The flag automatically resets when within the normal operating range.

(2) Resolution is dependent upon your filter selection. The maximum resolution is achieved with either the 50 or 60\ Hz filter selected.

(3) 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, 10V DC input signal and 20V DC potential above ground).

(4) For proper operation, both the plus and minus input terminals must be within ±10V DC of analog common.

(5) Includes offset, gain, nonlinearity, and repeatability error terms.

(6) Repeatability is the ability of the input module to register the same reading in successive measurements for the same input signal.

(7) Damage may occur to the input circuit if this value is exceeded.

Response Speed - 1769-IF8

Filter Frequency	Cut-off Frequency	Step Response	Channel Update
50 Hz	13.1 Hz	60 ms	22 ms
60 Hz	15.7 Hz	50 ms	19 ms
250 Hz	65.5 Hz	12 ms	6 ms
500 Hz	131 Hz	6 ms	4 ms

Certifications - 1769-IF8

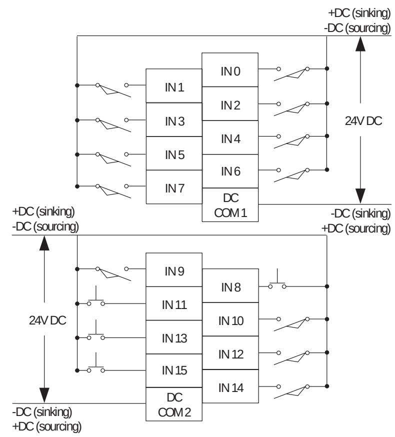
Certification[1]	1769-IF8
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1769-IQ16

Compact 24V DC sink/source input module

1769-IQ16



Technical Specifications - 1769-IQ16

Attribute	1769-IQ16
Inputs	16 (8 points/group)
Voltage category	24V DC sink/source
Operating voltage range	10...30V DC @ 30 °C (86 °F) 10...26.4V DC @ 60 °C (140 °F)
Input delay, on	8 ms
Input delay, off	8 ms
Current draw @ 5.1V	115 mA
Heat dissipation, max	3.55 W
Off-state voltage, max	5V DC
Off-state current, max	1.5 mA
On-state voltage, min	10V DC
On-state current, min	2 mA
Inrush current, max	250 mA
Input impedance, nom	3 kΩ
Isolation voltage	Verified by one of the following dielectric tests: 1200V AC for 1 s or 1697V DC for 1 s, input point to bus and group to group 75V DC working voltage (IEC Class 2 reinforced insulation)
Weight, approx.	270 g (0.60 lb)
Dimensions (HxWxD), approx.	118 x 35 x 87 mm (4.65 x 1.38 x 3.43 in.) Height with mounting tabs 138 mm (5.43 in.)
Slot width	1
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Power supply distance rating	8 modules
Terminal screw torque	0.68 N•m (6 lb•in)

Technical Specifications - 1769-IQ16

Attribute	1769-IQ16
Retaining screw torque	0.46 N•m (4.1 lb•in)
Wire size	(22…14 AWG) solid (22…16 AWG) stranded
Wire type	Cu-90 °C (194 °F)
IEC input compatibility	Type 1+
Replacement terminal block	1769-RTBN18 (1 per kit)
Replacement door label	1769-RL1 (2 per kit)
Replacement door	1769-RD (2 per kit)
Vendor ID code	1
Product type code	7
Product code	67
Enclosure type rating	None (open-style)

Certifications - 1769-IQ16

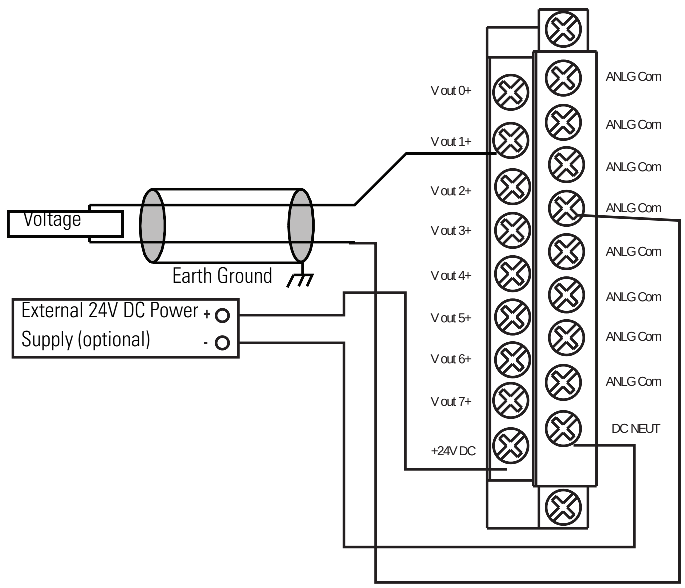
Certification(1)	1769-IQ16
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1769-OF8V

Compact voltage output analog module

1769-OF8V



The external power supply must be rated Class 2, with a 24V DC range of 20.4...6.4V DC and 60 mA minimum. Series B and later modules support this option.

Technical Specifications - 1769-OF8V

Attribute	1769-OF8V
Outputs	8 single-ended
Output range	±10V 0...10V 0...5V 1...5V
Full scale range(1)	±10.5V -0.5...10.5V -0.5...5.25V 0.5...5.25V
Resolution	16 bits plus sign (bipolar) ±10V DC: 15.89 bits, 330 μV/bit 0...10V DC: 14.89 bits, 330 μV/bit 0...5V DC: 13.89 bits, 330 μV/bit 1...5V DC: 13.57 bits, 330 μV/bit
Current draw @ 5.1V	145 mA
Current draw @ 24V	125 mA
Hear dissipation, max	2.16 W
Conversion rate (all channels), max	5.0 ms
Step response to 63%(2)	< 2.9 ms
Load output current, max	10 mA
Load range output	> 1 kΩ
Capacitive load (voltage outputs), max	1 μF

Technical Specifications - 1769-OF8V

Attribute	1769-OF8V
Field calibration	None required
Accuracy[3]	±0.5% full scale @ 25 °C (77 °F)
Accuracy drift with temperature	±0.0086% per °C
Output ripple[4]	±0.05% @ 0...50 kHz
Nonlinearity	±0.05%
Repeatability[5]	±0.05%
Module error	±0.8%
Offset error	±0.05%
Output impedance	< 1 Ω
Open and short-circuit protection	Yes
Short-circuit protection, max	30 mA
Output overvoltage protection	Yes
Output response at system powerup and power down	± 0.5V DC spike for < 5 ms
Rated working voltage[6]	30V AC/30V DC
Isolation voltage	500V AC or 710V DC for 1 min (qualification test), output group to bus 30V AC/30V DC working voltage (IEC Class 2 reinforced insulation)
Weight, approx.	263 g (0.58 lb)
Dimensions (HxWxD), approx.	118 x 35 x 87 mm (4.65 x 1.38 x 3.43 in.) Height with mounting tabs 138 mm (5.43 in.)
Slot width	1
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Optional 24V DC Class 2 power supply voltage range[7]	20.4...26.4V DC
Power supply distance rating	8 modules
Terminal screw torque	0.68 N•m (6 lb•in)
Retaining screw torque	0.46 N•m (4.1 lb•in)
Wire size	(22…14 AWG) solid (22…16 AWG) stranded
Wire type	Cu-90 °C (194 °F)
Replacement terminal block	1769-RTBN18 (1 per kit)
Replacement door label	1769-RL2 (2 per kit)
Replacement door	1769-RD (2 per kit)
Vendor ID code	1
Product type code	10
Product code	39
Input words	11
Output words	9
Configuration words	64
Enclosure type rating	None (open style)

(1) The over- or under-range flag will come on when the normal operating range (over/under) is exceeded. The module will continue to convert the analog input up to the maximum full scale range. The flag automatically resets when within the normal operating range.

(2) Step response is the period of time between when the D/A converter was instructed to go from minimum to full range until the device is at 63% of full range.

(3) Includes offset, gain, nonlinearity, and repeatability error terms.

(4) Output ripple is the amount a fixed output varies with time, assuming a constant load and temperature.

(5) Repeatability is the ability of the input module to register the same reading in successive measurements for the same input signal.

(6) 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, 10V DC input signal and 20V DC potential above ground).

(7) If the optional 24V DC Class 2 power supply is used, the 24V DC current draw from the bus is 0 mA.

Certifications - 1769-OF8V

Certification[1]	**1769-OF8V**
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Technical Specifications - 1769-OW8I

Attribute	1769-OW8I
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Power supply distance rating	8 modules
Terminal screw torque	0.68 N•m (6 lb•in)
Retaining screw torque	0.46 N•m (4.1 lb•in)
Wire size	(22…14 AWG) solid (22…16 AWG) stranded
Wire type	Cu-90 °C (194 °F)
Replacement terminal block	1769-RTBN18 (1 per kit)
Replacement door label	1769-RL1 (2 per kit)
Replacement door	1769-RD (2 per kit)
Vendor ID code	1
Product type code	7
Product code	87
Enclosure type rating	None (open style)

Relay Contact Ratings - 1769-OW8I

Volts, max	Continuous Amps per Point, max	Amperes(1)		Voltamperes		NEMA ICS 2-125
		Make	Break	Make	Break	
240V AC	2.5 A	7.5 A	0.75 A	1800VA	180VA	C300
120V AC		15 A	1.5 A			
125V DC	1.0 A	0.22 A(2)		28VA		R150
24V DC	2.0 A	1.2 A(2)		28VA		—

(1) Connecting surge suppressors across your external inductive load will extend the life of the relay contacts.

(2) For DC voltage applications, the make/break ampere rating for relay contacts can be determined by dividing 28VA by the applied DC voltage. For example, 28VA/48V DC = 0.58 A. For DC voltage applications less than 48V, the make/break ratings for relay contacts cannot exceed 2 A.

Certifications - 1769-OW8I

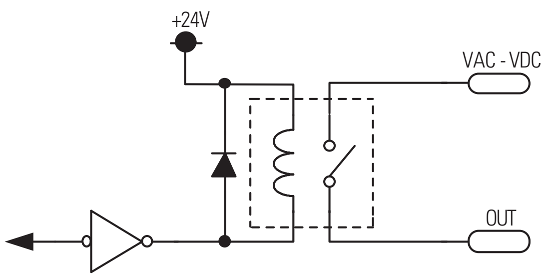
Certification(1)	1769-OW8I
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives
C-Tick	C-Tick compliant for all applicable directives

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

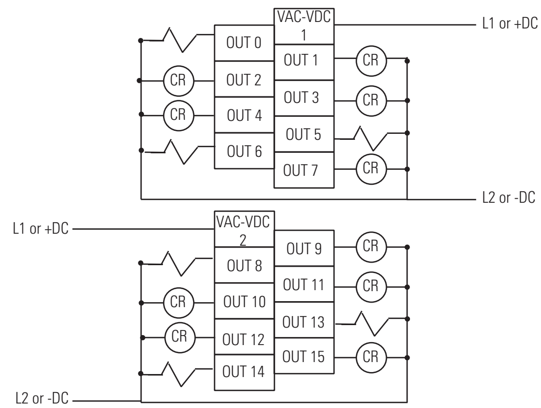
1769-OW16

Compact AC/DC relay contact module

Simplified Output Circuit Diagram



1769-OW16



Technical Specifications - 1769-OW16

Attribute	1769-OW16
Outputs	16 normally open (8 points/group)
Operating voltage range	5...265V AC 5...125V DC
Delay, on	10 ms
Delay, off	10 ms
Current draw @ 5.1V	205 mA
Current draw @ 24V	180 mA
Heat dissipation, max	4.75 W
Off-state leakage, max	0 mA
On-state current, min	10 mA @ 5V DC
Current per point, max	2.5 A
Current per module, max	20 A
Isolation voltage	Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s, output point to bus 265V AC working voltage (IEC Class 2 reinforced insulation) Verified by one of the following dielectric tests: 1836V AC for 1 s or 2596V DC for 1 s, group to group 265V AC working voltage (basic insulation) 150V AC working voltage (IEC Class 2 reinforced insulation)
Weight, approx.	450 g (0.99 lb)
Dimensions (HxWxD), approx.	118 x 52.5 x 87 mm (4.65 x 2.07 x 3.43 in.) Height with mounting tabs 138 mm (5.43 in.)
Slot width	1.5
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Power supply distance rating	8 modules

Technical Specifications - 1769-OW16

Attribute	1769-OW16
Terminal screw torque	0.68 N•m (6 lb•in)
Retaining screw torque	0.46 N•m (4.1 lb•in)
Wire size	(22…14 AWG) solid (22…16 AWG) stranded
Wire type	Cu-90 °C (194 °F)
Replacement terminal block	1769-RTBN18 (1 per kit)
Replacement door label	1769-RL1 (2 per kit)
Replacement door	1769-RD (2 per kit)
Vendor ID code	1
Product type code	7
Product code	85
Enclosure type rating	None (open style)

Relay Contact Ratings - 1769-OW16

Volts, max	Continuous Amps per Point, max	Amperes(1)		Voltamperes		NEMA ICS 2-125
		Make	Break	Make	Break	
240V AC	2.5 A	7.5 A	0.75 A	1800VA	180VA	C300
120V AC		15 A	1.5 A			
125V DC	1.0 A	0.22 A(2)		28VA		R150
24V DC	2.0 A	1.2 A(2)		28VA		—

(1) Connecting surge suppressors across your external inductive load will extend the life of the relay contacts.

(2) For DC voltage applications, the make/break ampere rating for relay contacts can be determined by dividing 28VA by the applied DC voltage. For example, 28VA/48V DC = 0.58 A. For DC voltage applications less than 48V, the make/break ratings for relay contacts cannot exceed 2 A.

Certifications - 1769-OW16

Certification(1)	1769-OW16
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives
C-Tick	C-Tick compliant for all applicable directives

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1769-ARM

Compact address reserve module

Use the 1769-ARM address reserve module in CompactLogix systems to cost-effectively reserve module slots. After creating the CompactLogix system's I/O configuration and user program, any I/O module in the system can be removed and replaced with a 1769-ARM module once the removed module is inhibited by using RSLogix 5000 programming software. Inhibiting a module creates an I/O configuration and user program removing all references to that module.

To use the 1769-ARM module in MicroLogix systems, configure a generic module by using RSLogix 5000 programming software. Any user-program references to the slot position occupied by the 1769-ARM module must not use another module's parameters.

Technical Specifications - 1769-ARM

Attribute	1769-ARM
Current draw @ 5.1V	60 mA
Current draw @ 24V	0 mA
Heat dissipation, max	0.3 W
Weight, approx.	280 g (0.62 lb)
Dimensions (HxWxD), approx.	118 x 35 x 87 mm (4.65 x 1.38 x 3.43 in.) Height with mounting tabs 138 mm (5.43 in.)
Slot width	1
Module location	DIN rail or panel mount
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4
Power supply distance rating	8 modules
Vendor ID code	1
Product type code	7
Product code	74
Enclosure type rating	None (open style)

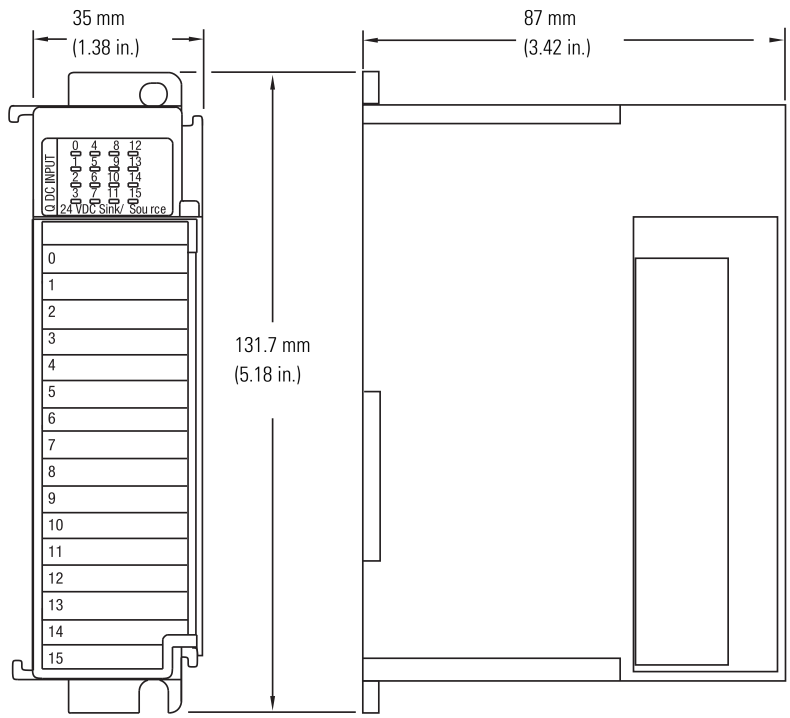
Certifications - 1769-ARM

Certification[1]	1769-ARM
c-UL	C-UL certified (under CSA C22.2 No. 142) UL 508 listed Class I, Division 2 Group A,B,C,D Hazardous Locations (UL 1604, C-UL under CSA C22.2 No. 213)
CE	CE compliant for all applicable directives
C-Tick	C-Tick compliant for all applicable directives

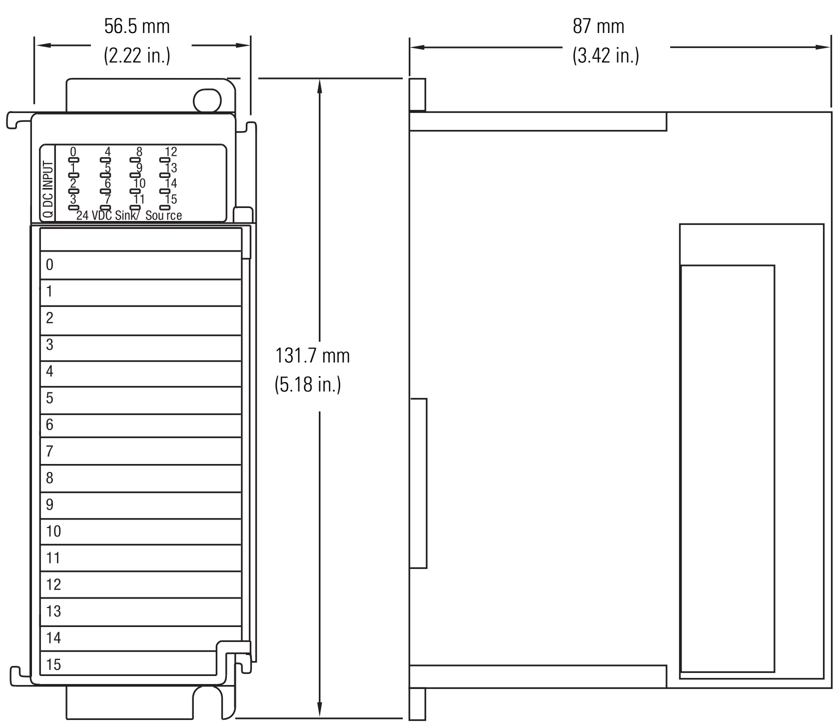
(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Compact I/O Mounting Dimensions

Single 1769 Slot Dimensions



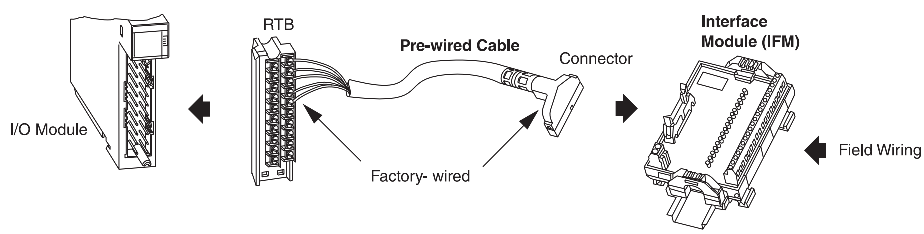
One-and-a-half 1769 Slot Dimensions



Wiring Systems

As an alternative to buying removable terminal blocks (RTBs) and connecting the wires yourself, you can buy a wiring system of:

- interface modules (IFMs) that provide the output terminal blocks for digital I/O modules. Use the pre-wired cables that match the I/O module to the IFM.
- analog interface modules (AIFMs) that provide the output terminal blocks for analog I/O modules. Use the pre-wired cables that match the I/O module to the AIFM.
- I/O module-ready cables. One end of the cable assembly is an RTB that plugs into the front of the I/O module. The other end has individually color-coded conductors that connect to a standard terminal block.



PanelConnect Modules

A PanelConnect module and its sensor connection system connect sensors directly to I/O modules by using convenient pre-built cables and connectors.

The PanelConnect module mounts on the enclosure and creates the correct seal for the entry of the sensor connections. You do not need to seal the opening where the sensor cables enter the enclosure, create custom connectors, or wire to those custom connectors.

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 an anomoly 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/.

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Publication 1769-TD006A-EN-P - January 2010
Supercedes 1769-SG002F-EN-P - March 2009

CompactLogix Controllers Specifications

1769 Packaged Controller Catalog Numbers

1769-L23-QBFC1B, 1769-L23E-QB1B, 1769-L23E-QBFC1B

1769 Modular Controller Catalog Numbers 1769-L31, 1769-L32C, 1769-L35CR, 1769-L32E, 1769-L35E

1768 Controller Catalog Numbers 1768-L43, 1768-L43S, 1768-L45, 1768-L45S

CompactFlash Card Catalog Numbers

1784-CF64, 1784-CF128

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.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

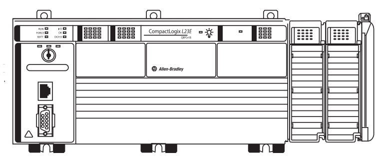
Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

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.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
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.

Environmental Specifications - 1768 and 1769 Controllers

Attribute	1769-L23-QBFC1B, 1769-L23E-QB1B, 1769-L23E-QBFC1B	1769-L31, 1769-L32C, 1769-L35CR, 1769-L32E, 1769-L35E, 1768-L43, 1768-L43S, 1768-L45, 1768-L45S
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5...95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	5 g @ 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	

1769 Packaged CompactLogix Controllers with Embedded I/O



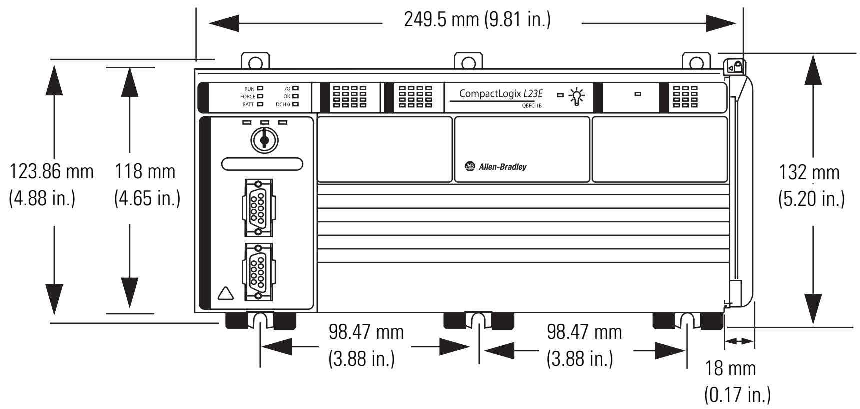
The 1769-L23*x* controller comes with:

- a built-in power supply.
- either two serial ports or one serial and one EtherNet/IP port.
- a combination of embedded digital, analog, and high-speed counter I/O.
- a 1769-ECR right-end cap.

Features - 1769 Packaged CompactLogix Controllers

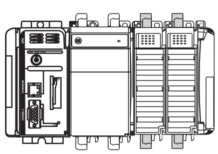
Characteristic	1769-L23-QBFC1B	1769-L23E-QB1B	1769-L23E-QBFC1B
Available user memory	512 KB	512 KB	512 KB
CompactFlash card	None	None	None
Communication ports	2 RS-232 ports (isolated DF1 or ASCII; nonisolated DF1 only)	1 EtherNet/IP port 1 RS-232 serial port (DF1 or ASCII)	1 EtherNet/IP port 1 RS-232 serial port (DF1 or ASCII)
Embedded I/O	• 16 DC inputs • 16 DC outputs • 4 analog inputs • 2 analog outputs • 4 high-speed counters	• 16 DC inputs • 16 DC outputs	• 16 DC inputs • 16 DC outputs • 4 analog inputs • 2 analog outputs • 4 high-speed counters
Module expansion capacity	Up to two additional 1769 modules	Up to three additional 1769 modules	Up to two additional 1769 modules
Embedded power supply	24V DC	24V DC	24V DC

1769-L23-QBFC1B CompactLogix Dimensions



1769 Modular CompactLogix Controllers

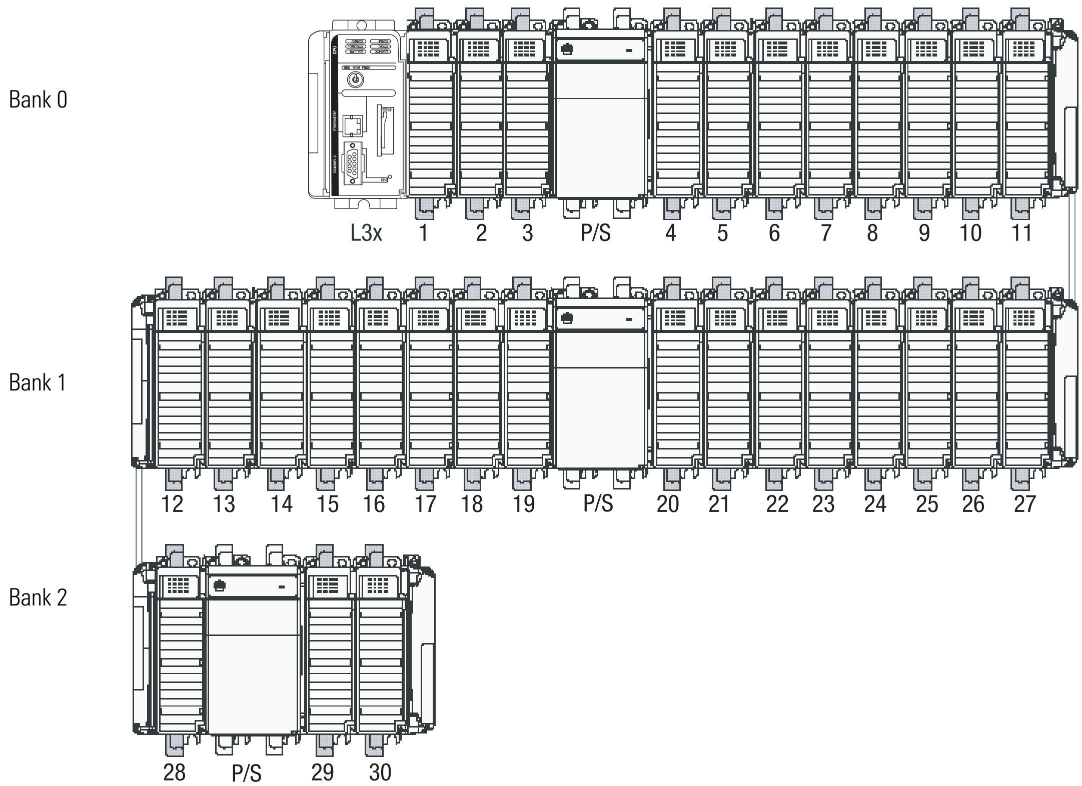
In a 1769-L3*x* controller system, the 1769 I/O modules can be placed to the left and the right of the power supply. As many as eight modules can be placed on each side of the power supply.



Features - 1769 Modular CompactLogix Controllers

Characteristic	1769-L31	1769-L32C	1769-L32E	1769-L35CR	1769-L35E
Available user memory	512 KB	750 KB	750 KB	1.5 MB	1.5 MB
CompactFlash card	• 1784-CF64 • 1784-CF128	• 1784-CF64 • 1784-CF128	• 1784-CF64 • 1784-CF128	• 1784-CF64 • 1784-CF128	• 1784-CF64 • 1784-CF128
Communication ports	2 RS-232 ports (isolated DF1 or ASCII; nonisolated DF1 only)	1 ControlNet port 1 RS-232 serial port (DF1 or ASCII)	1 EtherNet/IP port 1 RS-232 serial port (DF1 or ASCII)	1 ControlNet port 1 RS-232 serial port (DF1 or ASCII)	1 EtherNet/IP port 1 RS-232 serial port (DF1 or ASCII)
Module expansion capacity	16 1769 modules	16 1769 modules	16 1769 modules	30 1769 modules	30 1769 modules
Power supply distance rating	4 modules	4 modules	4 modules	4 modules	4 modules

The CompactLogix controller has a power supply distance rating of four modules. The controller must be the leftmost module in the first bank of the system. The maximum configuration for the first bank of a CompactLogix controller is the controller and three I/O modules to the left of the power supply and eight I/O modules to the right of the power supply.



1769-L3*x* Local I/O Performance

There is one requested packet interval (RPI) for the entire 1769 backplane (1...750 ms). As you install modules, the minimum backplane RPI increases. The RPI defines the frequency at which the controller sends and receives all I/O data on the backplane.

Type of Module	Considerations
Digital and analog (any mix)	• 1...4 modules can be scanned in 1 ms • 5...30 modules can be scanned in 2 ms • Some input modules have a fixed 8 ms filter, so selecting a faster RPI has no effect
Specialty	• Full-sized 1769-SDN modules add 2 ms per module • 1769-HSC modules add 1 ms per module • Full-sized 1769-ASCII modules add 1 ms per module

You can always select an RPI that is slower than listed above. These considerations show how fast modules can be scanned—not how fast an application can use the data. The RPI is asynchronous to the program scan. Other factors, such as program execution duration, affect I/O throughput.

Technical Specifications - 1769 Modular CompactLogix Controllers

Attribute	1769-L31	1769-L32C	1769-L32E	1769-L35CR	1769-L35E
User memory	512 KB	750 KB	750 KB	1.5 MB	1.5 MB
Optional flash memory	1784-CF64 1784-CF128				
Number of I/O modules, max	16	16	16	30	30
Number of I/O banks, max	3				
Number of expansion I/O modules, max	16 1769 modules			30 1769 modules	
Replacement battery	1769-BA				
Current draw @ 5V DC	330 mA	650 mA	660 mA	680 mA	660 mA
Current draw @ 24V DC	40 mA	40 mA	90 mA	40 mA	90 mA
Power dissipation	2.61 W	4.21 W	5.5 W	4.36 W	5.5 W
Isolation voltage	30V (continuous), basic insulation type Type tested at 710V DC for 60 s; RS232 channel 0 to system No isolation between RS232 channel 1 and system	30V (continuous), basic insulation type Type tested at 710V DC for 60 s; RS232 to system, ControlNet to system, RS232 to ControlNet, ControlNet channel A to ControlNet channel B	30V (continuous), basic insulation type Type tested at 710V DC for 60 s; RS232 to system, Ethernet to system, RS232 to Ethernet	30V (continuous), basic insulation type Type tested at 710V DC for 60 s; RS232 to system, ControlNet to system, RS232 to ControlNet, ControlNet channel A to ControlNet channel B	30V (continuous), basic insulation type Type tested at 710V DC for 60 s; RS232 to system, Ethernet to system, RS232 to Ethernet

Technical Specifications - 1769 Modular CompactLogix Controllers

Attribute	1769-L31	1769-L32C	1769-L32E	1769-L35CR	1769-L35E
Communication ports	CH0 - RS-232 DF1, DH-485, ASCII Fully isolated 38.4 Kbps max CH1 - RS-232 DF1, DH-485 Nonisolated 38.4 Kbps max	RS232 Fully isolated 38.4 Kbps max ControlNet port	RS232 Fully isolated 38.4 Kbps max EtherNet/IP port 10/100 BASE-T	RS232 Fully isolated 38.4 Kbps max ControlNet port	RS232 Fully isolated 38.4 Kbps max EtherNet/IP port 10/100 BASE-T
Serial cables	1756-CP3 or 1747-CP3, right angle connector to controller, straight to serial port, 3 m				
Weight, approx.	0.30 kg (0.66 lb)	0.32 kg (0.70 lb)	0.30 kg (0.66 lb)	0.32 kg (0.70 lb)	0.30 kg (0.66 lb)
Slot width	1				
Module location	DIN rail or panel mount				
Panel-mounting screw torque	1.1...1.8 N•m (10...16 lb•in) - use M4 or #8 screws				
Power supply distance rating	4 modules				
Power supply	1769-PA2, 1769-PB2, 1769-PA4, 1769-PB4				
Wire category[1]	2 - on communication ports				
North American temperature code	T5	T4A			
Enclosure type rating	None (open-style)				

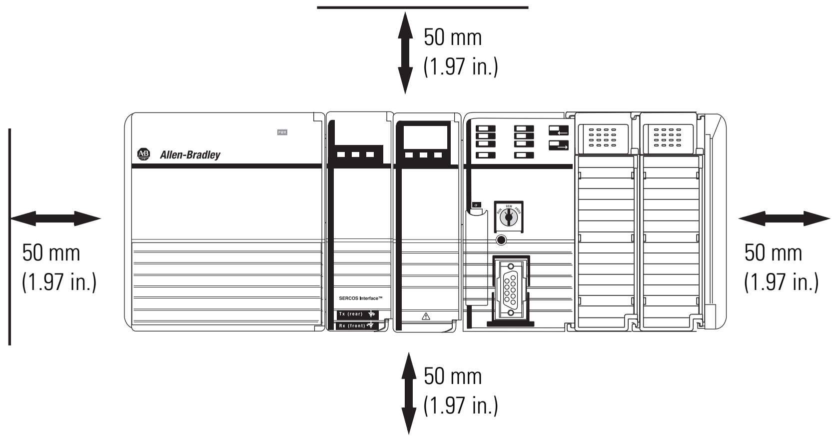
(1) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications - 1769 Modular CompactLogix Controllers

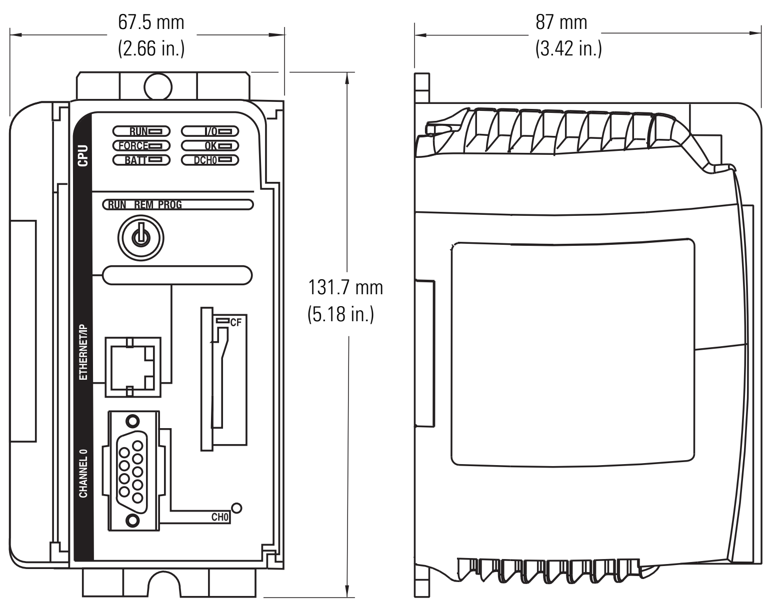
Certification[1]	1769-L31	1769-L32C, 1769-L35CR	1769-L32E, 1769-L35E
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.		
CE	European Union 89/336/EEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)		European Union 89/336/EEC EMC Directive, compliant with: • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions		
ATEX	—		European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection 'n' (II 3 G Ex nA IIC T4 X) • EN 60079-0; General Requirements (Zone 2)
CI	—	ControlNet International conformance tested to ControlNet specifications	—
EtherNet/IP	—	—	ODVA conformance tested to EtherNet/IP specifications.

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1769-L3*x* Minimum Spacing Requirements



1769-L3*x* CompactLogix Dimensions



Controller Compatibility

Control Distributed I/O Modules

The controller can control these distributed I/O modules.

I/O Modules	1768-ENBT, 1769-L23Ex 1769-L32E, 1769-L35E EtherNet/IP Network(1)	1768-CNB, 1768-CNBR 1769-L32X, 1769-L35CR ControlNet Network	1769-SDN DeviceNet Network(2) (3)
Chassis-based I/O			
1746 SLC I/O	No	No	No
1756 ControlLogix I/O	Yes	Yes	Yes
1769 Compact I/O	No	No	Yes
1771 Universal I/O	No	No	No
In-Cabinet I/O			
1734 POINT I/O	Yes	Yes	Yes
1734D POINTBlock I/O	Yes	Yes	Yes
1790, 1790D, 1790P CompactBlock LDX I/O	No	No	Yes
1791D, 1791P, 1791R CompactBlock I/O	No	No	Yes
1794 FLEX I/O	Yes	Yes	Yes
1797 FLEX Ex I/O	Yes	Yes	No
On-Machine I/O			
1732 ArmorBlock I/O	Yes	No	Yes
1738 ArmorPoint I/O	Yes	Yes	No
1792D ArmorBlock MaXum I/O	No	No	Yes
1799 Embedded I/O	No	No	Yes

(1) A non-EtherNet/IP CompactLogix controller requires a 1761-NET-ENI interface to connect to an EtherNet/IP network. This interface is only a messaging bridge.

(2) To control I/O, use a 1769-SDN scanner to connect the controller to the DeviceNet network.

(3) The 1769-SDN does not support safety communications to Guard I/O modules on a DeviceNet network.

Control Safety I/O Modules

The Compact GuardLogix controller can control these safety I/O modules in a safety system.

I/O Modules	EtherNet/IP	ControlNet
1791ES CompactBlock Guard I/O	Yes	No
1734 Point Guard I/O	Yes	No

Communicate with Display Devices

The controller can communicate with these display devices.

Display Devices	EtherNet/IP Network[1]	ControlNet Network	DeviceNet Network[2]	RS-232 (DF1) Network	DH-485 Network
Industrial Computers					
Rockwell Automation industrial computers (all)[3]	Yes	Yes	Yes	Yes	Yes
Graphic Terminals					
PanelView Plus and PanelView CE terminals	Yes	Yes	Yes	Yes	Yes
PanelView standard terminals	Yes	Yes	Yes	Yes	Yes
PanelView e terminals	No	No	No	No	No
Message Displays					
InView message displays	Yes	Yes	Yes	Yes	Yes

(1) A non-EtherNet/IP CompactLogix controller requires a 1761-NET-ENI interface to connect to an EtherNet/IP network. This interface is only a messaging bridge.

(2) For DeviceNet access, use either a 1769-SDN scanner (control I/O and send/receive messages) or a 1761-NET-DNI interface (messaging bridge).

(3) Includes: Rockwell Automation integrated display rotating media (HDD) and solid state (SSD) computers, Rockwell Automation non-display computers, and Rockwell Automation integrated display computers with keypad.

Communicate with Other Controllers

The controller can communicate with these programmable controllers.

Controller	EtherNet/IP Network[1]	ControlNet Network	DeviceNet Network[2]	RS-232 (DF1) Network	DH-485 Network
1756 ControlLogix 1756 GuardLogix	Yes	Yes	Yes	Yes	Yes
1768-L4*x* CompactLogix	Yes	Yes	Yes	Yes	Yes
1769-L3*x* CompactLogix	Yes	Yes	Yes	Yes	Yes
1769-L23*x* CompactLogix	Yes	No	Yes	Yes	Yes
1789 SoftLogix5800	Yes	Yes	Yes	Yes	No
1794 FlexLogix	Yes	Yes	Yes	Yes	Yes
PowerFlex with DriveLogix	Yes	Yes	Yes	Yes	Yes
1785 PLC-5	Yes[3] [4]	Yes	Yes[5]	Yes	—
1747 SLC	Yes[6]	Yes	Yes[4]	Yes	Yes
1761 MicroLogix	Yes	No	Yes[4]	Yes	Yes
1762 MicroLogix	Yes	No	Yes[4]	Yes	Yes
1763 MicroLogix	Yes	No	Yes[4]	Yes	Yes
1764 MicroLogix	Yes	No	Yes[4]	Yes	Yes
1772 PLC-2	—	—	—	Yes	—
1775 PLC-3	—	—	—	Yes	—
5250 PLC-5/250	—	—	No	Yes	—

(1) A non-EtherNet/IP controller requires a 1761-NET-ENI interface to connect to an EtherNet/IP network. This interface is only a messaging bridge.

(2) In the CompactLogix system, use either a 1769-SDN scanner (control I/O and send/receive messages) or a 1761-NET-DNI interface (messaging bridge).

(3) The Ethernet PLC-5 controller must be series C, firmware revision N.1 or later; series D, firmware revision E.1 or later; or series E, firmware revision D.1 or later.

(4) The 1785-ENET Ethernet communication interface module must be series A, firmware revision D or later.

(5) The PLC-5, SLC, and MicroLogix processors appear as I/O points to the Logix controller. Use the appropriate DeviceNet interface for the controller.

(6) Use a 1747-L55*x* controller with OS501 or later.

Communicate with Other Communication Devices

The controller can communicate with these communication devices.

Communication Device	EtherNet/IP Network[1]	ControlNet Network	DeviceNet Network[2]
Linking device (ControlLogix controllers only)	1788-EN2DN	1788-CN2DN 1788-CN2FF	1788-EN2DN[3] 1788-CN2DN
PCMCIA card	—	1784-PCC	1784-PCD
PCI card	—	1784-PCIC 1784-PCICS	1784-PCID 1784-PCIDS 1784-CPCIDS
Drives SCANport module	—	1203-FM1 1203-FB1[4]	—
Communication module	—	1203-CN[5] 1770-KFC15 1770-KFCD15 1747-KFC15	1770-KFD 1770-KFG
Communication card	—	1784-PKTCS 1784-KTCS 1784-KTCX15	1784-PKTX 1784-PKTXD
USB communication device	—	1784-U2CN	1784-U2DN

(1) A non-EtherNet/IP controller requires a 1761-NET-ENI interface to connect to an EtherNet/IP network. This interface is only a messaging bridge.

(2) In the CompactLogix system, use either a 1769-SDN scanner (control I/O and send/receive messages) or a 1761-NET-DNI interface (messaging bridge).

(3) The 1788-EN2DN does not support safety communications (CIP Safety).

(4) Use a CIP generic MSG instruction to communicate with the 1203-FM1 SCANport module on a DIN rail that is remote to the controller. The remote DIN rail also requires a 1794-ACN15 or 1794-ACNR15 ControlNet adapter module.

(5) Use the generic module configuration to configure the 1203-CN1 module and a CIP generic MSG instruction to communicate with the module.

Controller Connections

A CompactLogix system uses connections to establish communication links between devices. The types of connections include:

- controller-to-local I/O modules or local communication modules.
- controller-to-remote I/O or remote communication modules.
- controller-to-remote I/O (rack-optimized) modules.
- produced and consumed tags.
- messages.
- controller access by RSLogix 5000 programming software.
- controller access by RSLinx software for HMI or other applications.

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. The limit of connections may ultimately reside in the communication module you use for the connection. If a message path routes through a communication module, the connection related to the message also counts towards the connection limit of that communication module.

1769-L23*x* CompactLogix Connections

The controller you select determines the connections for I/O and messages.

Controller	Supports
1769-L23EQB1B	32 CIP connections 8 TCP/IP connections
1769-L23EQBFC1B	

The total connection requirements for a 1769 CompactLogix system include both local and remote (distributed) connections. The controller supports 100 connections. The available remote connections depend on the network interface.

1769-L3*x* CompactLogix Connections

The controller you select determines the connections for I/O and messages.

Controller	Supports
1769-L32C 1769-L35CR	32 CIP connections
1769-L32E 1769-L35E	32 CIP connections 32 TCP/IP connections

The total connection requirements for a 1769 CompactLogix system include both local and remote (distributed) connections. The controller supports 100 connections. The available remote connections depend on the network interface.

1768-L4*x* CompactLogix Connections

The communication module you select determines the connections for I/O and messages.

Communication Module	Supports
1768-ENBT 1768-EWEB	128 CIP connections 64 TCP/IP connections
1768-CNB 1768-CNBR	48 CIP connections

The total connection requirements for a 1768 CompactLogix system include both local and remote (distributed) connections. The controller supports 250 connections. The available remote connections depend on the network interface.

Determine Total Connection Use

The total connection requirements for a CompactLogix system include both local and remote (distributed) connections. The 1769-L23*x* and 1769-L3*x* controllers support 100 connections; the 1768-L4*x* controllers supports 250 connections. The available remote connections depends on the network interface.

Connection Type	Device Quantity	Connections per Device	Total Connections
Remote ControlNet communication module Configured as a direct (none) connection Configured as a rack-optimized connection		 0 **or** 1	
Remote I/O module over a ControlNet network (direct connection)		1	
Remote Ethernet communication module Configured as a direct (none) connection Configured as a rack-optimized connection		 0 **or** 1	
Remote I/O module over an EtherNet/IP network (direct connection)		1	
Remote device over a DeviceNet network (accounted for in rack-optimized connection for local 1756-DNB module)		0	
Produced tag and first consumer Each additional consumer		2	
		1	
Consumed tag		1	
Cached message		1	
Message		1	
RSLinx Enterprise subscriber (16 maximum)		1	
Total			

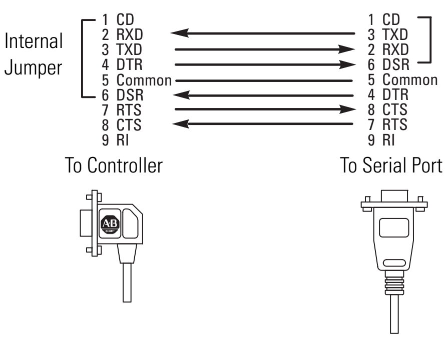
1769 CompactLogix Batteries

The 1769-L23*x* and 1769-L3*x* controllers come with one 1769-BA lithium battery. The 1768 controller does not require a battery. The controller uses internal flash memory to store its program during shutdown. Energy stored in the 1768 power supply maintains controller power long enough to store the program to internal flash memory (not the external CompactFlash card).

Technical Specifications - 1769-BA

Attribute	1769-BA
Description	Lithium battery (0.59 g)
CompactLogix controllers	1769-L23-QBFC1B, 1769-L23E-QB1B, 1769-L23E-QBFC1B 1769-L31 1769-L32C, 1769-L35CR 1769-L32E, 1769-L35E

Serial Communication Cables



Attribute	1756-CP3	1747-CP3
Connector type	Female 9-pin D-shell	
Connector angle	Right angle connector to controller, straight to serial port	
Length	3 m (118 in.)	

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 an anomoly 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

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication 1769-TD005B-EN-P - March 2010

Supersedes 1769-TD005A-EN-P - January 2010

Rockwell Automation

SWITCHES

Stratix 2000 Unmanaged Switches

Stratix 2000™ industrial-grade unmanaged switches require no configuration, which helps you set up and install your switch quickly. The Stratix 2000 line has flexible power requirements and can be used with AC or DC power. The switches connect easily with Logix controllers and have features to autonegotiate for speed and duplex per port. Stratix 2000 switches are ideal for small, isolated networks.

Features

- Easy to start up and use
- Multiple port count and fiber options available
- AC or DC power
- Autonegotiates speed & duplex setting
- Automatic cable cross over detection

Product Selection

Cat. No.	Description	
1783-US03T01F	3 copper ports 1 fiber port	

1783-US05T	5 copper ports	
1783-US06T01F	6 copper ports 1 fiber port	
1783-US08T	8 copper ports	

Accessories

See the Accessories tab for information on SFP transceivers and Ethernet cables.

Technical Specifications

	1783-US03T01F	1783-US05T	1783-US06T01F	1783-US08T
Ports per Module	4	5	7	8
Copper Ports	3	5	6	8
Fiber Ports	1	—	1	—
Power Requirements	24V DC (10...35V DC)			
Current Consumption, Max.	400 mA @ 10V DC			
Power Consumption, Max.	4 W (6 VA)			
Inrush Current, Max.	2.2 A			
Fiber Optic Ethernet Data Rate	100 Mbps	—	100 Mbps	—
Fiber Optic Link Budget	8 dB with 62.5 / 125 µm multimode cable 4 dB with 50 / 125 µm multimode cable	—	8 dB with 62.5 / 125 µm multimode cable 4 dB with 50 / 125 µm multimode cable	—

Fiber Optic Cable Length, Max	Graded index multimode fiber; 2000 m	—	Graded index multimode fiber; 2000 m	—
Fiber Optic Connector Type	LC			

LISTEN.
THINK.
SOLVE.®

PRODUCT PROFILE

Remote Access Modem Kits

Remote Connection Solutions For Your Control Systems

Serial Modems

- Designed for use in industrial environments
- Compact design uses only 2 inches of DIN rail space
- Flexible power requirements
- Phone line connection speeds up to 56K
- Multiple cables and adaptors are provided for connection to a variety of control system components
- Remote configuration (allows reconfiguration of a remote modem to match changes in the control system)
- Password protection, password with callback and Caller ID (protects control systems from unauthorized access)
- Profile selection switches (allow preprogrammed profiles to be selected without connecting to a computer)

Ethernet Modems

- Designed for use in industrial environments
- Compact design uses only 2 inches of DIN rail space
- Flexible power requirements
- Phone line connection speeds up to 56K
- Data compression increases phone line throughput by 40%
- 17 diagnostics LEDs report system status and network activity
- VLAN capability reduces network traffic
- Network debugging with port mirroring and port diagnostics
- IGMP Snooping to minimize network traffic
- Dial-out capability to route packets to other networks
- Multiple levels of security:
- DHCP/BOOTP server (services up to 30 nodes on your network)

Remote Access Modem Kits are specifically designed for remote connection to control systems and include everything you need to easily connect the first time, and every time.

Remotely connecting to a control system using an off-theshelf, computer store modem can often be a difficult task.

Remote Access Dial-in Ethernet Modems allow you to quickly connect to your remote Ethernet network from any standard phone line, improving your ability to respond to critical situations without actually being on site. Now you can eliminate those weekend trips to the plant, or costly travel to field locations.

From home, your office or another facility, you can easily:

- Perform diagnostics
- Make program changes
- Upload and download new programs
- Update firmware
- Collect data
- Monitor system status

Specifications

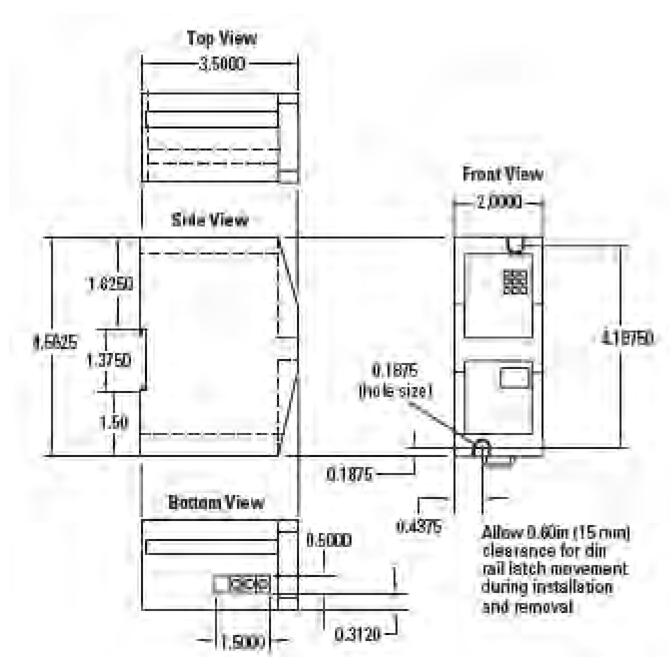
	9300-RADES Remote Access Dial-in Ethernet Modem	9300-RADKIT Remote Access Dial-in Modem	9300-RAPMKIT Remote Access Paging Modem
Environmental:			
Operating Temperature:	0 TO 60° C (32 TO 152° F)		
Storage Temperature:	-20 TO 70° C (-4 TO 158° F)		
Weight:	1.5 LBS.		
Compliance:	FCC part 68, Part 15-class a, UL/CSA/IC Certified, CTR 21, CE, UL Class 1 Div 2 Hazardous	FCC part 68, Part 15-class b, UL/CSA/IC Certified, CTR 21, UL Class 1 Div. 2	FCC part 68, Part 15-class b, UL/CSA/IC Certified, CTR 21
Power Requirements:	8 to 48VDC (200 mA at 24V, 300mA max)	8 to 48VDC (100 MA at 24V, 200MA at 12V)	
Network Ports:	4 RJ-45 10/100 full/half duplex jacks		
DTE Rates (Asynchronous):	Host to DSP - Internal high speed serial interface	230.4K,115K,57.6K, 38.4K, 19.2K, 9600, 4800, 2400,1200 and 300 bps	
Line Rates (V90):	56K thru 28K bps		
Line Rates (V.34):	28.8K thru 2400 bps		
Error Control/Data Compression:	V.42, V.42bis MNP Classes 3,4		
Phone Interface Connection:	RJ11C		
Phone Line Requirements:	Unconditioned PSTN dial-up		
Transmit Level:	Dial Line: -10dBm fixed		
Carrier Detect Threshold:	-10 to -43dBm		
Switch Characteristics:	VLAN, QoS, IGMP, Port Mirroring		
Routing Characteristics:	Automatic Dial-Out, DHCP, BOOTP, PAP, CHAP		
Protocols:	TCP/IP, PPP, RIP, NAT, Telnet, FTP, DHCP, BOOTP		
Switches:		4 Default Profile Selection Switches, Power Switch	
Facsimile Compatibility:		ITU Group 3 fax machines and fax modems, ITU V.17, V.29, V.27ter, V.21Channel 2, T.30, T.4, EIA-578 Class 1 compatibility for fax software	
Facsimile Operating Speeds:		Send/receive: 14,400 bps to 2400 bps	
Accessories:	Quick Start Guide, AC Adapter, 6 ft. Patch Cable, Phone line cable	Quick Start Guide, AC Adapter, Serial cable kit, Phone line cable	

Ordering

To order a Remote Access Modem kit use the appropriate part number above.

More Information

For more information about Remote Access Modems, contact your local Rockwell Automation sales office or authorized distributor, or visit: http://support.rockwellautomation.com/modem



www.rockwellautomation.com

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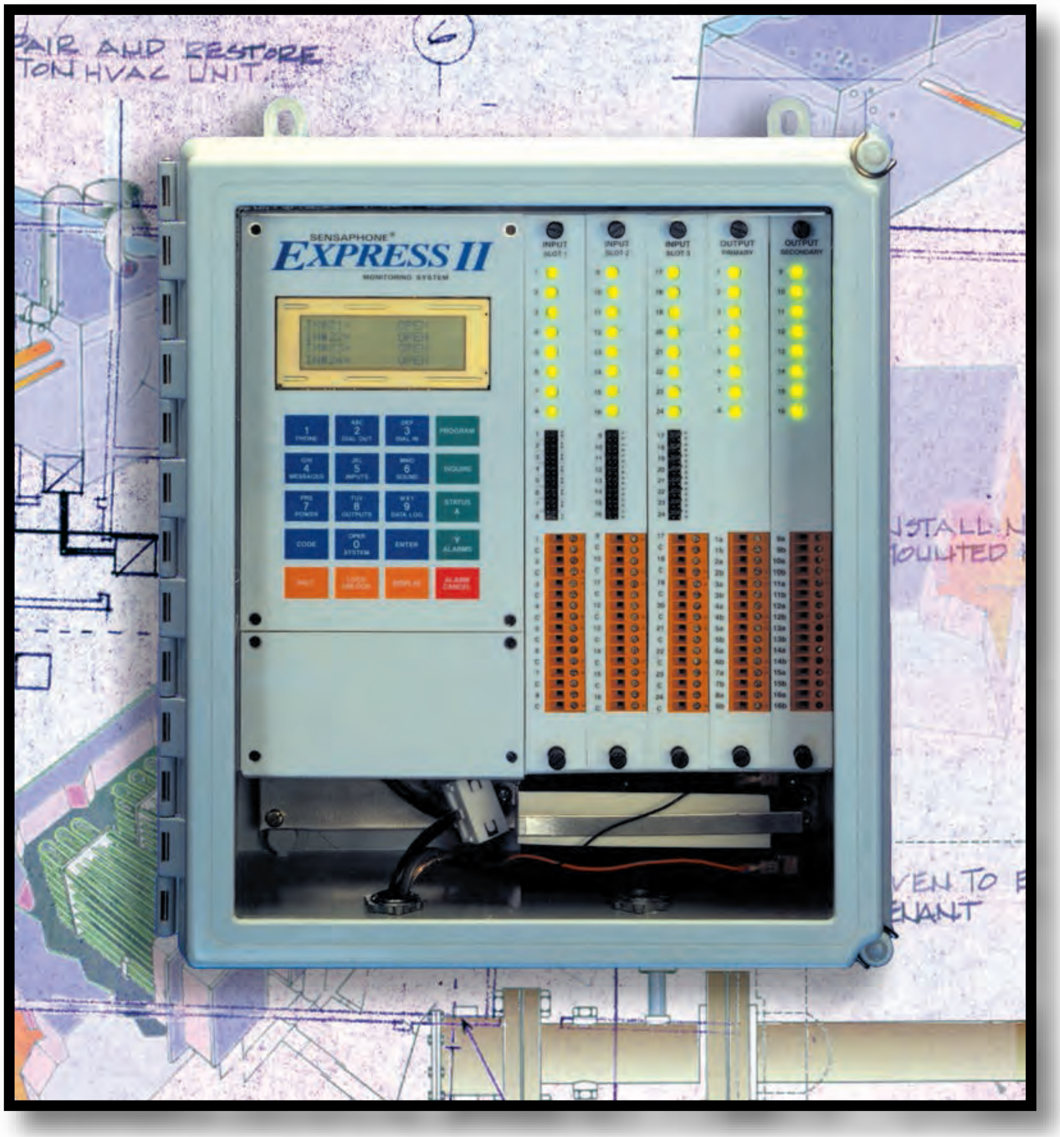
Publication GMSA10-PP014D -EN-E – July 2008 — Supersedes Publication GMSC10-PP004C-EN-P – October 2005

SENSAPHONE® *EXPRESS II*

REMOTE MONITORING SYSTEM



The Remote Telemetry System for Environmental and Industrial Monitoring, Communication, and Control

SENSAPHONE, INC.

901 Tryens Road Aston, PA 19014 • 610.558.2700 • Fax: 610.558.0222 • www.sensaphone.com

Express II: A comprehensive package of monitoring and control features offering powerful expansion options.

You can customize the Express II system for your specific needs. Add inputs and outputs as your application grows. Easy to install, program and expand.

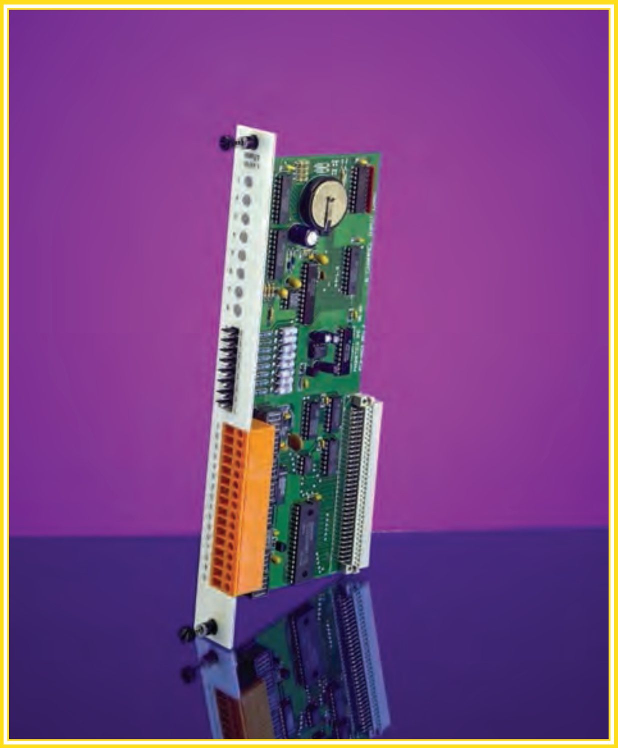
Express II: the first and last monitoring and control system you need to buy.

MONITORING

Express II is equipped with 8 universal inputs, configurable as dry contact, pulse count, 0-5V or 4-20mA analog, or temperature inputs.

Easy-to-install expansion cards let you increase your monitoring capacity by an additional 32 universal input channels. Each input, whether standard-installed or expanded, is fully programmable and complete with a two-color LED to indicate the alarm status locally.

Express II also features built-in AC power monitoring and a built-in microphone for sound level monitoring.



COMMUNICATIONS

The system works over standard phone lines to deliver recorded alarm messages to up to 48 phone numbers.

Call progress detection ensures that crucial alarm calls go through, with no wasted time on busy-signals or unanswered calls.

Alarm-specific dialing and phone list features allow you to customize the dialout process. The digital display indicates current alarm status and phone activity. The standard local serial port allows Express II to print alarm activity to a local printer.

MESSAGING

Digital speech technology allows you to record your voice for both dialout alarm messages and an ID message. When Express II dials out for an alarm, the system recites your personalized voice messages.

This feature is especially useful for service personnel when the system has been expanded with many inputs.

Your creativity and Express II's flexibility enable you to have extensive monitoring capacity without confusion or worry.

All recorded voice messages are stored in nonvolatile memory.

PROGRAMMABILITY

Express II is fully programmable via the local keypad or remotely by touch-tone phone.

Menu-style voice guidance makes programming simple and provides easy access to all parameters, whether you are calling in or using the keypad.

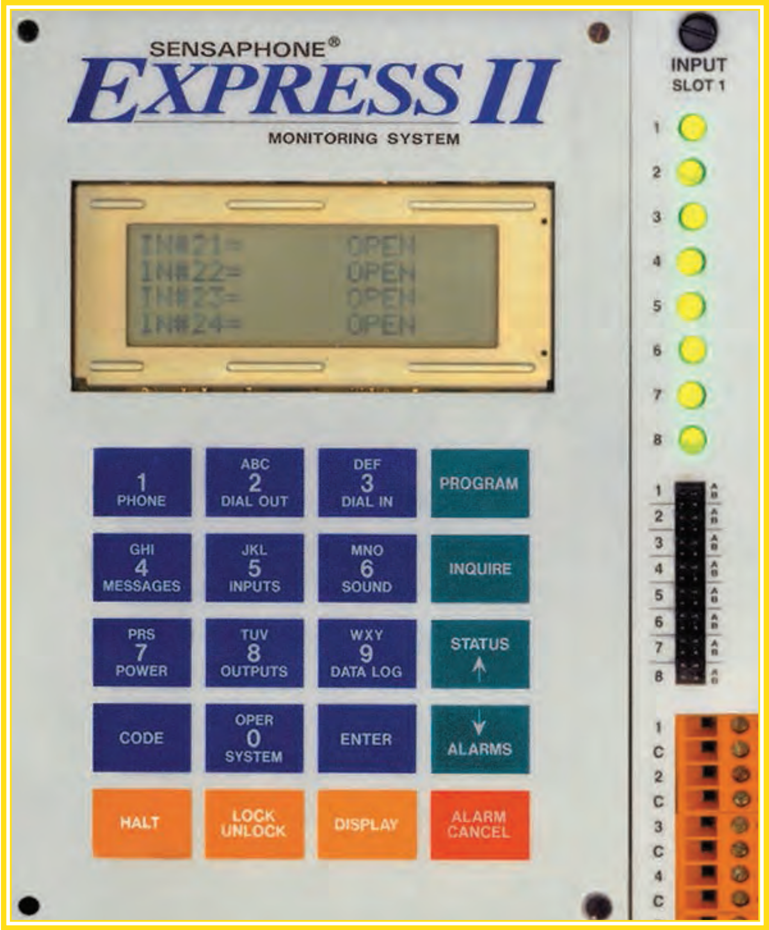
Nonvolatile memory ensures that your programming is not lost during a power failure or storage.

HARDWARE

Express II is equipped with one relay output that can be programmed to control automatically or manually.

Expansion cards allow you to increase Express II's output capacity by up to 32 relay output channels.

Express II is housed in a NEMA-4 fiberglass enclosure with 12-hour rechargeable Gel Cell battery backup.



FEATURES

- 32 additional channels for input/output expansion
- 8 standard universally configurable inputs
- Built-in power failure and sound level monitoring
- Built-in relay output for manual or automatic switching
- Digital speech recording allows the user to record custom ID and input messages
- Complete programming access using the local keypad or via remote touch-tone phone
- Dials up to 48 user-programmable phone numbers
- Alarm specific dialing and phone lists allow the user to customize the dialing process
- Housed in a NEMA-4 fiberglass enclosure with a 12-hour Gel Cell rechargeable battery backup
- Front panel LEDs indicate input status to on-site personnel

SPECIFICATIONS

GENERAL

Monitoring capacity: 8 universal input channels standard configurable as:
- Normally open dry contact
- Normally closed dry contact
- Pulse counter
- 4-20mA analog with custom look up table
- 0-5 Volt analog with custom look up table

Built-in power failure monitoring
Built-in sound level monitoring (smoke or fire alarm)

Output type: 1 built-in relay, SPST latching 2A 250 VAC

Expansion: 32 additional channels available for input/output expansion

Programming: All parameters can be programmed from the local keypad or any remote touch-tone phone

Speech technology: ADPCM 24 kb/s

Message length: User selectable 5, 7 or 11 seconds per input channel

Message types: 1 recorded ID message
1 recorded alarm message for each input channel

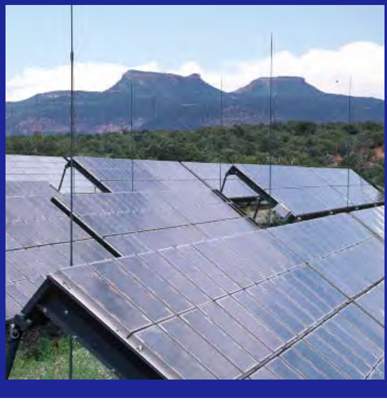
Telephone numbers: Total of 48 phone numbers with 32 digits each
Allows alarm specific dialing
Multiple phone lists for day/night/weekend

Dialing format: Touch-tone, pulse, or auto-detect

Phone connector: RJ11C

Activity log: Built in RS232 port
Can automatically print alarm activity to a local printer

Local indications: Built in LCD display to show alarm dialing status
Dual-color LED indication for each input channel



ELECTRICAL

Power requirements: 120 VAC, 60 Watts Max

Internal battery backup: 12 hour Gel Cell with built-in charger

ENVIRONMENTAL

Operating temperatures: 32–120 degrees F

Operating humidity: 0–90%, non-condensing

Storage temperatures: 0–130 degrees F

PHYSICAL

Dimensions: 14.4" x 12.4" x 7.3"

Weight: 15 lbs.

Enclosure: NEMA-4 fiberglass with latched window cover

SENSAPHONE, INC.
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Phone: 610.558.2700
FAX: 610.558.0222
www.sensaphone.com

LIT-6700 5.2003

ENGINEERING SPECIFICATIONS
SENSAPHONE® EXPRESS II

I. General

The Automatic dialer shall be a self-contained microprocessor controlled system capable of monitoring and controlling up to 40 alarm channels. The system shall be modular in construction, allowing up to 4 input/output Expansion Cards to be installed and configured for operation by the user by means of the built-in keypad and remotely by touch-tone phone. Characteristics of Input and Output channels include Universal Input and Digital Relay Output.

Upon detection of any alarm or status change, the system shall commence dialing telephone numbers from a list associated with the particular alarm condition(s) or combination thereof, and deliver a voice message identifying and describing the alarm condition(s). The alarm message shall be delivered in digitized human voice using messages recorded by the user. The system will continue to call telephone numbers in succession until a positive acknowledgment of the alarm message is received. Acknowledgment is accomplished by depressing tone keys from the called telephone, or by calling the system back within a programmed time period. The alarm may also be acknowledged using the local keypad. In addition, the system shall be able to receive incoming telephone calls. Upon answering, the system shall recite a menu of options and allow access to remote operation and programming.

The system shall be FCC registered for direct connection to the telephone network. The system shall have a one year warranty from the manufacturer. The system shall be a Sensaphone® Express II by Phonetics, Inc.

II. I/O Channel Attributes and Features

A. Inputs

The system shall come standard with 8 universal input channels. Up to 32 additional universal input channels may be installed by the user. All input channels shall be user-configurable as:

1. NO or NC digital dry contact, using 0.8mA loop current
2. 4-20mA analog, using custom look up table
3. 0-5V analog, using custom look up table
4. Pulse count
5. Temperature from thermistor, using 2.8K or 10K devices (-80ºF to 300ºF)
6. Time accumulator

The system shall have the following built-in monitoring features:

1. AC power failure detection
2. Sound level monitoring
3. Low battery detection

All monitored channels, including built-in monitoring features, shall allow keyboard and remote touch-tone programming of pertinent operational data including, but not limited to:

1. Input type (NO/NC, 4-20mA and 0-5V analog, pulse count, thermistor, time accumulator)
2. High and Low limits (-9999 to +9999)
3. Input recognition time (0 seconds to 12 hours)
4. Alarm reset time (0 seconds to 12 hours)
5. Phone Contacts list for each channel
6. Enable/disable for each channel to dialout for alarm

B. Outputs

The system shall have one built-in SPST latching 2A 250VAC relay output. The output may be programmed to switch automatically on alarm or manually via keyboard or Touch-Tone™ phone. Up to 16 additional relay output channels may be installed by the user.

III. Communications Features

A. Telephone Specifications

The system shall connect to a standard 2-wire telephone line using pulse or tone dialing methods, with loop start only. The system shall recognize ringer frequencies from 16 to 60 Hz. No leased or dedicated lines shall be required. The system shall also be capable of being used on the same telephone line as other answering devices. Call progress detection shall ensure that the alarm dialout is not hindered by no-answers or busy signals.

B. Telephone Numbers

The system shall be capable of dialing up to 48 telephone numbers, 40 digits each. There shall be a capacity to program, retain and use three separate lists based on a calling schedule of weekday, weeknight and weekend. Each list shall contain up to 16 phone numbers. In addition, individual phone contact lists may be programmed for each input channel.

The system shall allow local keypad and remote touch-tone programming of the following telephone dialing information:

1. Dialing method (Automatic, pulse, tone)
2. Retries on busy (0 to 15)
3. Message repetitions (0 to 10)
4. Maximum number of calls (0 to 65,535)
5. Call delay time (0 seconds to 12 hours)
6. Intercall delay time (0 seconds to 12 hours)

C. Voice Messages

The System shall have the ability to record, store and reproduce voice messages and to use those messages to articulate the location and status of the monitored channels. In absence of user-recorded voice messages, the system shall articulate channel status using the internally resident vocabulary. All digitized speech message data shall be stored in nonvolatile memory with a 3V lithium battery backup. Such battery backup shall be capable of protecting speech memory for at least 2 years of complete power outage.

There shall be one recorded identification message for the system, and one recorded alarm message for each input channel. A message may also be recorded for each output channel on the optional output expansion card. Message length shall be selectable from 5 to 11 seconds per input or output channel.

IV. Programming

A. Local Programming

The System shall contain an integral, sealed, alphanumeric keypad for the purpose of locally programming all system data. Programming is assisted by synthesized voice guidance. All operational data, system setup and configuration data, and all information regarding the monitored I/O channels shall be displayed on the LCD display panel. No display manipulation shall be required to view and assess the status of I/O points.

B. Remote Programming

The system shall be remotely programmable using a standard touch-tone telephone. All operational data, system setup and configuration data, and information regarding I/O channels shall be accessible and programmable. A user-programmable security password shall protect the system from unauthorized tampering. Remote programming shall be aided by menu-style voice guidance.

V. System Features

A. Power

The system shall be provided with a UL/CSA listed 15VAC grounded power transformer that the user may plug into a 120V AC outlet, $\pm$20%, 60HZ. The unit shall provide battery backed 12 volts DC (up to 100mA) and 24 volts DC (up to 400mA) to power 4-20mA current loops or other external devices.

B. Battery Backup

The system shall have a built-in 12V 3 AH sealed lead-acid rechargeable battery. This battery shall support approximately 6-12 hours of continued system operation in the absence of AC power. (Actual battery backup performance is dependent upon the age of the battery, the ambient temperature, the charge condition, and the number of external devices being powered by the system.)

C. Local Visual Indication

Each input shall have a corresponding LED that will indicate the alarm and acknowledgment status of each input. The system shall also have an LCD display that will list information about the current system status and input/output status.

D. Data Log

The system shall be capable of logging the input values on a user-defined time period via a serial printer. The system shall also log all system and alarm activity including, but not limited to: programming changes, alarms occurring and clearing, acknowledgments, call-ins, and alarm dialouts. The system shall be able to print the log information to a printer hooked up to its built-in RS232 serial port.

E. Halt Mode

The system shall be capable of entering a halt mode upon user command in which all inputs shall be disabled and dialout prevented. Halt mode shall end automatically after a preprogrammed time period.

F. Diagnostics and Testing

System diagnostics shall be performed each time the unit is started. The system shall be capable of performing a simulated alarm dialout for testing. The dialout can be requested locally or remotely.

G. Security

The system shall allow the user to lock the keypad to prevent unauthorized local or remote access unless a security password is entered.

VI. Remote Operation Features

A. Status Report

The system shall allow the user to call into the unit at any time using any standard telephone to obtain a full status report of all monitored channels. The status report shall be articulated using the resident voice-synthesized English vocabulary, in combination with digitized user-recorded voice messages.

B. Acknowledgment

An alarm on any monitored channel may be acknowledged remotely by pressing tones on a touch-tone telephone keypad or by calling the system back within a specified time period. An alarm may also be acknowledged locally using the built-in keypad.

VII. Enclosure and Environmental

A. Enclosure

The system shall be housed in a NEMA-4X fiberglass enclosure with a latched window cover and shall be internally constructed such that modular plug-in expansion cards may be used to facilitate field upgrades, repair, and maintenance.

B. Electrical Protection

Power and telephone connections shall have internal spike and surge protection using metal oxide varistors. All input channels shall have fault protected input circuits.

C. Additional Electrical Surge Protection

Additional Power and Telephone line surge protection shall be available from the manufacturer. When so installed, the system shall be fully warranted against any damage caused by transient surges entering the system through Power or Telephone lines.

D. Environmental

The system shall function over an operating range of 32°F - 120°F at up to 0 - 90% RH, non-condensing. The system may be stored over the temperature range of 0° - 130°F.

E. Maintenance

The system manufacturer shall have in-house service facilities and technical assistance available during normal business hours, Monday - Friday 8AM - 5PM(EST).

F. Safety Approvals

The system shall be approved by a Nationally Recognized Testing Laboratory (NRTL) to UL Standard 1950 "Information Technology Equipment" and CSA Standard 22.2 #950.

Specifications subject to change without notice.

Phonetics, Inc.
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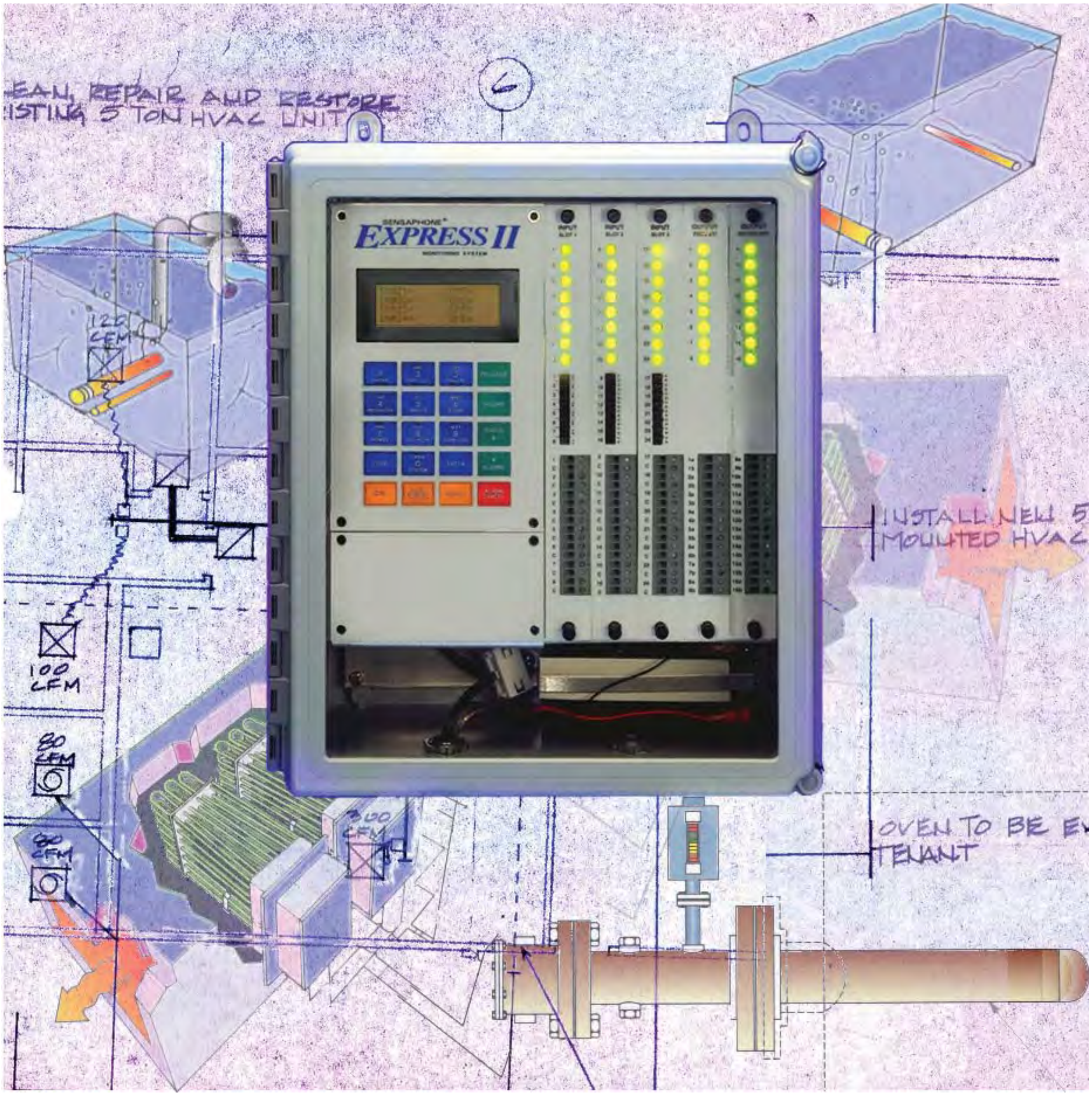


SENSAPHONE® *EXPRESS II*

USER'S MANUAL

LIT-0015

Every effort has been made to ensure that the information in this document is complete, accurate and up-to-date. Sensaphone, Inc. assumes no responsibility for the results of errors beyond its control. Sensaphone, Inc. also cannot guarantee that changes in equipment made by other manufacturers, and referred to in this manual, will not affect the applicability of the information in this manual.

Second Edition, version 2.33, January 2006.

Written and produced by Phonetics, Inc.

Please address comments on this publication to:

Phonetics, Inc.

901 Tryens Road

Aston, PA 19014

Important Safety Instructions

Your Sensaphone Express II has been carefully designed to give you years of safe, reliable performance. As with all electrical equipment, however, there are a few basic precautions you should take to avoid hurting yourself or damaging the unit:

- Read the installation and operating instructions in this manual carefully. Be sure to save it for future reference.
- Read and follow all warning and instruction labels on the product itself.
- To protect the Sensaphone Express II from overheating, make sure all openings on the unit are not blocked. Do not place on or near a heat source, such as a radiator or heat register.
- Do not use your Sensaphone Express II near water, or spill liquid of any kind into it.
- Be certain that your power source matches the rating listed on the AC power transformer. If you're not sure of the type of power supply to your facility, consult your dealer or local power company.
- Do not allow anything to rest on the power cord. Do not locate this product where the cord will be abused by persons walking on it.
- Do not overload wall outlets and extension cords, as this can result in the risk of fire or electric shock.
- Never push objects of any kind into this product through ventilation holes as they may touch dangerous voltage points or short out parts that could result in a risk of fire or electric shock.
- To reduce the risk of electric shock, do not disassemble this product, but return it to Sensaphone Customer Service, or another approved repair facility, when any service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect reassembly can cause electric shock when the unit is subsequently used.
- If anything happens that indicates that your Sensaphone Express II is not working properly or has been damaged, unplug it immediately and follow the procedures in the manual for having it serviced. Return the unit for servicing under the following conditions:
    1. The power cord or plug is frayed or damaged.
    2. Liquid has been spilled into the product or it has been exposed to water.
    3. Unit has been dropped, or the enclosure is damaged.
    4. Unit doesn't function normally when you're following the operating instructions.

- Avoid using a telephone (other than a cordless type) during an electrical storm. There may be a remote risk of electric shock from lightning.
- Do not use the telephone to report a gas leak in the vicinity of the leak.

CAUTION

To reduce the risk of fire or injury to persons, read and follow these instructions:

1. Use only the following type and size battery: Sealed lead-acid 12v 3.0 AH.
2. Do not dispose of the battery in a fire. The cell may explode. Check with local codes for possible special disposal instructions.
3. Do not open or mutilate the batteries. Released electrolyte is corrosive and may cause damage to the eyes or skin. It may be toxic if swallowed.
4. Exercise care in handling battery in order not to short the battery with conducting materials such as rings, bracelets, and keys. The battery or conductor may overheat and cause burns.

If you experience trouble with this equipment, or you need information on obtaining service or repairs, please contact Technical Support at:

Phonetics, Inc.

901 Tryens Road, Aston, PA 19014

610-558-2700

Fax: 610-558-0222

www.sensaphone.com

1 YEAR LIMITED WARRANTY

PLEASE READ THIS WARRANTY CAREFULLY BEFORE USING THE PRODUCT.

THIS LIMITED WARRANTY CONTAINS SENSAPHONE'S STANDARD TERMS AND CONDITIONS. WHERE PERMITTED BY THE APPLICABLE LAW, BY KEEPING YOUR SENSAPHONE PRODUCT BEYOND THIRTY (30) DAYS AFTER THE DATE OF DELIVERY, YOU FULLY ACCEPT THE TERMS AND CONDITIONS SET FORTH IN THIS LIMITED WARRANTY.

IN ADDITION, WHERE PERMITTED BY THE APPLICABLE LAW, YOUR INSTALLATION AND/OR USE OF THE PRODUCT CONSTITUTES FULL ACCEPTANCE OF THE TERMS AND CONDITIONS OF THIS LIMITED WARRANTY (HEREINAFTER REFERRED TO AS "LIMITED WARRANTY OR WARRANTY"). IF YOU DO NOT AGREE TO THE TERMS AND CONDITIONS OF THIS WARRANTY, INCLUDING ANY LIMITATIONS OF WARRANTY, INDEMNIFICATION TERMS OR LIMITATION OF LIABILITY, THEN YOU SHOULD NOT USE THE PRODUCT AND SHOULD RETURN IT TO THE SELLER FOR A REFUND OF THE PURCHASE PRICE. THE LAW MAY VARY BY JURISDICTION AS TO THE APPLICABILITY OF YOUR INSTALLATION OR USE ACTUALLY CONSTITUTING ACCEPTANCE OF THE TERMS AND CONDITIONS HEREIN AND AS TO THE APPLICABILITY OF ANY LIMITATION OF WARRANTY, INDEMNIFICATION TERMS OR LIMITATIONS OF LIABILITY.

1. **WARRANTOR**: In this Warranty, Warrantor shall mean "Dealer, Distributor, and/or Manufacturer."

2. **ELEMENTS OF WARRANTY**: This Product is warranted to be free from defects in materials and craftsmanship with only the limitations and exclusions set out below.3. WARRANTY AND REMEDY: One-Year Warranty — In the event that the Product does not conform to this warranty at any time during the time of one year from original purchase, warrantor will repair the defect and return it to you at no charge.

This warranty shall terminate and be of no further effect at the time the product is: (1) damaged by extraneous cause such as fire, water, lightning, etc. or not maintained as reasonable and necessary; or (2) modified; or (3) improperly installed; or (4) misused; or (5) repaired or serviced by someone other than Warrantors' authorized personnel or someone expressly authorized by Warrantor's to make such service or repairs; (6) used in a manner or purpose for which the product was not intended; or (7) sold by original purchaser.

LIMITED WARRANTY, LIMITATION OF DAMAGES AND DISCLAIMER OF LIABILITY FOR DAMAGES: THE WARRANTOR'S OBLIGATION UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AT THE WARRANTOR'S OPTION AS TO REPAIR OR REPLACEMENT. IN NO EVENT SHALL WARRANTORS BE LIABLE OR RESPONSIBLE FOR PAYMENT OF ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL AND/OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO ANY LABOR COSTS, PRODUCT COSTS, LOST REVENUE, BUSINESS INTERRUTPION LOSSES, LOST PROFITS, LOSS OF BUSINESS, LOSS OF DATA OR INFORMATION, OR FINANCIAL LOSS, FOR CLAIMS OF ANY NATURE, INCLUDING BUT NOT LIMITED TO CLAIMS IN CONTRACT, BREACH OF WARRANTY OR TORT, AND WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE. IN THE EVENT THAT IT IS DETERMINED IN ANY ADJUDICATION THAT THE LIMITED WARRANTIES OF REPAIR OR REPLACEMENT ARE INAPPLICABLE, THEN THE PURCHASER'S SOLE REMEDY SHALL BE PAYMENT TO THE PURCHASER OF THE ORIGINAL COST OF THE PRODUCT, AND IN NO EVENT SHALL WARRANTORS BE LIABLE OR RESPONSIBLE FOR PAYMENT OF ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL AND/OR PUNITIVE DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO ANY LOST REVENUE, BUSINESS INTERRUTPION LOSSES, LOST PROFITS, LOSS OF BUSINESS, LOSS OF DATA OR INFORMATION, OR FINANCIAL LOSS, FOR CLAIMS OF ANY NATURE, INCLUDING BUT NOT LIMITED TO CLAIMS IN CONTRACT, BREACH OF WARRANTY OR TORT, AND WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE.

WITHOUT WAIVING ANY PROVISION IN THIS LIMITED WARRANTY, IF A CIRCUMSTANCE ARISES WHERE WARRANTORS ARE FOUND TO BE LIABLE FOR ANY LOSS OR DAMAGE ARISING OUT OF MISTAKES, NEGLIGENCE, OMISSIONS, INTERRUPTIONS, DELAYS, ERRORS OR DEFECTS IN WARRANTORS' PRODUCTS OR SERVICES, SUCH LIABILITY SHALL NOT EXCEED THE TOTAL AMOUNT PAID BY THE CUSTOMER FOR WARRANTORS' PRODUCT AND SERVICES OR $250.00, WHICHEVER IS GREATER. YOU HEREBY RELEASE WARRANTORS FROM ANY AND ALL OBLIGATIONS, LIABILITIES AND CLAIMS IN EXCESS OF THIS LIMITATION.

INDEMNIFICATION AND COVENANT NOT TO SUE: YOU WILL INDEMNIFY, DEFEND AND HOLD HARMLESS WARRANTORS, THEIR OWNERS, DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, SUPPLIERS OR AFFILIATED COMPANIES, AGAINST ANY AND ALL CLAIMS, DEMANDS OR ACTIONS BASED UPON ANY LOSSES, LIABILITIES, DAMAGES OR COSTS, INCLUDING BUT NOT LIMITED TO DAMAGES THAT ARE DIRECT OR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, AND INCLUDING ATTORNEYS FEES AND LEGAL COSTS, THAT MAY RESULT FROM THE INSTALLATION, OPERATION, USE OF, OR INABILITY

TO USE WARRANTORS' PRODUCTS AND SERVICES, OR FROM THE FAILURE OF THE WARRANTORS' SYSTEM TO REPORT A GIVEN EVENT OR CONDITION, WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE.

YOU AGREE TO RELEASE, WAIVE, DISCHARGE AND COVENANT NOT TO SUE WARRANTORS, THEIR OWNERS, DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, SUPPLIERS OR AFFILIATED COMPANIES, FOR ANY AND ALL LIABILITIES POTENTIALLY ARISING FROM ANY CLAIM, DEMAND OR ACTION BASED UPON ANY LOSSES, LIABILITIES, DAMAGES OR COSTS, INCLUDING BUT NOT LIMITED TO DAMAGES THAT ARE DIRECT OR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, AND INCLUDING ATTORNEYS FEES AND LEGAL COSTS, THAT MAY RESULT FROM THE INSTALLATION, OPERATION, USE OF, OR INABILITY TO USE WARRANTORS' PRODUCTS AND SERVICES, OR FROM THE FAILURE OF THE WARRANTORS' SYSTEM TO REPORT A GIVEN EVENT OR CONDITION, WHETHER OR NOT CAUSED BY WARRANTORS' NEGLIGENCE, EXCEPT AS NECESSARY TO ENFORCE THE EXPRESS TERMS OF THIS LIMITED WARRANTY.

EXCLUSIVE WARRANTY: THE LIMITED WARRANTY OR WARRANTIES DESCRIBED HEREIN CONSTITUTE THE SOLE WARRANTY OR WARRANTIES TO THE PURCHASER. ALL IMPLIED WARRANTIES ARE EXPRESSLY DISCLAIMED, INCLUDING: THE WARRANTY OF MERCHANTIBILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR USE AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND THE WARRANTY OF NON-INFRINGEMENT AND/OR ANY WARRANTY ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

It must be clear that the Warrantors are not insuring your premises or business or guaranteeing that there will not be damage to your person or property or business if you use this Product. You should maintain insurance coverage sufficient to provide compensation for any loss, damage, or expense that may arise in connection with the use of products or services, even if caused by Warrantors' negligence. The warrantors assume no liability for installation of the Product and/or interruptions of the service due to strikes, riots, floods, fire, and/or any cause beyond Seller's control, further subject to the limitations expressed in any License Agreement or other Agreement provided by Warrantors to purchaser.

The agreement between the Warrantors and the Purchaser, including but not limited to the terms and conditions herein shall not be governed by the Convention for the International Sale of Goods. Where applicable, the Uniform Commercial Code as adopted by the State of Delaware shall apply.

4. **PROCEDURE FOR OBTAINING PERFORMANCE OF WARRANTY**: In the event that the Product does not conform to this warranty, the Product should be shipped or delivered freight prepaid to a Warrantor with evidence of original purchase.

5. **LEGAL REMEDIES AND DISCLAIMER**: Some jurisdictions may not allow, or may place limits upon, the exclusion and/or limitation of implied warranties, incidental damages and/or consequential damages for some types of goods or products sold to consumers and/or the use of indemnification terms. Thus, the exclusions, indemnification terms and limitations set out above may not apply, or may be limited in their application, to you. If the implied warranties can not be excluded, and the applicable law permits limiting the duration of implied warranties, then the implied warranties herein are to be limited to the same duration as the applicable written warranty or warranties herein. The warranty or warranties herein may give you specific legal rights that will depend upon the applicable law. You may also have other legal rights depending upon the law in your jurisdiction.

6. **CHOICE OF FORUM AND CHOICE OF LAW**: In the event that a dispute arises out of or in connection with this Limited Warranty, then any claims or suits of any kind concerning such disputes shall only and exclusively be brought in either the Court of Common Pleas of Delaware County, Pennsylvania or the United States District Court for the Eastern District of Pennsylvania.

Regardless of the place of contracting or performance, this Limited Warranty and all questions relating to its validity, interpretation, performance and enforcement shall be governed by and construed in accordance with the laws of the State of Delaware, without regard to the principles of conflicts of law.

Effective date 05/01/2004

PHONETICS, INC. d.b.a. SENSAPHONE
901 Tryens Road
Aston, PA 19014
Phone: 610.558.2700 Fax: 610.558.0222
www.sensaphone.com

Table of Contents

CHAPTER 1: INTRODUCTION

Welcome to the Sensaphone Express II by Phonetics, Inc. Express II is a powerful environmental and process monitoring system. It handles your current monitoring, alarm and control needs, and is able to grow when your application grows.

Express II comes standard with 8 universal input channels and one built-in relay output. Input capacity is expandable up to 40 channels (on 5 cards). Output capacity may be expanded up to 16 channels (on two cards), in which case input is limited to 24 channels (3 cards).

Express II can call up to 48 Phone Contacts, using pulse or Touch-Tone dialing. Dialing Schedules and Phone Contact List features enable you to create a priority dialing list depending on which input is alarm-activated, the time of day, and day of week. Call progress detection ensures that no time is wasted on busy signals and no-answers during the dialout sequence.

PROGRAMMING Express II

Express II's unique programming style allows you to access all programmable parameters quickly and easily. The parameters are organized into 10 categories. From there, programming is completely voice guided in a menu-style format. You simply enter the category number for the parameters you want to program and enter values as prompted. All programming can be accomplished using the local keypad on the unit, or remotely using a Touch-Tone™ phone.

The Express II has a one-year limited warranty. Within the packaging will be a Warranty Registration card. Please take the time to fill this out and mail. The warranty is explained in the back of this manual.

If any questions arise during installation or operation, please contact Technical Support at:

Phonetics, Inc.
901 Tryens Road
Aston, PA 19014
Phone: (610) 558-2700
FAX: (610) 558-0222

ABOUT THIS MANUAL

This manual comprises the instructions and commands necessary to install and program Express II. In addition, summary and application chapters are included to help you speed programming and to understand Express II's features.

NOTES

CHAPTER 2: INSTALLATION

This chapter provides the information necessary to install the Sensaphone® Express II. Correctly installing the unit will ensure proper functioning and maximum service life. Please read the entire chapter before attempting installation.

Within the packaging is a Warranty Registration card. Please take the time to fill this out and mail it. The Limited 1 Year Warranty is explained on the last page of this manual.

OPERATING ENVIRONMENT

Express II should be mounted and operated in a safe environment. Do not mount the unit where it will be subject to shock and vibration. The temperature range the Express II can operate in is 32°F to 130°F (0°C to 55°C). If you require Express II to operate in a below freezing environment, you must take safe and practical measures to keep the unit's temperature above 32°F or it will not operate reliably.

CAUTION: Express II is a sensitive electronic device. Personnel and work area should be grounded before handling this device. Do not install Express II near strong electrostatic, electromagnetic, magnetic or radioactive fields. Do not expose it to fumes or corrosive vapors.

MOUNTING Express II

When you receive Express II, carefully remove it from the box. On the top and bottom of the enclosure are mounting holes to attach the unit to either a panel or wall. The mounting surface should be sturdy enough to support 15 lbs. The unit should be mounted using four #12-24 bolts where appropriate, or four #12 tapping screws. When mounting the unit to a wall make sure the mounting screws fully engage a solid member, (e.g. a stud), of the support structure. Mount Express II in an upright position so that you can easily gain access to the front panel. There must be a power outlet and telephone jack nearby. The dimensions of the full enclosure are: 14.50"H x 13.06"W x 8.31"D. See Figure 1.

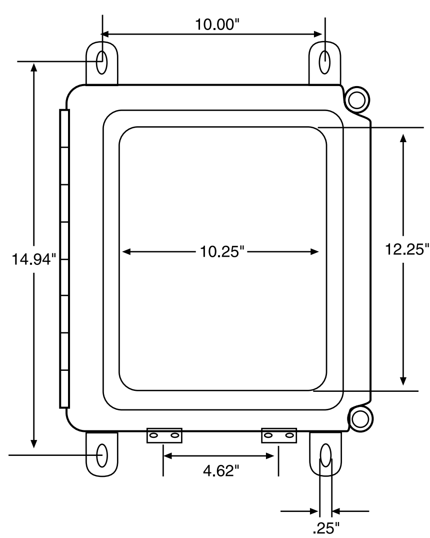


Figure 1: Mounting dimensions

STRAIN RELIEF

Strain relief clamps are provided on the Express II enclosure to prevent wiring from being pulled from the circuit board or damaged when passing through the enclosure. To use the strain relief, thread wires through the clamp and the clear rubber bushing. Position the bushing in the clamp and tighten the screws on either side so that the wiring does not move. See Figure 2 below:

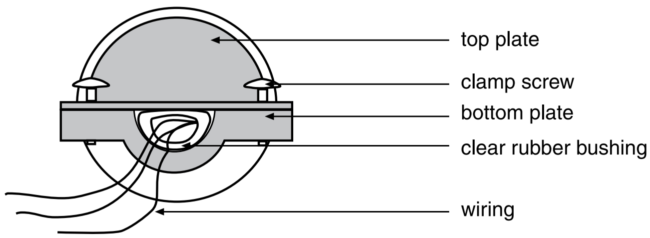


Figure 2: Strain relief clamp

POWERING UP

Express II is provided with a 12V AC power transformer. This should be plugged into a 117V AC outlet, +20%, 60HZ.

The transformer is pre-wired to the terminals labelled AC.

GROUNDING AND POWER SURGE PROTECTION

Express II should be earth grounded by connecting a true earth ground to the terminal labeled EG. This is not essential for Express II to operate, but it is necessary to prevent possible damage by a lightning strike.

The Sensaphone Express II can be damaged by power surges and lightning through the telephone line and the power supply. Although Express II has built-in surge protection, we strongly recommend that additional protection be obtained for the unit and for any electronic equipment that is attached to your power supply and telephone lines. Power surge protection is especially important if you live in a lightning-prone area. Surge protection is available through Phonetics, Inc. Call for details.

BACKUP BATTERY

Express II has a 12V 3AH sealed lead-acid Gel-Cell rechargeable battery. This will provide approximately 6–12 hours backup time. Actual backup time will depend upon the number of input/output cards installed in the unit, the number of sensors being powered from the unit, temperature, battery age, and dialing activity. The battery comes pre-wired with the red wire attached to the BAT IN(+) terminal and the black wire attached to the BAT IN(-) terminal.

Express II will automatically charge the battery whenever the power switch is turned on and the power transformer is plugged in. The unit also includes special circuity to prevent the battery from being damaged in the event of an extended power outage. When the battery runs down to 9V, the unit will automatically disconnect it, preventing deep-discharge damage. The battery will remain disconnected until it charges back up to 12.3 volts. The battery should provide 5 years of service before needing replacement.

NOTE: Have battery serviced by qualified service personnel only.

The main motherboard and plug-in cards also include a 3V lithium battery to retain user-recorded messages and programming when the unit is turned off. Each battery will provide two years of backup time while the unit is turned off and up to 10 years of intermittent use.

NOTE: Have the lithium battery serviced by qualified service personnel only.

TURNING EXPRESS II ON

Now that Express II has power, the ON-OFF switch may be turned on.

When the unit is turned ON, it will perform a series of diagnostic tests of its internal circuity. When all of the tests have been completed, the unit will say, “Express II, OK.” The unit is now operating and will respond to keypad commands and answer telephone calls.

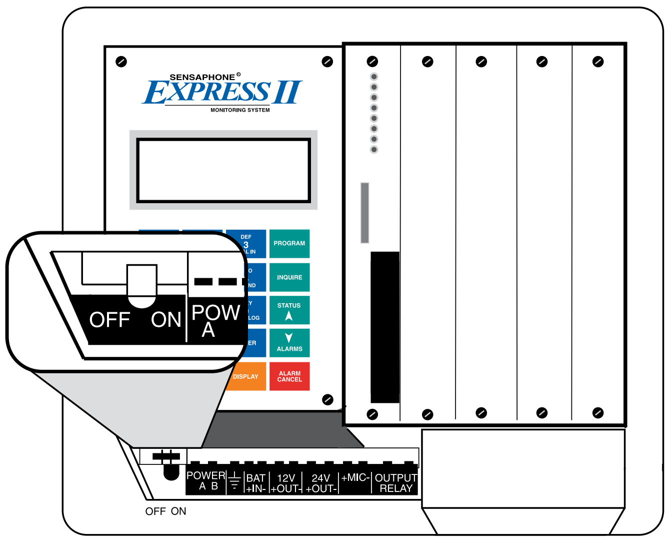


Figure 3: On/Off Switch Location

PHONE LINE INSTALLATION

Connect Express II to a standard 2-wire analog phone line. Express II dials using pulse or tone, with loop start only. Express II will operate with all standard telephone systems that accept pulse or tone dialing and will recognize ringer frequencies from 16 to 60 Hz.

NOTE: Certain private telephone systems and public switching equipment may not accept Express II dialing or may generate an unacceptable ring signal. In those cases, a dedicated line may be required for Express II. Consult the supplier of your telephone system if you encounter problems.

CAUTION: Never install telephone wiring during a lightning storm. Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations. Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface. Use caution when installing or modifying telephone lines.

POWER SUPPLIES

Express II will provide battery-backed 12 Volts DC (100 mA max.) and 24 Volts DC (400 mA max.) to power current loops and other external devices.

RS232 Printer Port

Express II has the ability to send serial data via RS232 to a serial printer or computer with an optional cable (*contact Sensaphone for more details*). This can be used to perform data logging of input values and/or unit activity directly to a printer *(see Chapter 5)*. You may also print the unit's programming parameters *(see Chapter 7)*. The RJ11 connector at the end of the cable must be connected to the RJ11 jack labeled RS232 on the main board, located below the access panel. The default baud rate of the RS232 port is 9600 baud. The baud rate may be changed from the System menu under Unit Configuration *(see Chapter 5)*. The communications protocol is 8 data bits, no parity, and 1 stop bit. Shown below are the RS232 pin descriptions for the DB25 connector.

Pin	Signal	Symbol	Direction
1	Frame Ground	FG	N/A
2	Transmitted Data	TD	From Printer
3	Received Data	RD	From Express II
6	Data Set Ready	DSR	From Express II
7	Signal Ground	SG	N/A
20	Data Terminal Ready	DTR	From Printer

FCC REQUIREMENTS

PART 68—This equipment complies with Part 68 of the FCC rules. On the side of the enclosure there is a label that contains, among other information, the FCC Registration Number and the Ringer Equivalence Number (REN) for this equipment. You must, upon request, provide this information to your local telephone company.

The REN is useful to determine the quantity of devices that you may connect to your telephone line and still have all of those devices ring when your telephone number is called. In most, but not all areas, the sum of the REN's of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices that you may connect to your line, you may want to contact your local telephone company to determine the maximum REN for your calling area.

This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

Should Express II cause harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance. But if advanced notice isn't practical, the telephone company may temporarily discontinue service without notice and you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC. The telephone company may make changes in its facilities, equipment, operations, or procedures where such action is reasonably required in the operation of its business and is not inconsistent with the rules and regulations of the FCC that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with this equipment, or you need information to obtain service or repairs, please contact:

PHONETICS, INC.
901 Tryens Road
Aston, PA 19014
(610) 558-2700
Fax: (610) 558-0222

for information on obtaining service or repairs. The telephone company may ask that you disconnect this equipment from the network until the problem has been corrected or until you are sure that the equipment is not malfunctioning.

PART 15—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 his own expense.

Safety Approvals

The Sensaphone Express II Remote Monitoring System (Model 6700) is NRTL listed in compliance with UL Standard 1950 “Information Technology Equipment” and CSA Standard 22.2 #950. The unit is certified by MET Laboratories, a Nationally Recognized Testing Laboratory (NRTL), and is listed under file number E1 12098.

NOTICE

The Canadian Department of Communications label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective operational and safety requirements. The Department does not guarantee the equipment will operate to the user’s satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company’s inside wiring associated with a single line individual service may be extended by means of a certified connector assembly (telephone extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

> **CAUTION**: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The Load Number (LN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device to prevent overloading. The termination on a loop may consist of any combination of devices subject only to the requirement that the total of the Load Numbers of all the devices does not exceed 100. For the Sensaphone Express II the Load Number is **7**.

CHAPTER 3: INPUTS

Express II comes standard with 8 universal inputs. The input capacity may be expanded in additional sets of 8 inputs. There are 5 slots, offering a total of 40 possible universal input channels. All the inputs—the 8 standard and the expanded sets—can be configured to accept the following type sensors:

- Normally closed dry contact (digital)
- Normally open dry contact (digital)
- Pulse count
- 4–20 mA (analog)
- 0–5 Volts (analog)
- Temperature
    - 2.8K F thermistor (analog)
    - 2.8K C thermistor (analog)
    - 10K F thermistor (analog)
    - 10K C thermistor (analog)
- Time accumulator

The standard 8 input terminal block is located to the right of the built-in keypad in the first card slot. Above the terminal block are a row of 8 LEDs that indicate the status of the inputs to on-site personnel.

HOW THE INPUTS WORK

Express II reads the value of each input by measuring the voltage across the input and the common terminals. When the shunts are positioned for a specific type of sensor, Express II uses a different circuit to measure the appropriate reading for that sensor. The common Express II sensor types follow:

Dry Contact—These digital sensors can be either Normally Open or Normally Closed (designated N.O/N.C). If a normally open sensor becomes closed, a contact occurs. This causes an alarm. Conversely, if a normally closed sensor becomes open, the contact disappears, and this condition causes an alarm. Typical dry contact sensors include magnetic reed switches and water detection sensors. An example would be a security system where a N.C. magnetic switch opens as a window is raised.

Pulse Count—This configuration will allow the input channel to count pulses. A typical pulse count sensor is a flow meter that uses a turbine to measure flow by accumulating pulses. Max pulse rate for this configuration is 1Hz. Compatible with mechanical relays, open drain and open collector transistor devices.

4–20 mA—This sensor configuration connects the input signal to a 237 Ohm load resistor. This allows Express II to measure the current at the input. Any powered or unpowered sensor that puts out 4–20mA can be wired. Any input range can be specified by the user. Typical sensors include pressure gauges, analog flow meters, and temperature gauges. Input resolution is 12 bits.

0–5 Volts—This configuration connects the input signal directly to Express II's analog to digital converter for measuring the output of 0 to 5V transducers. Any sensor that puts out 0–5V can be wired. Any input range can be specified by the user. Typical sensors include pressure gauges, voltage meters, and flow meters. Express II can read the voltage between 0 Volts and 5 Volts in increments of .00122 Volts. Input resolution is 12 bits.

Thermistor—Two kinds of thermistors may be used with Express II: a 2.8K thermistor or a 10K thermistor. The range for an input measuring temperature for 2.8k is –65.0° to 93.33°C (-85° F to 200° F), and for 10k is -62.22° C to 148.89° C (-80° F to 300° F) . This configuration type connects the input signal to a 5V reference through a 6.34K pull-up resistor.

Time accumulator—The time accumulator works only with N.O. Dry Contacts. As the name suggests, it will accumulate and tally the total amount of time—in hours, minutes, and seconds—that the input sensor is in the closed position. This would be useful, for instance, in maintaining total run time for a given device.

LEDs

Each input has a corresponding LED that indicates input status. The LEDs are located above the terminal block. When an LED is steady green, that indicates that the input is OK and no alarms exist. When an LED is blinking green, the input is in alarm condition, but the preset recognition time has not been met to qualify as an unacknowledged alarm. When an LED is blinking red, that indicates that an unacknowledged alarm exists on the corresponding input.

When an LED is steady red, it indicates that an alarm has been acknowledged but still exists on the corresponding input. If the input is disabled, the LED goes off for that input. **NOTE**: If the LED changes from blinking green directly to steady red, the input is not set up properly to dial out with an alarm.

CONFIGURING THE INPUTS

Each of the inputs must be configured so that Express II will know what type of signal it must read. To configure the inputs, you must position the shunts that are located on the input card directly above the input terminal block. The inputs may be set in one of three configurations:

1. 4–20mA
2. Thermistor, dry contact, or pulse
3. 0–5V

1. To configure the input as 4–20mA, place the shunt to enclose the two bottom pins (B position).

2. To configure the input as thermistor, dry contact, or pulse, place the shunt to enclose the two top pins (A position).

3. To configure the input as 0–5V, remove the shunt. See Figure 4:

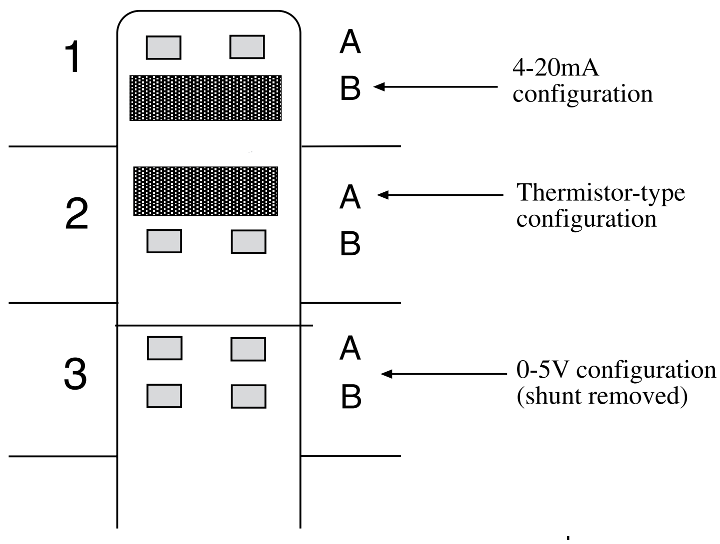


Figure 4: shunt configurations

WIRING THE INPUTS

To use a dry contact or temperature sensor on an input, wire one lead to the numbered screw of input terminal and the other lead to the corresponding common screw. See Figure 5:

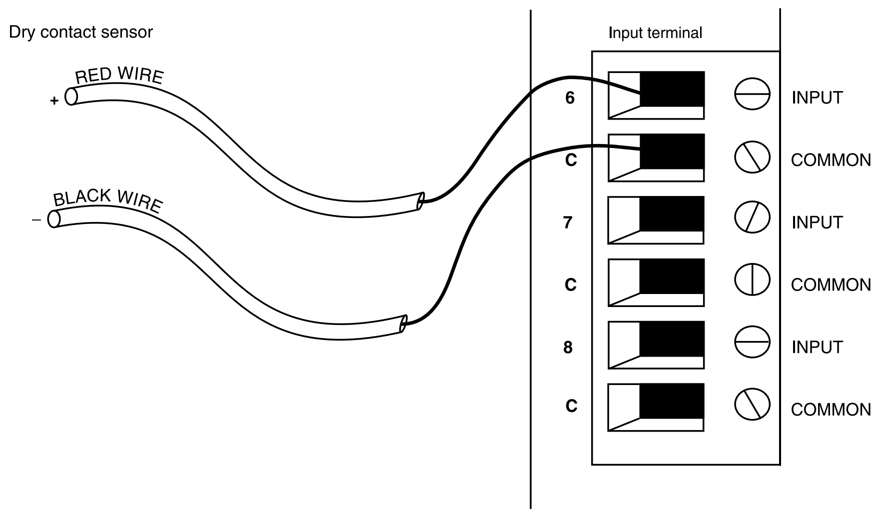


Figure 5: Dry contact sensor

To use a 4–20mA sensor on an input, you must supply power to it. You may power a 4–20mA sensor using the Express II internal power supply, or you may wire the sensor to an external power supply.

To use the internal power supply, wire the positive lead from the sensor to the unit 24V power supply. Wire the negative lead to a numbered input terminal screw. See Figure 6.

NOTE: The number of internally powered sensors will affect battery backup time during a power failure.

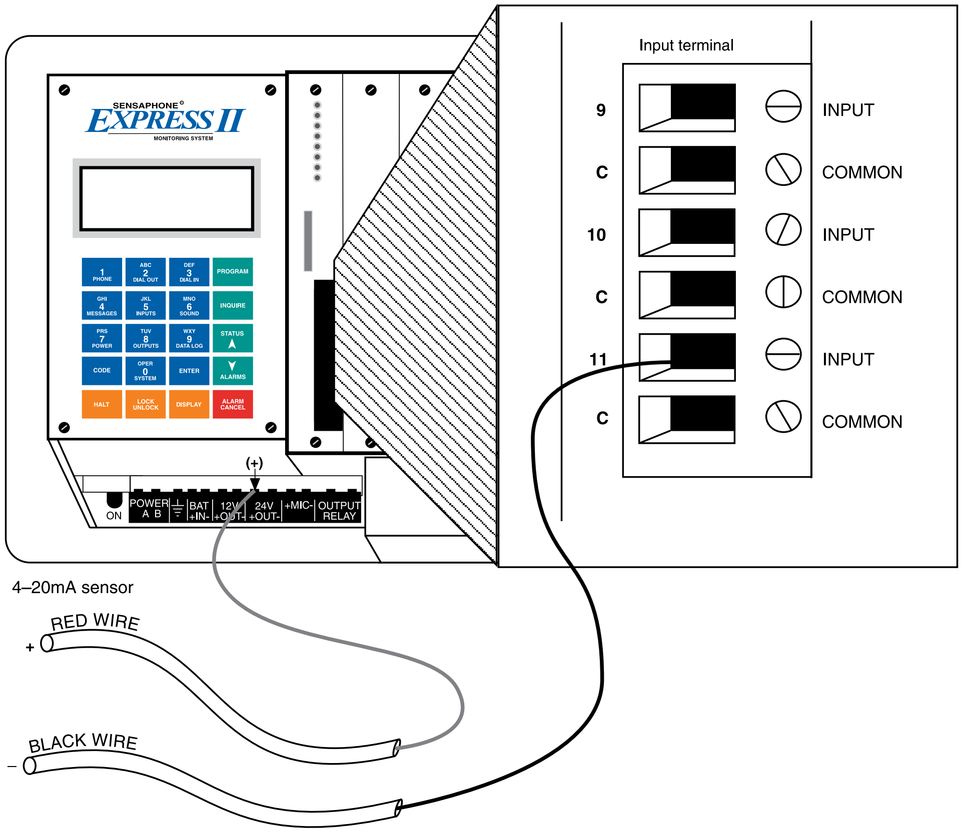


Figure 6: 4–20mA transducer using internal power supply

To use an external power supply, wire the positive lead from the sensor to the positive terminal on the external power source. Wire the negative lead from the sensor to a numbered input screw on Express II. Next, connect the power supply to Express II by wiring the negative terminal on the power supply to the corresponding common screw on Express. See Figure 7.

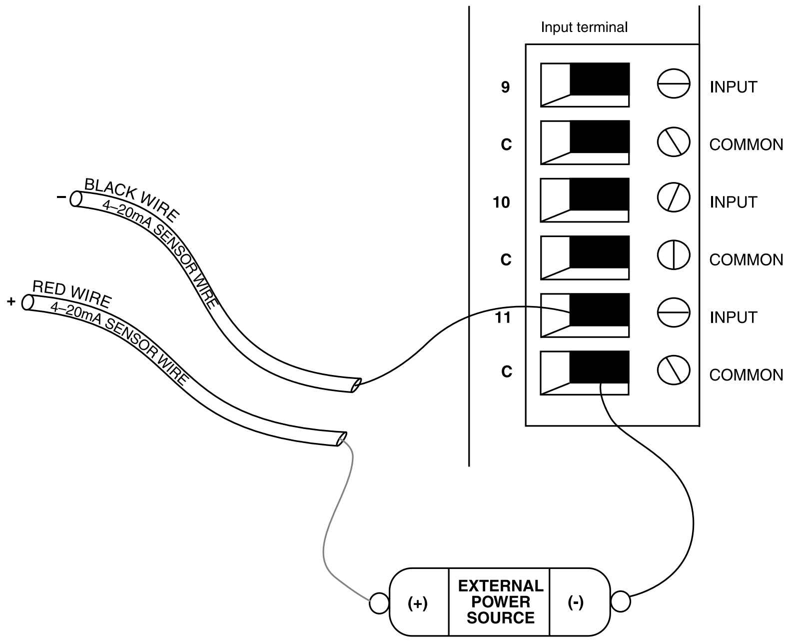


Figure 7: 4–20mA sensor using external power source

To use a 0–5V sensor with Express II, wire the sensor signal lead to a numbered terminal screw on the unit. Then, wire the sensor common to the corresponding common screw on Express II. See Figure 8.

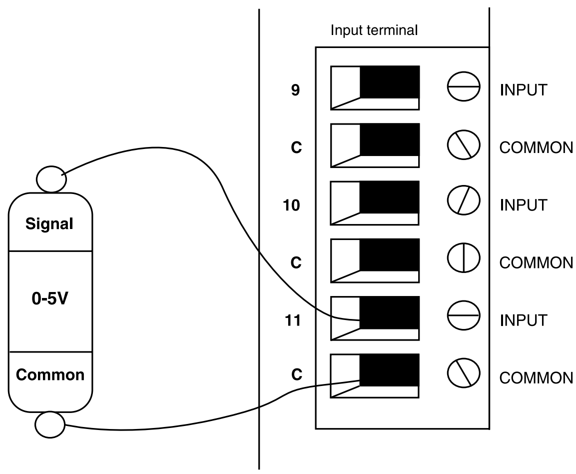


Figure 8: 0–5V sensor

STRAIN RELIEF

Strain relief clamps are provided on the Express II enclosure to prevent wiring from being pulled from the circuit board or damaged when passing through the enclosure. To use the strain relief, thread wires through the clamp and the clear rubber bushing. Position the bushing in the clamp and tighten the screws on either side so that the wiring does not move. See Figure 9 below:

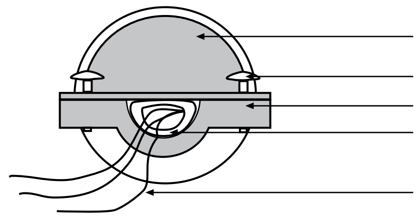


Figure 9: Strain relief clamp

SHIELDED WIRE

Express II is designed to work in most installations without the need for shielded wire. However, this does not apply to wire run outdoors or in conduit that has other noise-generating conductors such as 60 Hz AC. It is strongly recommended that input wiring be run in a conduit separated from AC power or output wiring. When wire runs are long or are in close proximity to large power consuming, power generating or power switching equipment, it is recommended that shielded wire be used.

WIRE LENGTH

Temperature—It is recommended that long wire runs be avoided when using a thermistor as a sensor. A long run of wire could alter the resistance of the circuit therefore providing an inaccurate temperature reading of the input. Below is a chart of recommended gauges and wire lengths:

MIN WIRE GAUGE	MAX WIRE LENGTH
#26	250 ft.
#24	700 ft.
#22	1500 ft.
#20	2500 ft.

Dry contact—The total resistance of the loop cannot exceed 50 Ohms. Use the appropriate gauge wire for your application.

Analog current—Long wire runs will not affect the accuracy of the input because there is constant current being driven through the sensor wire.

Analog voltage—Wire runs should be kept as short as possible to avoid voltage drops and noise susceptibility. Use the gauge chart above as a guideline.

NOTE: All wiring should comply with section 17 of the UL requirements.

INSTALLING INPUT EXPANSION CARDS

To install an input expansion card:

1. Turn the unit off. Damage may occur to the motherboard or to the input card if installed while power is still on.
2. Working from left to right, loosen the thumbscrews and remove the blank plate of the first unused slot. See Figure 10.

   NOTE: Always install cards side by side—do not skip a slot.

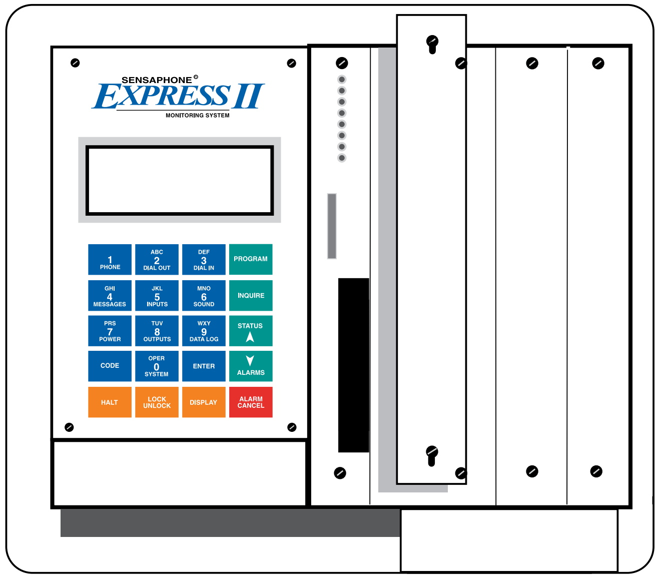


Figure 10: Remove blank plate

3. Hold the card with the LEDs at the top, and line up the DIN connector plug on the card with the DIN connector socket on the motherboard. See Figure 11.

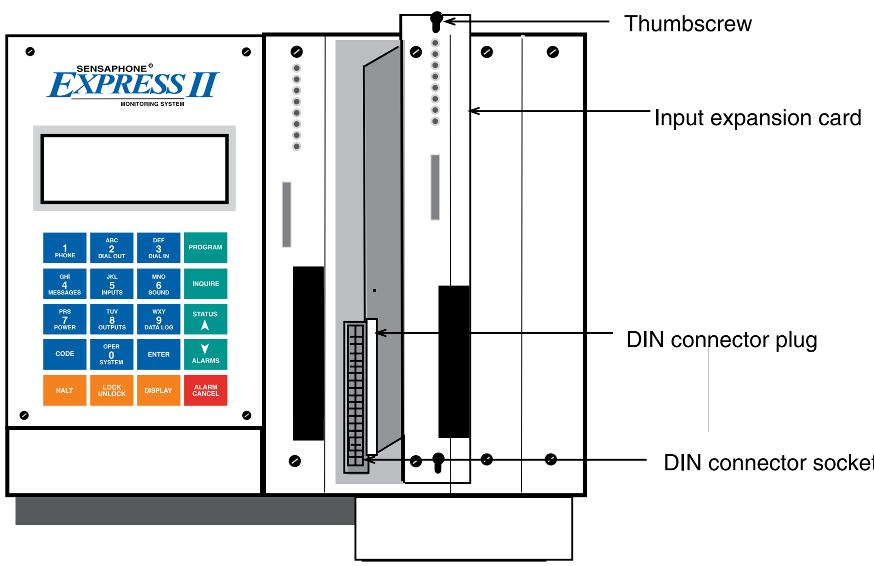


Figure 11: Line up and insert card

4. Insert the DIN connector plug into the DIN connector socket and press down slightly to connect.

5. Re-tighten the thumbscrews.

6. Turn the unit on.

7. Configure and wire the inputs as described in this chapter.

NOTE: When installing a combination of input and output cards, always install the input cards grouped together in the left slots and the output cards to the right of them. If you install an input expansion card after an output card has been installed, you must disconnect the output card, install the input card in its place, and reinstall the output card to the right of it.

INPUT SPECIFICATIONS

Voltage Range:	0 to +5 VDC
Input Resolution:	12 Bit or 0.00122V
A/D Converter Typical Total Unadjusted Error	+ 1 LSB
Accuracy (Temperature)	+1°F typical using 2.8K temperature sensor
Accuracy (4–20mA)	+1.25%
Min/Max Input Voltage	-0.5VDC to +5.5VDC
Max Pulse Frequency	1.0Hz
Noise Filtering	2300Hz low pass filter -20db/Decade

2.8K THERMISTOR LOOK-UP TABLE

DEGREES (Celsius)	DEGREES (Fahrenheit)	RESISTANCE (Ohms)
-50	-58	188.83K
-40	-40	94.47K
-30	-22	49.64K
-20	-4	27.21K
-10	14	15.51K
0	32	9.15K
5	41	7.11K
10	50	5.57K
15	59	4.40K
20	68	3.50K
25	77	2.80K
30	86	2.26K
35	95	1.83K
40	104	1.49K
45	113	1.22K
50	122	1.01K
55	131	0.84K
60	140	0.70K
65	149	0.58K
70	158	0.49K

10K THERMISTOR LOOK-UP TABLE

DEGREES (Celsius)	DEGREES (Fahrenheit)	RESISTANCE (Ohms)
-37	-35	203.60K
-35	-30	173.60K
-32	-25	148.30K
-29	-20	127.10K
-26	-15	109.20K
-23	-10	94.07K
-21	-5	81.23K
-18	0	70.32K
-15	5	61.02K
-12	10	53.07K
-9	15	46.27K
-6	20	40.42K
-4	25	35.39K
-1	30	31.06K
2	35	27.31K
4	40	24.06K
7	45	21.24K
10	50	18.79K
13	55	16.65K
16	60	14.78K
18	65	13.15K
21	70	11.72K
24	75	10.46K
27	80	9.35K
30	85	8.38K
32	90	7.52K
35	95	6.75K
38	100	6.08K
41	105	5.48K
44	110	4.95K
47	115	4.47K
49	120	4.05K
52	125	3.67K
55	130	3.33K
58	135	3.31K
60	140	2.76K
63	145	2.52K
66	150	2.30K
69	155	2.10K
71	160	1.92K
74	165	1.76K
77	170	1.61K
80	175	1.48K
83	180	1.36K
86	185	1.25K
88	190	1.16K
91	195	1.07K
94	200	0.98K
97	205	0.91K

CHAPTER 4: OUTPUTS

Express II comes standard with one on-board relay output. The output capability may be expanded up to 16 relay outputs.

HOW THE OUTPUTS WORK

Relay outputs are used to switch equipment on or off. The 16 expansion outputs can only be operated manually; however, the on-board output may be programmed to operate in two ways: *Manual* or *Auto*.

Manual—When configured as manual, the output may be turned on or off by the user. This may be accomplished using the local keypad or via Touch-Tone™ phone.

Auto—The built-in output (Output Zero) is the only output with the "Auto" option available. When this option is programmed, Output Zero will activate when alarm recognition occurs (LED is blinking red) and will deactivate when the alarm has been acknowledged. (**Note**: the alarm condition may still exist.)

WIRING THE OUTPUTS

The standard on-board relay output, output #0, is located on the orange terminal strip to the far right of the ON/OFF switch (see Figure 12).

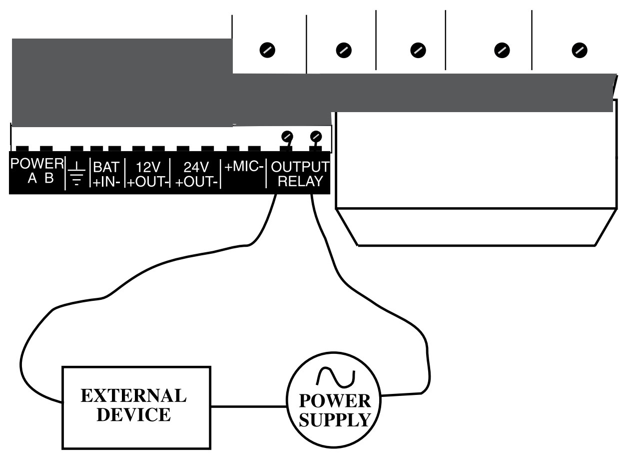


Figure 12: Location of On-board Output relay

It is labeled "Output Relay." It is a single-pole, single-throw, latching relay. See "Outputs" section in Chapter Five for more information.

NOTE: All wiring should comply with section 17 of the UL requirements.

STRAIN RELIEF

Strain relief clamps are provided on the Express II enclosure to prevent wiring from being pulled from the circuit board or damaged when passing through the enclosure. To use the strain relief, thread wires through the clamp and the clear rubber bushing. Position the bushing in the clamp and tighten the screws on either side so that the wiring does not move. See Figure 13.

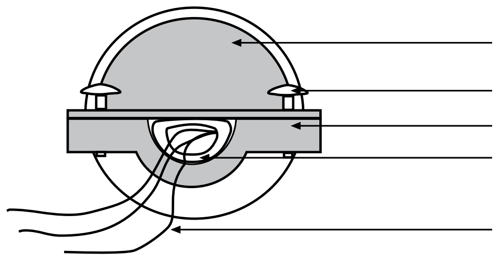


Figure 13: Strain relief clamp

INSTALLING OUTPUT EXPANSION CARDS

To install an output expansion card:

1. Turn the unit off. Damage may occur to the motherboard or to the output card if installed while power is still on.
2. Remove the screws and blank plate of the first available slot from left to right.

   NOTE: Always install cards side by side—do not skip a slot.
3. Hold the card with the LEDs at the top with the DIN connector plug on the card lined up with the DIN connector socket on the motherboard.
4. Insert the DIN connector plug into the DIN connector socket and press down slightly to connect.
5. Turn the unit on.

Wire the outputs for the configuration you want—manual or auto—as described above. See Chapter 5 for programming information.

NOTE: When installing a combination of input and output cards, always install the input cards grouped together in the left slots and the output cards to the right of them. If you install an input expansion card after an output card has been installed, you must disconnect the output card, install the input card in its place, and reinstall the output card to the right of it.

RELAY OUTPUT SPECIFICATIONS

TYPE:	Latching, SPST
Related Load:	2A at 250VAC 2A at 30VDC
Carry Current:	2A
Maximum Operating Voltage:	250VAC 125VDC
Maximum Operating Current:	2A (AC/DC)
Maximum Switching Capacity:	500VA, 60W

CHAPTER 5: PROGRAMMING

Express II features a unique voice-guided, menu-based programming method. Programmable parameters are organized into ten categories, with main menus encompassing several levels of sub-menus. The ten primary categories (designated on Express II's keypad, see fig. 14) are:

1 • PHONE—phone contacts information

2 • DIAL OUT—outgoing communications

3 • DIAL IN—incoming (call-in) communications

4 • MESSAGES—alarm, output and ID message recording

5 • INPUTS—input configuration

6 • SOUND—sound monitoring and listen in

7 • POWER—power failure and battery low monitoring

8 • OUTPUTS—output control setup

9 • DATA LOG—input log and activity log setup

0 • SYSTEM—other system parameters

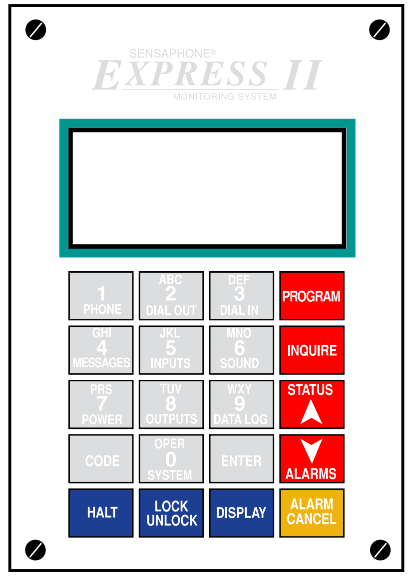


Figure 14: Express II Local Display and Keypad

Programming "How To": Moving Through the Menus

All programming actions begin by pressing the PROGRAM key, followed by one of the primary category keys (listed above).

These two key presses lead directly to Express II's voice guided instructions, accompanied by text selections shown in the local display. From this point, menu selections are made by pressing the number keys, followed by the ENTER key. Press "0" (zero) to exit any numbered-list menu.

The CODE key allows you to navigate between menus during programming. To repeat a menu while programming, press the CODE key once. To return to a previous menu, press the CODE twice.

To return to the main menu at any time, press CODE until the main menu is reached.

You may also make your programming selections using the local display. Each option conveyed through an audible voice message will also be listed as text on the local display. If you press the arrow keys on the keypad, an arrow will appear next to a selection (if it is not already present, as in some selection listings). This arrow can be repositioned next to any of the options by pressing the down arrow on the ALARMS key. To move back up the list, press the up arrow on the STATUS key. When the arrow appears next to your selection, press the ENTER key.

In the demonstrations that follow, each illustrated sequence shows how options are selected from a list, while moving through Express II's multilevel menu system.

Programming PHONE Parameters [1]

The PHONE parameters allow you to program when, how and to which location Express II will dial out during an alarm. Express II is capable of dialing out to 48 different locations.

Phone parameters are divided into two separately-programmed categories—Calling Schedule and Phone Contacts. We'll deal with Communications Type a little later.

1. **Calling Schedule**—the day and time settings during which specified groups of Phone Contacts will be called, in the event of an alarm.
2. **Phone Contacts**—the telephone numbers to which Express II will dial out, in the event of an alarm. Up to 48 telephone numbers can be used, and may include Special Dialing codes.

1. Calling Schedule

Calling Schedule allows you to assign Phone Contacts to specific calling groups to accommodate shift work schedules. Time is measured using the "24 hour" format. There are 3 calling schedules from which to choose. The default is "All," indicating that no grouping of Phone Contacts is in effect and that dial-out will occur around the clock, at all times. Selecting Calling Schedule brings up the following choices:

1. All

This schedule programs Express II to call all the Phone Contacts that are programmed regardless of the time of day, or day of week. This is the default setting. Phone Contacts from 1–48 are called regardless of time, day or day of week

2. Days and Nights

This schedule allows Express II to create two groups for dialing out: a daytime set of Phone Contacts (Monday to Friday), and a night-time/weekend set of Phone Contacts (Friday night to Monday morning).

- Phone Contacts from 1–24 are called during the day (Monday to Friday).
- Phone Contacts from 25–48 are called during the night and weekend.

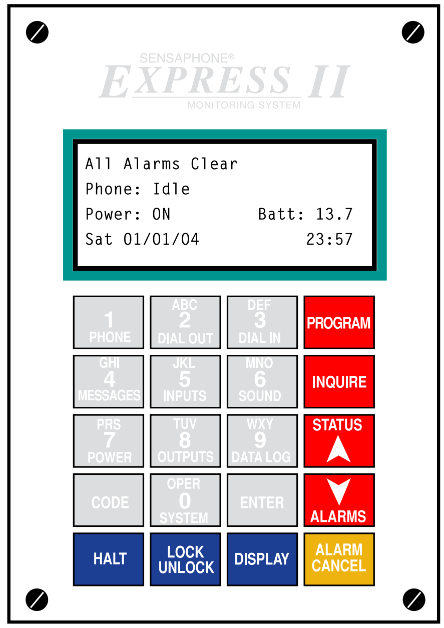


Figure 14a: Express II Local Display and Keypad

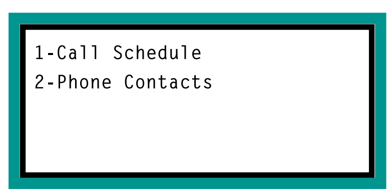
PHONE PARAMETERS

Calling Schedule:

1) Press PROGRAM

2) Press PHONE.

3) A new list appears in the local display.



Press **1** for Call Schedule.

4) A new list appears in the local display.

3. Day, Night, Wknds

This schedule allows you to program Express II to call a set of Phone Contacts during the day (Monday to Friday), a set of Phone Contacts during the night (Monday to Thursday), and a set of Phone Contacts for the weekend (Friday night through Monday morning).

- Phone Contacts from 1–16 are called during the day (Monday to Friday).
- Phone Contacts from 17–32 are called during the night (Monday to Thursday).
- Phone Contacts from 33–48 are called during the weekend (Friday night to Monday morning).

Day and night starting times are separately programmed to control how Express II differentiates day and night periods.

Programming Day and Night Starting Times

If option 2 (Days and Nights), or 3 (Day, Night and Wknds) was selected, then you will be prompted to set the starting times for day hours/minutes and night hours/minutes. After you have separated your Phone Contacts into groups, setting the day and night starting times allows you to define when one shift ends and another begins. This way, dial-out can occur in any 24 hour period, to report an alarm around the clock.

It is important to note that time is programmed using the “24 hour” format: A day hour set to “5” is equal to 5:00 am. A night hour set to “17” is equal to 5:00 pm. The default setting is 7 hours, 0 minutes for day hours, and 19 hours, 0 minutes for night hours.

24-Hour Time: PM Conversion

1:00 pm equal to 13 hours	7:00 pm equal to 19 hours
2:00 pm equal to 14 hours	8:00 pm equal to 20 hours
3:00 pm equal to 15 hours	9:00 pm equal to 21 hours
4:00 pm equal to 16 hours	10:00 pm equal to 22 hours
5:00 pm equal to 17 hours	11:00 pm equal to 23 hours
6:00 pm equal to 18 hours	12:00 pm equal to 24 hours

Select one option:

```
1-All
2-Days and Nights
3-Day, Night, Wknds
```

Press **1** if selecting All.

Press **2** if selecting Days and Nights.

Press **3** if selecting Day, Night, Wknds.

5) If option **2** or **3** is selected, current starting times, first for day, and then for night, will be displayed, along with the option to reset these times.
To keep current settings, just press the ENTER key.

To change settings, use the number keys on the keypad and press ENTER. When Express II says, *“Enter day hours,”* enter the hour (0 to 23); then press ENTER. The new hour will appear in the local display.

```
Current:            7

Enter day hours:
```

When Express II says, *“Enter day minutes,”* enter the minutes (0 to 59); then press ENTER.

```
Current:            Ø

Enter day minutes:
```

2. Phone Contacts

Express II can store up to 48 telephone numbers, with up to 40 digits permitted for each one. These numbers will be dialed in the event of an alarm. Special dialing codes that reflect a pause, pound, asterisk or other similar code may be incorporated into the telephone number as required, to access various phone and beeper systems.

Once you've set the schedule times, choose "2" from the previous menu to select Phone Contacts. Remember that you can program up to 48 phone numbers (contacts); however, if you are using a calling schedule other than ALL, you will have to program those phone numbers in the appropriate group of contact numbers (e.g., Contact numbers 1–24 for day, 25–48 for night & weekend).

Note that all contact numbers in the group will be called in numerical order, *so program the most important numbers first.* If you want someone called regardless of time of day, simply program that phone number in each contact group.

On the "Enter Phone Number Selection" screen, select the contact number you want to program by pressing a number or set of numbers on the keypad, followed by the [Enter] key.

The Express II will then give you a choice between two types of phone calls for it to make.

Communications Type

Express II is capable of dialing out over standard telephone lines in either Voice or Beeper mode. When dialing out in *Voice* mode, Express II will recite the prerecorded alarm message when its outgoing call is answered. The default setting is **Voice**.

When Dialing out in *Beeper* mode, no message will be recited. The Express II delivers a Touch-Tone code message to your beeper or pager. The two choices come up as:

1 - Voice

2 - Beeper

6) Next, current starting times for night hours and night minutes are displayed, along with the option to reset these times. ***To keep current settings, press the ENTER key.***

To change settings, use the number keys on the keypad and press ENTER. When Express II says, *"Enter night hours,"* enter the hour (0 to 23); then press ENTER. (Remember… "19" is the same as 7:00 pm, using a 24-hour system.)

```
Current:                19

Enter night hours:
```

When Express II says, *"Enter night minutes,"* enter the new time; then press ENTER.

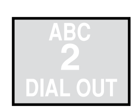
```
Current:                Ø

Enter night minutes:
```

Phone Contacts:

After the Call Schedule has been set, the local display returns to the previous menu.

```
1-Call Schedule
2-Phone Contacts
```

1) Press **2** for Phone Contacts.



2) Allocate a number to each contact, assigning them a position in the calling schedule. Assign phone contact a position number (1–48). Enter the number corresponding to that position

Special Dialing Codes

Special Dialing Codes are commonly used when accessing a beeper or pager system, or in order to reach a dial tone for connection to an outside line. To incorporate a Special Dialing Code into the phone number you are programming, press the blue CODE key, followed by the corresponding number key from the list below. Insert the code or combinations of codes where required in the telephone number.

Code 1
Generates a two second pause.

Code 2
Waits for a dial tone before proceeding.

Code 3
Inserts a "T" command. The voice will say "Tone dial." This is specifically for connection to a beeper from a rotary (pulse) phone line. Type in the phone number for the beeper service, followed by [Code 1] [Code 3] followed by the beeper number and the alarm characters (see Code 5). The "T" code turns all numbers following it into Touch-tones, which the beeper requires.

Code 4
Forces the Express II to wait until the telephone is answered.

Code 5
Sends two digits to appear on the display of a beeper or pager, indicating which input is in alarm.

NOTE: This information must come at the end of the phone number string. (See Example below)

EXAMPLE: At "Enter Phone Number," you would type in: 18005551839 [Code1] [Code1] 5556488 [Code5] [Code6] [Enter]. The first string is the beeper number, followed by two two-second pauses, followed by the Express II's phone number, followed by the Code 5, which is where the number of the first alarm will show up, followed by a Code 6 to "close" the dialing string, followed by "Enter" to end it.

Code 6
Sends the pound (#) , as required in some dialing sequences.

Code 7
Sends the asterisk (*), as required in some dialing sequences.

To *clear* a programmed phone number, select the same priority number you've chosen for that number (Program/Phone Contacts/Phone Number Selection) and simply press "Enter" when prompted to "Enter Phone Number."

using the number keys. Then press the ENTER key.

```
Enter phone number
selection:
```

"Phone number selection" refers to the contact's position number.

(Keep track of the Calling Schedule currently in place, since this determines when a Phone Contact is able to dial out.)

3) When the Phone Contact has been assigned a number value, two choices appear in the local display. Using the number keys, select the appropriate option.

```
1 - Voice
2 - Beeper
```

4) Now that Voice or Beeper mode has been established, the local display prompts you to enter the complete dial-out telephone number. Up to 40 digits are possible, including 1 and the area code, or any Special Dialing codes that are required to reach the target telephone or beeper system.

```
Enter Phone Number:
```

When the complete dial-out telephone number is entered, press the ENTER key.

The local display returns to the previous menu. Repeat steps shown above to program additional Phone Contacts.

To return to the main menu, press CODE twice.

DIAL OUT [2]

The following parameters control how Express II communicates when it dials out for an alarm.

1. Dialing Method—This parameter determines whether Express II will dial out using tone or pulse dialing. The programming choices for this parameter are Pulse, Tone, or Automatic.

Automatic instructs Express II to determine whether to dial out in tone or pulse automatically.

> **NOTE**: You must have a dedicated phone line for Express II to use the Automatic method. If you have Express II installed on an office system that requires dialing an access number to reach an outside line, you MUST program this parameter as Tone or Pulse.

The default setting is AUTOMATIC. The choices under "Dialing Method" are:

1 = Pulse;   2 = Tone;   3 = Automatic.

2. Retries on Busy—This determines how may times Express II will hang up and attempt to recall a phone number when it detects a busy signal. This parameter may be programmed from 0–15. The default is **0**.

> **NOTE**: Each retry applies toward the Maximum number of calls.

3. Message Repeat—When Express II dials out and the call has been answered, this parameter determine s how many times the unit will recite the recorded alarm message per call. This parameter may be programmed from 0 to 10 repetitions. The default is **3**.

4. Maximum Number of Calls—This parameter determines the maximum number of calls Express II will make if the unit does not receive acknowledgment. The maximum calls may be programmed from 0 to 65,535. The default is 100. If the Express II has only one phone number programmed to dial out for a particular alarm, it will limit the maximum calls to 15 regardless of the Maximum number of calls programmed.

5. Call Delay Time—This parameter is the length of time that Express II will wait after an alarm is recognized before it starts the dial out sequence. (Note: This is not the same as input recognition time.)

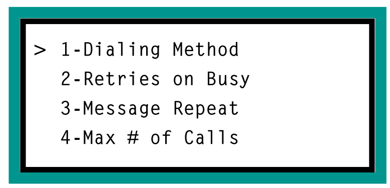
DIAL OUT PARAMETERS

1-Dialing Method:

1) Press PROGRAM.

2) Press DIAL-OUT.

DIAL-OUT menu will then appear on local display.



3) Press **1** for Dialing Method.

Press **1** for Pulse.

Press **2** for Tone.

Press **3** for Automatic.

2-Retries on Busy:

Return to Dial-Out menu.

1) Press **2** for RETRIES ON BUSY.

2) Press the amount of retries desired using the number keys. Press ENTER.

3-Message Repeat:

Return to Dial-Out menu.

1) Press **3** for MESSAGE REPEAT.

The call delay time dictates the delay before the *first* call. To set the delay time between calls, see Intercall Delay Time. This parameter may be programmed from 0 to 12 hours. The default for the call delay time is 30 seconds. During call delay, the unit will announce the message locally.

6. Intercall Delay Time—If an alarm call has not been acknowledged, the intercall delay time is the length of time between each phone call that Express II will wait before dialing the next phone number. This parameter may be programmed from 0 to 12 hours. The default is **30** seconds.

2) Then, enter number of times the message will repeat itself for each call during an alarm.

4-Maximum Number of Calls:

Return to Dial-Out menu.

1) Press **4** for MAXIMUM # OF CALLS.

2) Enter the total number of outgoing calls alloted for an alarm.(prior to acknowledgement)

5-Call Delay Time:

Return to Dial-Out menu.

1) Press **5** for CALL DELAY TIME.

2) Enter Hours.

3) Enter Minutes.

4) Enter Seconds.

6-Intercall Delay Time:

Return to Dial-Out menu.

1) Press **6** for INTERCALL DELAY TIME.

2) Enter Hours.

3) Enter Minutes.

4) Enter Seconds.

DIAL IN [3]

The following parameters determine how Express II will communicate when the unit is called.

1. Rings Until Answer—This parameter determines the number of rings that must occur before Express II will answer. This value can be from 1 to 15. The default is **1** ring.

2. Telephone Answering Device compatibility (TAD)—Express II can be used on the same telephone line that also has a telephone answering device, such as an answering machine, modem or FAX. The TAD feature is especially useful because it integrates the operation of the Express II with your telephone answering device in a way that retains the full flexibility of each system. This allows you to have on-demand telephone access to the Express II, for obtaining a Status Report, or for issuing call-in commands, while your telephone answering device is set to receive outside calls. Programming for use with a telephone answering device (TAD) is always used in conjunction with RINGS UNTIL ANSWER, detailed on this page.

> **NOTE**: The TAD feature only applies to answering devices connected to the same telephone line as the Express II.

USING TAD:

By enabling this feature, you will be able to bypass the answering device and access Express II for a status report or programming. If there are no other devices hooked up to the phone line, this feature should be disabled. The default is **disabled**.

1) Make sure the TAD feature is enabled. The default setting is disabled, so you must enable it initially.
2) Determine the number of rings your telephone answering device uses to answer the telephone. Most answering devices require 4 rings; others are selectable.
3) Program the Express II RINGS UNTIL ANSWER to a greater number than that of the number of rings set on your answering device.

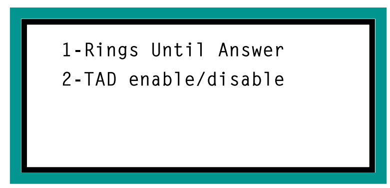
DIAL IN PARAMETERS

1-Rings Until Answer:

1) Press Program.

2) Press DIAL IN.

DIAL IN menu will appear on local display.

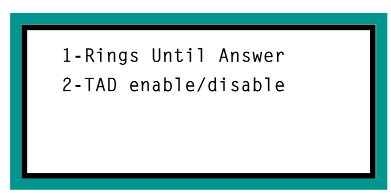


3) Press **1** for RINGS UNTIL ANSWER.
4) Enter the number of rings desired before EXPRESS II answers.(1–15)

NOTE: Read section on TAD before programming RINGS UNTIL ANSWER.

2-TAD enable/disable:

Return to DIAL IN menu.



1) Press **2** for TAD.
2) Press **1** to disable.

   Press **2** to enable.

Example:

Telephone answering device: rings = 4.
Express II: RINGS UNTIL ANSWER = 6.

Calling Express II with TAD Enabled

To have the Express II answer the phone with a Telephone Answering Device on the same line, call the unit's telephone number and let the line ring once, then hang up. Wait several seconds and then call back again. The Express II will answer the line on the first ring, bypassing your answering machine.

Explanation: The pattern of one ring, followed by a second call (within 30 seconds), signals the Express II to answer your incoming call, excluding the telephone answering device.

> **NOTE**: If the Express II unit shares the same telephone line with a Telephone Answering Device, and during certain time periods frequent incoming calls are expected on that line, then you may want to temporarily disable the TAD feature. If you leave the TAD enabled, it will not adversely affect normal operation, but if two outside telephone calls are received within the same 30 second time window, the Express II unit will interpret this pattern as a signal to answer the telephone. If this occurs, press the ALARM/CANCEL key on the unit to hang up.

MESSAGES [4]

Recording your own messages provides a valuable, expeditious communication link between the Express II and service personnel.

Voice messages—Express II allows you to program your own voice for the ID (identification) and dial-out alarm messages. This means that when Express II calls you or someone on your staff during an alarm, your personalized voice message will indicate exactly which alarm condition exists. Depending on what the input is monitoring, you might program a warning message, or provide brief vital monitoring data.

The voice message choices are:

1 - Record ID Message (default length: 10 seconds)
2 - Record Input Message (default length: 5 seconds)
3 - Record Output Message (default length: 5 seconds)
4 - Message length

The **ID Message** allows you to identify the Express II and/or the system it's monitoring as the caller.

The **Input Message** is the alarm message corresponding to each specific input that the Express II is monitoring. You must program this by entering the number of the Input (1–8 on the first card, etc.)to identify it, and then recording the relevant alarm message for it.

The **Output Message** feature can only be used if you've purchased and installed an Output Card in the Express II.

Message length—This parameter determines how many seconds long each message can be. A message can be 5, 7, or 11 seconds long. However, you can cut any message short if you finish recording it, by pressing [Enter].

(Note that the shorter the message length, the better the quality of the recording. We recommend that you program this parameter to 5 seconds for optimum clarity.)

NOTE: Do not change the message length parameter after you have recorded voice messages. If you do so, you will automatically erase all programmed voice messages and reset them to the default.

MESSAGE PARAMETERS

Messages:

1) Press Program.

2) Press Messages.

Messages menu will then appear on local display.

```
> 1-Record ID msg
  2-Record input msg
  3-Record output ms
  4-Message length
```

4) Press **1** to record ID message.

Speak message after beep.

5) Press **2** to record input messages.

Enter the input number to which the message corresponds.

Speak message after beep.

6) Press **3** to record output message.

Enter the output number to which the message corresponds.

Speak message after beep.

7) Press **4** for message length.

Enter **5**, **7**, or **11**.(the default is **5**)

Messages can be cut short by pressing Enter during recording.

INPUTS [5]

Express II comes standard with 8 universal inputs. The input capacity may be expanded up to a total of 40 universal channels. The following parameters determine how each input functions. The parameters apply to both the standard and expanded inputs.

1. Enable/Disable Inputs—This function allows you to enable or disable an alarm on an input to cause a dial out. An enabled input will respond to an alarm and allow dial out. A disabled input will not initiate a dial out if an alarm occurs. The default setting for all inputs is **enabled**.

2. Input Type—Express II's inputs are universal inputs. This means that they may be configured to accept the following type sensors:

- 1 = Normally closed dry contact (digital)
- 2 = Normally open dry contact (digital)
- 3 = Pulse count (counts to 65,535 then resets to zero)
- 4 = 4–20 mA (analog)
- 5 = 0–5 Volts (analog)
- 6 = Temperature (thermistor):
  - 1) 2.8K F thermistor (analog)
  - 2) 2.8K C thermistor (analog)
  - 3) 10K F thermistor (analog)
  - 4) 10K C thermistor (analog)
- 7 = Time accumulator

The default input type is **2** (normally open dry contact)

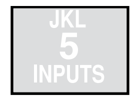
3. Input Recognition Time—The input recognition time is the length of time an input must have an alarm continuously before Express II will recognize the condition. If an alarm is tripped and then clears within the recognition time, it is not recognized as a valid alarm. Express II will not dial out. This feature is useful to prevent dial outs for momentary blips or on self-correcting equipment. Each input can be programmed with a different recognition time. You may program the recognition time from 0 seconds to 12 hours. The default is **3** seconds.

INPUT PARAMETERS

The first step in programming the INPUT parameters is to enter the number of the input for which you intend to program.

1) Press Program.

2) Press Input.



3) Press the input number (1-40).

Press Enter.

The Input menu will then appear on the local display.

```
> 1-enable/disable
  2-Input type
  3-Recognition time
  4-High and Low limits
```

```
> 5-Alarm Reset Time
  6-Dial out Selection
  7-Calibration
  8-Reset Value
```

1-Enable/Disable Inputs:

1) At the Input menu, select Enable/disable by pressing **1** on the keypad. Or, by pressing arrow keys until the ">" symbol, on the local display, is next to Enable/disable.

2) Press **1** to disable.

Press **2** to enable.

2-Input Type:

1) Press **2** at the Input menu, to select Input Type.(or on local display as described in Enable/disable inputs)

A list of Input Types will then appear on the local display.

4. High and Low Limits—Express II allows you to program high and low limits for inputs defined as an analog input type or pulse count. Inputs defined as normally open or normally closed cannot be programmed to have high or low limits. During voice prompted programming, high and low limits will only be prompted when the input is defined as an analog type or pulse count. The limits are -9999 to +9999. Express II defaults to these limits.

> **NOTE**: The Pulse Count Low Alarm Limit is set at -1. You cannot go below zero on a pulse count, but the *Alarm* limit is -1 to be distinct from the possible value of 0. **DO NOT change this Low Limit.**

5. Alarm Reset Time—After an alarm is acknowledged, Express II stops the dial out sequence. However, the alarm condition will still exist until the alarm clears itself or some action occurs to clear the alarm. If the alarm is not cleared after a certain amount of time, Express II can be programmed to restart the dial out sequence. This is called the alarm reset time. This parameter may be programmed from 0 seconds to 12 hours.

Setting the alarm reset time to 0 seconds will disable it. This means that once the alarm has been acknowledged, it will not retrip an alarm regardless of how long it exists. The default for this parameter is **0** seconds.

For example, you program the alarm reset time for input 1 to 2 hours. An alarm occurs on input 1 and Express II dials out. The alarm is acknowledged but the condition still exists. Two hours later, the alarm condition still has not been cleared. Express II will restart the dial out.

6. Dial Out Selection—You may program Express II to dial specific phone contacts according to which input is in alarm. This is the Dial Out Selection. For example, input 6 can be programmed to initiate calling to Phone Contact 1, 3, 4, and 16. Meanwhile, an alarm on input 2 can initiate calling to Phone numbers 2–13. This parameter allows you to have specialized personnel being called only for specific alarms. To return to the default, all contacts, press '9' '9' and then press ENTER.

```
> 1-Normally Closed
  2-Normally Open
  3-Pulse count
  4-4-20mA
```

```
> 5-0-5 Volts
  6-Temperature
  7-Time accumulator
```

2) Key in the appropriate Input type.

(the default is **2**; normally open dry contact)

Press **1** for normally closed.

Press **2** for normally open.

Press **3** for pulse count.

Press **4** for 4-20 milliamp.

-Enter table low limit, press Enter.

-Enter table high limit, press Enter.

Press **5** for 0-5 Volts.

-Enter table low limit, press Enter.

-Enter table high limit, press Enter.

Press **6** for temperature.

-Press **1** for 2.8K° F thermistor.

-Press **2** for 2.8K° C thermistor.

-Press **3** for 10K° F thermistor.

-Press **4** for 10K° C thermistor.

-Press **7** for time accumulator.

3-Recognition Time:

1) Return to Input menu. Press **3** for Recognition Time.

2) Enter hours.

Enter minutes.

Enter seconds.

4-High/Low Limits:

1) Return to Input menu. Press **4** for High/Low Limits.

2) Enter low limit.

Enter high limit.

7. Calibration—This feature works for analog inputs (4–20mA, 0–5 volts, or temperature) only. The default analog setting is 1.000. The calibration feature acts as a multiplier of that value.

Pressing [Program] increases the reading in increments of .01 (hundredths).

Pressing [Inquire] decreases the setting in increments of .01.

Pressing [Status/Up Arrow] will increase it by .001 (thousandths).

Pressing [Alarm/Down Arrow] decreases it by .001.

If, for example, your current temperature is 75° but the Express II is reading 72°, you would recalibrate by pressing the *Program* and/or *Status* keys to raise it. As you'll see if you use this feature, it takes very little increase in the multiplier to raise the value. With the four keys, you can fine tune the calibration to the exact reading you want. When done calibrating, press [Enter] to set.

8. Reset Value—Although both Pulse Count and Time Accumulator inputs have ultimate values (65,535 for Pulse Count; 99:59:59 for Time Accumulator) after which they wrap automatically to zero, you will likely want to reset the count to zero before that value is reached. Selecting the Reset Input Value and pressing [Enter] clears the values to zero.

NOTE: Each input's set of parameters can be programmed independently of the other inputs. But the input number must be entered before programming the parameters.

5-Alarm Reset Time:

1) Return to Input menu. Press **5** for Alarm Reset Time.

2) Enter hours.

   Enter minutes.

   Enter seconds.

6-Dial Out Selection:

1) Determine the Dial Out Selection for each input before you begin programming.

2) Return to Input menu. Press **6** for Dial Out Selection.

3) Enter list of dial out selection.

   Press individual position numbers. (1-48)

   Press Enter.

4) When all position numbers in list are entered, press Enter again.

5) The default is all contacts.

   Press "**9**" "**9**" for the default.

7-Calibration

1) Determine that the input you want to calibrate is one of the analog types.

2) Using the Program and Status keys to increase the value, and Inquire and Alarms to decrease it, adjust the value of your input until it reads correctly.

3) Press Enter to set this value.

8-Reset Value

1) Select an input. Determine that it is either Pulse Count or Time Accumulator. Press Enter.

2) Press "**8**." Press Enter. The value is returned to "**0**".

SOUND [6]

Express II allows you to listen to sound levels through its built-in microphone when you call in for a status report. Express II also monitors the sound levels through its built-in microphone. When the current sound level suddenly exceeds the normal sound level, Express II can be programmed to dial out with a high sound alarm.

1. Listen-in Time—The listen-in time is the amount of time you can listen to sounds at the microphone site when you call in for a status report. The programming range is from 0 to 255 seconds. The default time is **15** seconds.

2. Enable/disable Sound Monitoring—This parameter determines whether Express II will initiate the dial out sequence if it detects a high sound. If the sound is enabled, Express II will dial out. If the sound is disabled, Express II will not dial out for high sound. 1 = enabled; 0 = disabled. The default is **enabled.**

3. Sound Sensitivity—This parameter allows you to change the sensitivity of the sound monitoring. This may be useful to desensitize Express II if it is installed in an area with relatively high sound level, or where loud noises occur but are not associated with an alarm. Also, this feature allows you to increase sensitivity in situations where you want to monitor lower sound levels. The sensitivity range for sound alarm monitoring is 1 to 100. A value of 1 is the most sensitive; 100 is the least sensitive. The default is **50**.

4. Sound Recognition Time—The sound recognition time is the length of time that a high sound condition must exist continuously before Express II will recognize the condition. If the high sound stops before the recognition time is up, it is not recognized as a valid alarm. Express II will not dial out. This feature is useful to prevent dial outs for momentary occurrences of high sound. You may program the recognition time from 2 seconds to 1 minute. The default is **8** seconds.

SOUND PARAMETERS

1) Press Program.

2) Press Sound.

The Sound Parameters menu will then appear on the local display.

```
> 1-Listen in time
  2-Sound Monitoring
  3-Sound sensitivity
  4-Recognition time
```

```
> 5-Alarm Reset time
  6-Sound selection
  7-Mute Local Spkr
```

1-Listen-in Time:

1) Press **1** for Listen-in Time.

2) Enter seconds. (0-255)

2-Sound Monitoring:

1) Press **2** for Sound Monitoring.

2) Press **1** to enable.
Press **0** to disable.

3-Sound Sensitivity:

1) Press **3** for Sound Sensitivity.

2) Enter value. (0-100)

4-Recognition Time:

1) Press **4** for Recognition.

2) Enter hours.
Enter minutes.
Enter seconds.

5. Sound Alarm Reset Time—After a sound alarm is acknowledged, Express II stops the dial out sequence. However, the high sound condition will still exist until the alarm clears itself or some action occurs to clear the alarm. If the high sound is not cleared after a certain amount of time, Express II can be programmed to restart the dial out sequence. This is called the sound alarm reset time. This parameter may be programmed from 2 seconds to 12 hours.

If the alarm reset time is programmed to 0 seconds, the feature is disabled. Express II will not restart the dial out regardless of how long the alarm exists.

6. Sound Dial Out Selection—You may program Express II to dial specific phone contacts if a high sound alarm occurs. This is the Sound Dial out selection. To return to the default, all contacts, press "9" "9," and then press ENTER.

7. Mute Local Speaker—When the Express II detects an alarm, it announces the alarm locally for the duration of the Call Delay. If the Mute Local Speaker is enabled, it is silent for that time period. The default is **Disabled**.

5-Alarm Reset Time:

1) Press **5** for Alarm Reset Time.
2) Enter hours.
   Enter minutes.
   Enter seconds.

6-Dialout Selection:

1) Return to the Sound Parameters menu. Press **6** for Dial Out Selection.
2) Enter the position numbers, (1-48), of the phone contacts to be called in the event of a high sound level alarm.
3) Enter list of dial out selection.
   Press individual position numbers. (1-48)
   Press Enter.
4) When all position numbers in list are entered, press Enter again.
5) The default is all contacts.
   Press "**9**" "**9**" for the default.

7-Mute Local Speaker:

1) Press **7** for Mute Local Speaker at the Sound menu.
2) Press **1** to disable.
   Press **2** to enable.

POWER [7]

Express II monitors AC power failure and low battery condition. Power monitoring and low battery monitoring is explained below.

1= AC Power

2= Battery

Power Failure

1. Power Failure Monitoring enable/disable—This command enables or disables the power failure detection. When enabled, Express II will monitor power and dial out if a valid failure occurs. When disabled, Express II will not dial out for a power failure. 1 = disable, 2 = enable. The default is **enabled**.

2. Power Recognition Time—The power recognition time is the length of time that a power failure must exist continuously before Express II will recognize it as an actual alarm and initiate the dial out sequence. Power recognition time may be programmed from 0 seconds to 12 hours. The default is **5** minutes.

3. Alarm Reset Time—After power failure is acknowledged, Express II stops the dial out sequence. However, the power failure condition will still exist until power is restored. If the power is not restored after a certain amount of time, Express II can be programmed to restart the dial out sequence. This is called the alarm reset time. This parameter may be programmed from 0 seconds to 12 hours.

If the alarm reset time is programmed to 0 seconds, the feature is disabled. Express II will not restart the dial out regardless of how long the alarm exists.

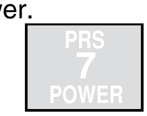
4. Dial Out Selection—You may program Express II to call a specific set of Phone Contacts for power failure only. This is called the *Dialout Selection.* To return to the default setting, all contacts, press "9" "9," and then press ENTER.

POWER PARAMETERS

AC POWER

1) Press Program.

2) Press Power.



3) Power menu will appear. Press **1** for AC Power Parameters.

The AC Power menu will then be displayed.

```
> 1-Failure monitor
  2-Recognition time
  3-Alarm reset time
  4-Dialout Selectn
```

1-Power Failure Monitoring:

1) At the AC Power menu press **1** for Failure Monitor.

2) Press **1** to disable.

Press **2** to enable.

2-Power Recognition Time:

1) Press **2** at the AC Power menu.

2) Enter hours.

Enter minutes.

Enter seconds.

3-Alarm Reset Time:

1) Return to the AC Power menu. Press **3** for Alarm Reset time.

2) Enter hours.

Enter minutes.

Enter seconds.

4-Dialout Selection:

1) Press **4** at the AC Power menu for Dial Out Selection.

2) Enter the list of position numbers, (1-48), for those contacts to be dialed by Express II in the event of AC Power Failure. (Failure monitor must be *enabled*.)

Battery Low

1. Battery monitoring enable/disable—This command enables or disables the battery low detection. When *enabled*, Express II will monitor battery condition and dial out if it becomes low. When *disabled*, Express II will not dial out for a battery low condition. The default is **disabled**.

2. Alarm reset time—After battery low condition is acknowledged, Express II stops the dial out sequence. However, the low battery condition will continue to exist until it is recharged. If the battery is not recharged after a certain amount of time, Express II can be programmed to restart the dial out sequence. This is called the *alarm reset time*. This parameter may be programmed from 0 seconds to 12 hours.

If the alarm reset time is programmed to 0 seconds, the feature is disabled. Express II will not restart the dial out regardless of how long the alarm exists.

3. Dial Out Selection—You may program Express II to call a specific set of Phone Contacts for battery low only. This is called the *Dialout Selection*. To return to the default, all contacts, press “9” “9,” and then press ENTER.

3) Enter list of dial out selection.

Press individual position numbers. (1–48)

Press Enter.

4) When all position numbers in list are entered, press Enter again.

5) The default is all contacts.

Press “**9**” “**9**” for the default.

BATTERY

1) Return to the Power menu. Press **2** for Battery Parameters.

The Battery menu will then be displayed.

```
> 1-Battery monitor
  2-Alarm reset time
  3-Dialout Selectn
```

1-Battery monitor:

1) Press **1** for Battery monitor at the Battery menu.

2) Press **1** to disable.

Press **2** to enable.

2-Alarm reset time:

1) Return to the Battery menu. Press **2** for Alarm Reset Time.

2) Enter hours.

Enter minutes.

Enter seconds.

3-Dialout selection:

1) Press **3** for Dial Out Selection at the Battery menu.

2) Enter the list of position numbers, (1-48), for the phone contacts to be dialed by Express II in the event of Battery Failure.(Battery monitor must be *enabled*.)

3) Enter list of dial out selection.

Press individual position numbers. (1-48)

Press Enter.

4) When all position numbers in list are entered, press Enter again.

5) The default is all contacts.

Press “**9**” “**9**” for the default.

OUTPUTS [8]

Up to 16 outputs may be installed in Express II.

1. Manual—This type of output is turned on/off manually by the user. It is available only if you purchased an output card for the Express II. These cards look no different than the Input cards you can add and are installed the same way.

2. Auto-any alarm—Output #0, which comes built into the unit, can be switched on automatically when alarm recognition occurs, and off again when the alarm is acknowledged. The condition causing the alarm may still exist, but the auto-alarm will be off. *(See Figure 11 for location of this Output Relay.)*

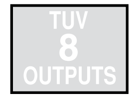
Outputs may be useful if you want to have equipment hooked up to the Express II. For instance, if the unit is monitoring temperature in a particular environment, you might have a fan or heater hooked up to an output, which you could switch on over the phone if the temperature exceeded prescribed parameters.

See Chapter Four for more information on Outputs.

OUTPUT PARAMETERS

1) Press Program.

2) Press Output.



3) Enter output number (0-16).

4) Press **1** for manual.

Press **1** for OFF.

Press **2** for ON.

5) Press **2** for automatic-any alarm. *Only for output # 0.*

DATA LOG [9]

Express II has two logging features, the Input Log and the Activity Log. The Data Log features require the use of a printer with a serial port. If either data log is enabled, Express II will send information to the serial port to be printed via the RS232 socket located to the right of the phone jack and above the orange terminal block at the bottom of the unit *(optional cable required)*.

1. Input/Output Log—Logs the input (or output) values on a user-defined basis. The menu offers four choices:

1. Enable/Disable: 1=disable; 2=enable

2. Time between logs: set the hours, minutes, and seconds. The minimum allowed time is 5 seconds; the maximum is 12 hours, 59 minutes, 59 seconds.

3. Number of inputs: the maximum this can be set to is 40.

4. Line length: this determines the number of characters that a data log printout will allow on each line. The default setting is 80 characters per line. Check your printer setup before changing this number.

2. Activity Log—Logs limited system and alarm activity. This includes alarms occurring and clearing, acknowledgments, any call-ins to the unit and alarm dial-outs.

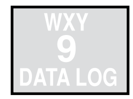
NOTE: Once datalogging is enabled, the system will automatically default to an RS232 rate of 9600 baud. If your target printer is not configured to 9600 baud, refer to your printer manual to adjust the printer's baud rate. (See also "Unit configuration" in the following section.)

DATA LOG PARAMETERS

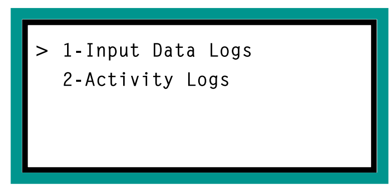
1-Input/Output Log:

1) Press Program.

2) Press Data Log.



Data Log menu will appear on local display.



3) Press **1** for Input/Output Log.

4) Press **1** for Enable/Disable.

Press **1** to Disable; **2** to Enable

5) Press **2** Time Between Log.

Enter hours, minutes, seconds.

6) Press **3** for Number of Inputs.

Enter the number of inputs to be monitored.

7) Press **4** for Line length.

Enter number of characters you want per line in your printout.

2-Activity Log:

1) Return to the Data Log menu.

Press **2** for Activity Log.

2) Press **1** to disable.

Press **2** to enable.

SYSTEM [0]

The following parameters determine the functioning of various system features.

1. Password—The password is a security feature that you may program to prevent unauthorized access to Express II's programming. The password may be any combination of up to 6 digits.

2. Date and Time—Setting the current date and precise time is critical for operation of various features of the Express II. For example, to make proper use of the alarm calling schedule and any data logging, the unit Clock must be set.

3. Acknowledgment Code—(default: 555) The acknowledgment code is the number, up to 6 digits, you enter when you acknowledge an alarm using a Touch-Tone phone. This code is also used when you call Express II back using a Touch-Tone phone to acknowledge an alarm. **NOTE**: This code cannot be used from a pulse (rotary) phone.

4. Halt Mode Delay time—Halt mode allows you to disable all inputs and prevent dial out for a user-programmed time. Halt mode is useful if you must perform periodic tests or other activities that would trip false alarms and initiate dial out. Halt mode can be programmed from 0 seconds to 12 hours.

> **NOTE**: If you program the halt mode time to zero, the halt mode feature is disabled. The default is 1 hour.

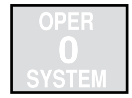
5. Callback Acknowledgment—This feature determines whether you can simply call Express II back to acknowledge an alarm or if you must also enter the acknowledgment code. When callback acknowledgment is enabled, you may acknowledge an alarm from either a pulse or Touch-Tone phone. No code needs to be entered. After receiving the alarm call, you just call the unit back. When callback acknowledgment is disabled, you must use a Touch-Tone phone to acknowledge the alarm by entering the acknowledgment code, or else acknowledge the alarm locally.

> Note that with Callback enabled, the unit will not answer until the phone has rung **10** times, regardless of what number of rings the alarm feature is set to. (See also "Unit Configuration" below.)

SYSTEM PARAMETERS

1) Press Program.

2) Press System.



3) System menu will be displayed.

```
> 1-Password
  2-Date and time
  3-Acknwldgment code
  4-Halt mode delay
```

```
> 5-Callback ackn
  6-Call cancel
  7-Auto test
  8-Unit reset
  9-Unit configure
```

1-Password:

1) Press **1** to program password.

2) Enter password.(up to 6 digits)

The default is no password.

2-Date and time:

1) Press **2** to set Clock.

2) Enter: day, month, year, hours, minutes, seconds, and day of the week.

3-Acknowledgment code:

1) Press **3** for Acknowledgment Code.

2) Enter code. (6 digits; the default is "555")

4-Halt mode delay time:

1) Press **4** for Halt Mode Delay Time.

2) Enter minutes.

5-Callback acknowledgment:

1) Press **5** for Callback Acknowledge.

2) Enter **1** to enable.

Enter **0** to disable.

6. Call Cancel—This feature determines whether or not Express II will continue dialing out for an alarm after the alarm has physically cleared.

When Call Cancel is enabled, Express II will stop dialing out when the alarm clears, even if the alarm has not yet been acknowledged. When Call Cancel is disabled, Express II will continue dialing out for the alarm until it receives acknowledgment, even if the alarm clears in the meantime.

7. Auto Test—This feature allows you to simulate an alarm on an input to test the dial out procedure. When you call Auto Test, it will ask you to specify an input number to test.

> **NOTE**: Auto Test will make actual phone calls to the Phone Contacts using the specifications you programmed. You must acknowledge the alarm as if it were real.

Also, the Auto Test feature will not work if “Call Cancel” is enabled (see #6 above).

8. Unit reset—Generally for factory use, the Unit Reset feature will reset the various unit parameters you’ve programmed in. Should you want to reset the unit, enter a reset code of “159,” and press Enter. Choose from Full Reset, Programming Reset, or Voice Reset.

> **Note**: only “Voice reset” offers options. Selecting the other two will clear system parameters.

9. Unit configuration—The Unit Configuration menu offers you three choices:

> **1 - RS232 Rate** (default: 9600 baud): This is the baud rate for the RS232 port to which you would connect a printer. Its default setting is 9600 baud. You can reset it in a range from 1200 to 38,400.
>
> **2 - Callback Rings** (default: 10): As mentioned under the “Callback Acknowledgment” section above, the Express II will not answer your call to acknowledge an alarm until the phone has rung ten times. This is the default setting. If you wish, you can change that number here.
>
> **3 - Ack over voice** (default: disabled): This feature, when activated, allows you to punch in a code number of “555” while the unit is speaking to cut off the message. This is a factory testing feature and in practice is not a dependable override. Generally it should be left disabled. (See Chapter 5: System, Acknowledgement Code for more information on setting the code number.)

6-Call Cancel:

1) Press **6** for Call Cancel enabling.

7-Auto Test:

1) Press **7** for Auto Test.
2) Enter input number.
3) Press Enter.

   Note that *Call Cancel* and *Auto Test* are mutually exclusive.

8-Unit Reset:

1) Press **8** for Unit Reset
2) Full reset: “Enter” clears everything.

   Programming reset: clears programming settings you’ve entered and returns them to the defaults.

   Voice messages reset: resets individual expansion card messages and/or the voice ID message.

9-Unit Configure:

1) Press **9** for Unit configuration. Choose from:

   RS232 rate: Set this rate from 300–38,400 bauds

   Callback rings to answer: choose a new number if you don’t want 10.

   Ack over voice: choose from disabled/enabled.

SECURITY

Express II allows you to lock the keyboard using the system password to prevent unauthorized personnel from making programming changes using the keypad or via Touch-Tone phone. Inquiry, status and alarm reports may be obtained without the password.

The keyboard may only be locked locally using the keypad. You cannot lock the keypad remotely via Touch-Tone phone.

When programming locally, you must unlock the keypad if it is locked, and relock when finished.

When programming remotely via Touch-Tone phone, you must enter the password to access the programming. The keypad remains locked locally.

SECURITY PARAMETERS

To Lock:

1) Press Program.

2) Press Lock/Unlock key.

3) Enter System password.

4) Express II will indicate:

"Locked" or "Unlocked" in a voiced response.

To Unlock:

REPEAT LOCK INSTRUCTIONS

NOTE: Programming is allowed only when the keyboard is Unlocked. System Inquiry will not include password.

CHAPTER 6: OPERATION

After installation and programming is completed, the Express II is fully operational. This chapter explains the sequence of events that occur during an alarm dialout to illustrate how the Express II operates.

Alarm Detection, Dial-out and Acknowledgment

Generally, an alarm event is structured in the following manner:

I. Express II detects a change at the sensor.
II. A valid alarm is recognized.
III. Dial-out begins.
IV. The alarm is acknowledged.

Often, an alarm does not proceed through all stages: either an alert condition does not persist long enough to be considered valid, or a valid alarm is cancelled.

The following table explains the alarm detection, dial-out and acknowledgment features and lists important variable factors affecting their operation.

I. Express II Detects a Change at the Sensor	Variable Factors	Indicator Light
• Express II detects a change in the monitored condition (from the sensor wired to one of the inputs). This is considered an *alert condition*, and does not qualify as a valid alarm at this point. • The condition continues throughout the programmed Recognition Time. If the condition (or sensor) reverts to its normal state before the Recognition Time is reached, no alarm will occur.	*Input Type and Configuration* *Recognition Time: Activated*	*Changes from steady green to blinking green*

II. A Valid Alarm is Recognized	Variable Factors	Indicator Light
• The condition must persist long enough to meet or exceed the programmed Recognition Time. When Recognition Time has expired, (or if set to zero), and the alarm condition continues, the Express II will determine that a valid alarm exists. • When a valid alarm is determined, Call Delay is activated (if not set to zero), forcing the Express II to wait for a programmed period of time before starting the dial-out process. Call Delay applies to the period just prior to dial-out, before the first telephone call is made. • Call Delay provides the opportunity to cancel a valid alarm at the Express II's installation site, before dial-out occurs. An audible voice message indicates which of the inputs is in alarm. If on-site personnel acknowledge the alarm within the Call Delay time, the Express II will not dial out. (Local Voice Mute is disabled, so that alarm messages can be heard at the site.)	*Recognition Time: Expired* *Valid Alarm: Esists* *Call Delay: Activated* *Alarm Message: Audible, On-site Activated* *Local Voice Mute: Disabled*	*Changes from blinking green to blinking red.*

III. Dial-out Begins	Variable Factors	Indicator Light
• The dial-out process is activated as soon as the Call Delay time expires (if the alarm has not been cancelled at the Express II's installation site.) The dial-out begins with the first selected telephone number, and proceeds sequentially, through the remaining telephone numbers listed in the dialout selection.	*Call Delay: Expired*	*Red light continues blinking*
• Call Progress, an automatic feature, enables the Express II to detect whether or not the telephone call is answered. After 10 rings, or if a busy signal is encountered, the Express II will hang up, wait the programmed Intercall Time, and proceed to dial the next telephone number.	*Call Progress: Activated*	
• When the telephone is answered, the Express II will immediately begin reciting a message that indicates which of the inputs is in alarm. The Express II will request acknowledgement, if it has not yet occurred.	*Alarm Messages: By Telephone*	
• When the telephone is answered, the programmed Voice Repititions determine the number of times per call the Express II recites the alarm message.	*Voice Repititions: Activated*	
• If the alarm is not acknowledged with the first dial-out telephone call, the Express II waits the duration of Intercall Time before dialing the next telephone number. Intercall Time is the programmed waiting period in between each dial-out telephone call.	*Intercall Time: Activated*	
• If no telephone calls are answered, the Express II dials out sequentially, through the remaining telephone numbers and continues to cycle until the programmed Maximum Number of Calls is reached.	*Max Calls: Activated*	*Red light continues blinking*

IV. The Alarm is Acknowledged	Variable Factors	Indicator Light
• At any time after a valid alarm is determined, the alarm may be acknowledged at the Express II's installation site, by pressing ALARM CANCEL.	*Local, On-site Acknowledgment*	*Red light blinks until alarm is acknowledged*
• When the Express II dials out and the call is answered using a Touch-Tone telephone, it may be instantly acknowledged by pressing "555" (the default code) or by entering a programmable code.	*Touch-Tone Acknowledgment: Default Code 555*	
• The alarm message repeats for the number of programmed Voice Repetitions. If "555" has been entered, the Express II will say: *"OK."* The alarm is considered acknowledged and the dialout will stop. (If the alert condition continues to exists, then Reset Time may reactivate the dial out process—refer to "Alarm Reset Time" sections of Chapter Five.)	*Touch-Tone Acknowledgment: Default Code 555*	
• If the Express II does not receive the Touch-Tone code, it recites the following: *"No Acknowledgment."*		
• After the acknowledgment period, it says: *"Press any key for unit activity."* If a key is pressed, the unit enters command mode. If no key is pressed it will hang up.		
• The recipient of this message must call the Express II back within the period programmed for Intercall Time, in order to acknowledge the alarm. If local voice mute is off, the unit will beep at the installation site while waiting for this call.	*Tone or Pulse Callback Acknowledgment: Within Intercall Time*	

IV. The Alarm is Acknowledged	Variable Factors	Indicator Light
• Callback: The Express II waits 10 rings before answering to guard against random acknowledgment. If an answering device is connected to the same line as the Express II and TAD is enabled, the Express II will answer on the first ring. Once answered, the Express II will recite a status report and say: *"Have a good day."*	*Tone or Pulse Callback Acknowledgment: TAD Enabled*	*Red light blinks until alarm is acknowledged*
When the Express II hangs up, the alarm is acknowledged and dial-out stops (unless Alert Conditions still exist—see Reset Time, below).		*Changes from blinking red to steady red if acknowledged and alert condition still exists.*
• If calls remain unanswered, or if they are received by an answering machine or FAX, the Express II continues the dialout sequence; it waits the Intercall Time and proceeds to dial the next telephone number. Telephone numbers are dialed sequentially, and this cycle continues for the number of Max Calls programmed. If no acknowledgment occurs, then at the completion of Max Calls, the alarm is automatically acknowledged and the dial-out process stops (unless Alert Conditions still exist—see Reset Time below).	*Max Calls Acknowledgment*	
• If an alarm is acknowledged by telephone or at the local keypad, yet the alert condition continues to exist, the Express II will reactivate the dialout process, following a programmable waiting period, or Reset Time.		*Changes from steady red back to blinking red when Reset Time reactivates dialout.*
If Reset Time is set to zero, the dialout process will not be repeated for that alarm.	*Reset Time*	*Changes from blinking red to steady green when alarm is acknowledged and alert condition no longer exists.*

CHAPTER 7: OTHER KEYPAD FUNCTIONS

INQUIRING:

The same menu system that is used for programming the Express II is also used to verify programming. To check the programming of a particular parameter, just follow the same steps as if programming, except start with the INQUIRE key *instead of* the PROGRAM key. The Express II will prompt you with the same menu choices as if you were programming until you have reached the desired information. Express II will “speak” the programming parameters and display them at the same time. You can also:

Inquire Status:

General status information can also be requested from the keypad. If you press INQUIRE and then STATUS, the Express II will first give you information from internal functions on power, battery and sound levels, then ask what else you want status information from. You will be given four choices:

1-Input Status
2-Output Status
3-Mic Listen In (valid only remotely)
4-Dump Programming

1–2 - Input/Output Status: If you choose Input or Output Status the Express II will ask you for an input or output number or have you press “**9**” “**9**” to hear the status of all inputs or outputs.

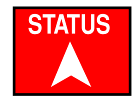
3 - Mic Listen In: Allows you to listen in to sounds on site through the Express II’s microphone.

4 - Dump Programming: Dumps all the program settings to a printer for recording. Remember that you must have a printer with a serial port connected to the Express II in order to use this feature *(optional cable required)*. It is useful if you wish to clear and reprogram the unit or to have a printed record of settings.

Inquiring:

1) Press Inquire.

2) Press Status



3) The Express II will read off current power and sound settings, and then display a menu of choices:

```
> 1-Input Status
  2-Output Status
  3-Mic Listen in
  4-Dump Programming
```

4) If you select **Input status** or **Output status**, the Express II will ask you to select a specific input/output, or else choose all of them by pressing “**9**” “**9**”.

5) **Mic Listen In** is useful if you need to hear on-site sounds, and activates the Express II microphone.

6) **Dump Programming** is useful only when a printer with a serial port is connected to the Express II. It does not reset or clear settings. For that, consult “System” in Chapter 5.

Inquire Alarms:

To check alarm information, press INQUIRE and then ALARMS. If there are any unacknowledged alarms, the Express II will recite which input alarms have not been acknowledged. Otherwise it will tell you that no alarms are active.

Halt Mode Delay Time

Halt mode allows you to disable all inputs and prevent dial-out for a user-programmed time. Halt mode is useful if you must perform periodic tests or other activities that would trip false alarms and initiate dial out. The Input lights will flash red for the duration. Halt mode can be programmed from 0 seconds to 12 hours.

To initiate Halt mode press the orange HALT button. To exit Halt mode press ALARM CANCEL.

> **NOTE**: If you program the halt mode time to zero, the halt mode feature is disabled. The default setting is **1** hour.
>
> (See also "Halt mode delay time" as part of the System programming section of Chapter Five.)

Inquire Alarms:

1) Press Inquire

2) Press Alarms

Halt Mode Delay Time:

1) Press Halt

To Exit Halt mode, press Alarm Cancel.

CHAPTER 8: REACHING EXPRESS II BY TELEPHONE

Express II is at your disposal whenever you need it—no matter where you are. And it's as easy as dialing your telephone! All you need is your Express II's phone number and a Touch-Tone phone.

Simply follow these first steps to reach Express II's built-in, voice-guided system. The voice-guided system comprises a main menu and proceeding sub-menus. It works much the same as when you are programming Express II. The only difference is that you use the telephone dial pad in place of the Express II keypad.

Phone-in Parameters:

Dial the phone number of your Express II unit.

Express II will pick-up and "say":

"Hello, this is... *(programmed ID message that you record)*"

Enter Password (if you programmed one)

" Press 1 for Status."

" 2 for Alarm."

" 3 to Inquire Programming."

" 4 to Change Programming."

" 5 to Exit."

The Main Menu:

"Press 1 for Status."
The response for this function is the same as the response to [Inquire] [Status] at the local keypad. (See Chapter 7)

"2 for Alarm."
The response for this function is the same as the response for [Inquire] [Alarm] at the local keypad. (See Chapter 7)

"3 to Inquire Programming."
Press 3 for a list of the 10 programming categories (See the primary menu categories in Chapter 5). Once a category is chosen, the menus and responses are identical to those if you were inquiring a programming parameter status at the local keypad.

"4 to Change Programming."
Press 4 for a list of the 10 programming categories. (See the primary menu categories in Chapter 5) Once a category is chosen, the menus and responses are identical to programming at the local keypad.

"5 to Exit."
Press 5 and the unit will respond, "Have a good day!" The unit will then hang up.

Special Keys:

Press the "star" button (*****) once to repeat the current menu.

Press the "star" button (******) twice to repeat the previous menu.

Use the "pound" button (**#**) as the Enter key.

Notes regarding uses of the "Star" Button[*]: During the programming of Phone Contact Numbers, the "Star" [*] button is the Code Key—i.e., for Code 1 you would press "*1." If, on the other hand, you are inputting analog tables or alarm limits, if you press the "star" button [*] **before** a digit, it acts as a minus [-] sign; if you press the "star" button[*] **after** a digit, it acts as a decimal point.

Security:

The unit's local keypad may not be "Unlocked" or "Locked" over the phone. This will not affect any Phone-in parameters; however, if the local keypad is "Locked" you must know the System Password to gain access and change programming over the telephone. Press the pound sign (#) after the password.

Note: The ID message must be recorded after installation. There is no default ID message. However, it can be recorded over the phone. Just remember that message time limits apply. (See "Messages" section of Chapter 5.)

Input Calibration cannot be programmed over the phone.

Phone Contact List

NAME	PHONE NUMBER	SCHEDULE* ALL/DAY	NIGHT	WEEKEND
1.		☐	☐	☐
2.		☐	☐	☐
3.		☐	☐	☐
4.		☐	☐	☐
5.		☐	☐	☐
6.		☐	☐	☐
7.		☐	☐	☐
8.		☐	☐	☐
9.		☐	☐	☐
10.		☐	☐	☐
11.		☐	☐	☐
12.		☐	☐	☐
13.		☐	☐	☐
14.		☐	☐	☐
15.		☐	☐	☐
16.		☐	☐	☐
17.		☐	☐	☐
18.		☐	☐	☐
19.		☐	☐	☐
20.		☐	☐	☐
21.		☐	☐	☐
22.		☐	☐	☐
23.		☐	☐	☐
24.		☐	☐	☐

*Schedule Options:

Schedule 1: ALL.   Schedule 2: 1-24=DAY, 25-48=NIGHT.

Schedule 3: 1-16=DAY. 17-32=NIGHT. 33-48=WEEKENDS

for further information see “Phone Parameters” in Chapter 5.

Phone Contact List

NAME	PHONE NUMBER	SCHEDULE* ALL/DAY	NIGHT	WEEKEND
25.		☐	☐	☐
26.		☐	☐	☐
27.		☐	☐	☐
28.		☐	☐	☐
29.		☐	☐	☐
30.		☐	☐	☐
31.		☐	☐	☐
32.		☐	☐	☐
33.		☐	☐	☐
34.		☐	☐	☐
35.		☐	☐	☐
36.		☐	☐	☐
37.		☐	☐	☐
38.		☐	☐	☐
39.		☐	☐	☐
40.		☐	☐	☐
41.		☐	☐	☐
42.		☐	☐	☐
43.		☐	☐	☐
44.		☐	☐	☐
45.		☐	☐	☐
46.		☐	☐	☐
47.		☐	☐	☐
48.		☐	☐	☐

*Schedule Options:

Schedule 1: ALL. Schedule 2: 1-24=DAY, 25-48=NIGHT.

Schedule 3: 1-16=DAY. 17-32=NIGHT. 33-48=WEEKENDS

for further information see “Phone Parameters” in Chapter 5.

PROGRAMMING SUMMARY

I. PHONE

A. Calling Schedule
  1. all
  2. days and nights
    a. enter day hours; enter day minutes
    b. enter night hours; enter night minutes
  3. day, night, and weekends
    a. enter day hours; enter day minutes
    b. enter night hours; enter night minutes

B. Phone Contacts
  1. enter position number / “phone number selection”(1–48)
    a. voice
    b. beeper
  2. enter phone number

C. To Remove a Phone Contact Number
  1. phone
  2. phone contacts
  3. specific assigned contact number
  4. enter

II. DIAL OUT

A. Dialing method
   1. pulse
   2. tone
   3. automatic
B. Retries on Busy
   1. enter number of retries on busy
C. Message Repeats
   1. enter number of times alarm message will repeat for each call
D. Maximum Number of Calls
   1. enter total number of outgoing calls during an alarm
E. Call Delay Time
   1. enter hours
   2. enter minutes
   3. enter seconds
F. Intercall Delay Time
   1. enter hours
   2. enter minutes
   3. enter seconds

III. DIAL IN

A. Rings Until Answer
   1. enter number of rings until Express II answers
      (see section on TAD in Chapter Five)

B. Telephone Answering Device (TAD)
   1. enable
   2. disable

IV. MESSAGES

A. Record ID Message
   1. speak message
B. Record Input Message
   1. enter input number
   2. speak message
C. Record Output Message
   1. enter output number
   2. speak message
D. Message Length
   1. enter 5
   2. enter 7
   3. enter 11

V. INPUTS

A. Enter Input Number (1–40)
   1. enable/disable
   2. input type
      a. normally closed
      b. normally open
      c. pulse count
      d. 4–20 milliamp
         1. enter table low limit
         2. enter table high limit
      e. 0–5 volt
         1. enter table low limit
         2. enter table high limit
      f. thermistor (temperature)
         1. 2.8K °F thermistor
         2. 2.8K °C thermistor
         3. 10K °F thermistor
         4. 10K °C thermistor
      g. time accumulator
   3. recognition time
      a. enter hours
      b. enter minutes
      c. enter seconds
   4. high/low limits
      a. enter low limit
      b. enter high limit
   5. alarm reset time
      a. enter hours
      b. enter minutes
      c. enter seconds
   6. dial out selection
      a. establish specific number for each input
      b. enter position numbers (1–48)
         1. press enter twice

VI. SOUND

A. Listen-in Time
   1. enter seconds (0–255)
B. Sound Monitoring
   1. disable
   2. enable
C. Sound Sensitivity
   1. enter value (0–100)
D. Recognition Time
   1. enter hours
   2. enter minutes
   3. enter seconds
E. Alarm Reset Time
   1. enter hours
   2. enter minutes
   3. enter seconds
F. Dial Out Selection
   1. enter position numbers (1–48)
G. Mute Local Speaker
   1. disable
   2. enable

VII. AC POWER

A. AC Power
   1. failure monitor
      a. disable
      b. enable
   2. power recognition time
      a. enter hours
      b. enter minutes
      c. enter seconds
   3. alarm reset time
      a. enter hours
      b. enter minutes
      c. enter seconds
   4. dial out selection
      a. enter position numbers (1–48)

B. Battery
   1. battery monitor
      a. disable
      b. enable
   2. alarm reset time
      a. enter hours
      b. enter minutes
      c. enter seconds
   3. dial out selection
      a. enter position numbers (1–48)

VIII. OUTPUTS

A. Enter Output Number
   1. on-board output (output 0)
      a. manual
      b. automatic
   2. optional outputs—manual
      a. off
      b. on

IX. DATA LOG

A. Input Log
   1. enable/disable
   2. time between logs
      a. enter hours
      b. enter minutes
      c. enter seconds
   3. number of inputs
   4. line length

B. Activity Logs
   1. enable
   2. disable

X. SYSTEM

- A. Password
  - 1. enter password (up to 6 digits)
- B. Date and Time
  - 1. enter month
  - 2. enter day
  - 3. enter year
  - 4. enter hours
  - 5. enter minutes
  - 6. enter seconds
- C. Acknowledgment Code
  - 1. enter code (3 digits; default=555)
- D. Halt Mode Delay Time
  - 1. enter hours
  - 2. enter minutes
  - 3. enter seconds
- E. Callback Acknowledgment
  - 1. disable
  - 2. enable
- F. Call Cancel
  - 1. disable
  - 2. enable
- G. Auto Test (only if call cancel is disabled)
  - 1. enter input number
- H. Unit Reset
  - 1. enter code 159
    - a. full reset
    - b. programming reset
    - c. voice reset
      - 1–5. expansion cards
      - 6. ID message
- I. Unit Calibration
  - 1. RS232 rate (default 9600 baud)
    - a. baud rates 300–38,400
  - 2. callback rings (default 10)
  - 3. ack over voice
    - a. disabled
    - b. enabled

XI. SECURITY

A. Lock
   1. program
   2. lock/unlock key
   3. enter system password

B. Unlock
   1. program
   2. lock/unlock key
   3. enter system password

APPENDIX A: TROUBLESHOOTING

In the event that a problem is encountered, this section will assist you in determining the cause, so that you can return the unit to its monitoring routine with minimal interruption.

Most problems with the Express II are easy to identify and can be quickly corrected, and are found under the following general headings:

- Communications/Dial-Out
- Temperature Monitoring
- Sound Level Monitoring
- Other Monitoring Functions

If you have tried the solutions outlined in this section and are not satisfied with the results, call Phonetics Technical Support at (610)558-2700, or follow the guidelines for shipping the Express II to Phonetics, Inc. for service *(see Appendix E)*.

Problem	Cause	Solution
I. COMMUNICATIONS/ DIALOUT		
1. The Express II won't dial out for an alarm.		An unacknowledged alarm exists when the LED for the input is **blinking red.** The unit will not dial out unless there is a **red blinking LED**. A **blinking green LED** indicates that the input has an alarm but has not met the recognition time yet. An unacknowledged alarm does not exist until the recognition time has been met. A **steady red LED** indicates that the alarm is acknowledged and no dialout will occur. Check the following items: Make sure the input is enabled; check the recognition time for the input; make sure a phone number is programmed; make sure the input has contact numbers selected for the dialout; make sure the phone number to be called is within the calling schedule time period.
		Set the call delay time shorter.
		Check the telephone number programming. Does your telephone system require a "9" to connect with an outside line?

Problem	Cause	Solution
		If you are on an older phone system, try setting the dialing method to "pulse." If this doesn't work, try setting it to "tone." (See also "Dial Out" in Chapter Five.) Increase maximum number of calls to a number greater than or equal to one. (See "Dial Out" in Chapter Five.) The Express II must be connected to a standard (2-wire analog) telephone line, and **NOT a digital extension** to a phone system. If the unit will not dial out and the factors previously listed have been ruled out, try connecting the unit to a standard residential telephone line and see if it will operate on that line.
2. The Express II will not answer the telephone when called for a status report.		Recheck the programming of "rings until answer" feature. (See "Dial In" in Chapter Five.)
3. The Express II will not answer the telephone when called back for alarm acknowledgment.		Allow the telephone to ring ten times.
4. The Express II dials out correctly but fails to audibly recite its alarm message when you answer the call.		Reprogram voice repetitions to 1 or greater.
5. The Express II and telephone answering device (sharing the same line) answer incoming calls simultaneously.	The Express II's number of "rings until answer" is set to the same number of rings as the telephone answering device.	Increase the "rings until answer" in the Express II.

II. TEMPERATURE MONITORING		
1. The temperature reading is low: -85°F or -65°C.	Open circuit on the input.	Check wires for a loose connection or broken wire.
2. The temperature reading is high: 200°F or 93°C.	The circuit is shorted.	Check the wiring to see if the wires touch.
3. The temperature reading is inaccurate.	The sensor may be incompatible with the unit. See 2.8K and 10K thermistor look-up tables in Chapter Three.	Replace the sensor with a compatible model.
	The sensor may simply need calibration.	Calibrate the input. See “Inputs” in Chapter Five for information on calibrating the input properly.
III. SOUND MONITORING		
1. False high sound alarms occur frequently.	The programmed sound sensitivity and recognition time results in over-sensitivity to non-alarm sounds as well as alarm sound.	Reprogram the sound sensitivity to a less sensitive value and increase the recognition time. See “Sound” in Chapter Five.
2. High sound does not cause an alarm.	The microphone is not close enough to the sound source, or the programmed sound setting results in a lack of sensitivity to the high sound.	Move the microphone closer to the sound source and/or reprogram the sensitivity and recognition time. See “Sound” in Chapter Five.
IV. OTHER		
1. Alarm status of input is incorrect.	Incorrect input normality.	Reprogram the input type to the correct normality. See “Inputs” in Chapter Five.
2. The unit won't perform an autotest.	The call-cancel feature is enabled. An auto test won't execute if this feature is enabled.	Disable the Call Cancel feature. (See Chapter Five)
3. The unit calls again with the same alarm after I acknowledge it.	Alarm reset time is set at too short an interval.	Increase the “Alarm reset” value. See “Alarm Reset Time” sections in Chapter Five and “Alarm is Acknowledged” in Chapter Six.
	Alarm condition is sporadic, going on and off.	Lengthen recognition time. See various “Recognition Time” sections in Chapter Five.

APPENDIX B: CHECKING YOUR EXPRESS II FOR PROPER OPERATION

We recommend that you test your Sensaphone Express II weekly to be sure it is functioning properly. This will ensure that when a problem arises the Express II will be ready to alert the appropriate personnel.

There are several tests that can be performed:

1) Call the unit and listen to a Status Report. This will test the unit's ability to answer the phone and speak a message. It will also verify that all of the inputs are reading properly, the alarm conditions are OK, the power is on and the microphone is functioning.

2) Create an alarm on each input and allow the unit to contact all programmed telephone numbers. This will ensure that the Sensaphone is programmed properly. It will also prepare personnel to respond appropriately when they receive a call from the Sensaphone.

3) Test the battery by unplugging the AC adapter and making sure that the Sensaphone continues to function. Press INQUIRE, then STATUS on the keypad, and listen to the status report. Make sure the report states that "the power is off" and "the battery level is 13.5 volts" (or higher). Keep the AC adapter unplugged so that a Power Failure alarm occurs. Allow the unit to dial all programmed telephone numbers while running on battery backup. Plug in the AC adapter after the unit has finished dialing all of the telephone numbers.

4) If you are using your Sensaphone to listen for a smoke alarm, then be sure to test the smoke alarm to make sure that the Sensaphone picks up the audible signal and triggers a high-sound-level alarm. Allow the unit to dial all programmed telephone numbers.

APPENDIX C: ACCESSORIES

The sensors listed below are available from Sensaphone, Inc. and represent the most commonly used input devices. Other dry contact sensors, designed for more specialized applications, may also be used. Commercial or industrial electrical supply houses can provide devices to monitor virtually any condition.

For further information, contact Phonetics Customer Service at 610-558-2700.

MODEL NUMBER	SENSOR / SWITCH
FGD-0006	Magnetic Reed Switch
FGD-0007	Passive Infra-Red Detector
FGD-0010	50' two-conductor #22AWG shielded accessory Cable
FGD-0013	Spot Water Detector
FGD-0022	Temp° Alert
FGD-0023	ISOTEL Surge Protector
FGD-0027	Humidistat
FGD-0049	Smoke Detector with Built-in Relay
FGD-0052	Humidity Transmitter
FGD-0054	Power-Out Alert™
FGD-0056	Zone Water Detector w/Water Rope
FGD-0063	10' additional Water Rope for FGD-0056
FGD-0100	Remote Temperature Sensor
FGD-0101	2.8K Weatherproof Temperature Probe
FGD-0102	10K Weatherproof Temperature Probe
FGD-0103	10K Indoor Decorator Zone Temperature Sensor
FGD-0104	10K Outdoor Air Weatherproof Temperature Sensor
FGD-0105	10K Immersion Temperature Sensor

APPENDIX D: ENGINEERING SPECIFICATIONS

I. General

The Automatic dialer shall be a self-contained microprocessor controlled system capable of monitoring and controlling up to 40 alarm channels. The system shall be modular in construction, allowing up to 4 input/output Expansion Cards to be installed and configured for operation by the user by means of the built-in keypad and remotely by touch-tone phone. Characteristics of Input and Output channels include Universal Input and Digital Relay Output.

Upon detection of any alarm or status change, the system shall commence dialing telephone numbers from a list associated with the particular alarm condition(s) or combination thereof, and deliver a voice message identifying and describing the alarm condition(s). The alarm message shall be delivered in digitized human voice using messages recorded by the user. The system will continue to call telephone numbers in succession until a positive acknowledgment of the alarm message is received. Acknowledgment is accomplished by depressing tone keys from the called telephone, or by calling the system back within a programmed time period. The alarm may also be acknowledged using the local keypad. In addition, the system shall be able to receive incoming telephone calls. Upon answering, the system shall recite a status report and allow access to remote operation and programming.

The system shall be FCC registered for direct connection to the telephone network. The system shall have a one year warranty from the manufacturer. The system shall be a Sensaphone® Express II by Phonetics, Inc.

II. I/O Channel Attributes and Features

A. Inputs

The system shall come standard with 8 universal input channels. Up to 32 additional universal input channels may be installed by the user. All input channels shall be user-configurable as:

1. NO or NC digital dry contact, using 0.8mA loop current
2. 4–20mA analog, using custom look up table
3. 0–5V analog, using custom look up table
4. Pulse count
5. Temperature from thermistor, using 2.8K or 10K devices
6. Time accumulator

The system shall have the following built-in monitoring features:

1. AC power failure detection
2. Sound level monitoring
3. Low battery detection

All monitored channels, including built-in monitoring features, shall allow keyboard and remote touch-tone programming of pertinent operational data including, but not limited to:

1. Input type (NO/NC, 4–20mA and 0–5V analog, pulse count, thermistor, time accumulator)
2. High and Low limits (-9999 to +9999)
3. Input recognition time (0 seconds to 12 hours)
4. Alarm reset time (0 seconds to 12 hours)
5. Phone Contacts list for each channel
6. Enable/disable for each channel to dialout for alarm

B. Outputs

The system shall have one built-in SPST latching 2A 250VAC relay output. The output may be programmed to switch automatically on alarm or manually via keyboard or Touch-Tone™ phone. Up to 16 additional relay output channels may be installed by the user.

III. Communications Features

A. Telephone Specifications

The system shall connect to a standard 2-wire telephone line using pulse or tone dialing methods, with loop start only. The system shall recognize ringer frequencies from 16 to 60 Hz. No leased or dedicated lines shall be required. The system shall also be capable of being used on the same telephone line as other answering devices. Call progress detection shall ensure that the alarm dialout is not hindered by no-answers or busy signals.

B. Telephone Numbers

The system shall be capable of dialing up to 48 telephone numbers, 40 digits each. There shall be a capacity to program, retain and use three separate lists based on a calling schedule of weekday, weeknight and weekend. Each list shall contain up to 16 phone numbers. In addition, individual phone contact lists may be programmed for each input channel.

The system shall allow local keypad and remote touch-tone programming of the following telephone dialing information:

1. Dialing method (Automatic, pulse, tone)
2. Retries on busy (0 to 15)
3. Message repetitions (0 to 10)
4. Maximum number of calls (0 to 65,535)
5. Call delay time (0 seconds to 12 hours)
6. Intercall delay time (0 seconds to 12 hours)

C. Voice Messages

The System shall have the ability to record, store and reproduce voice messages and to use those messages to articulate the location and status of the monitored channels. In absence of user-recorded voice messages, the system shall articulate channel status using the internally resident vocabulary. All digitized speech message data shall be stored in nonvolatile memory with a 3V lithium battery backup. Such battery backup shall be capable of protecting speech memory for at least 2 years of complete power outage.

There shall be one recorded identification message for the system, and one recorded alarm message for each input channel. A message may also be recorded for each output channel on the optional output expansion card. Message length shall be selectable from 5 to 11 seconds per input or output channel.

IV. Programming

A. Local Programming

The System shall contain an integral, sealed, alphanumeric keypad for the purpose of locally programming all system data. Programming is assisted by synthesized voice guidance. All operational data, system setup and configuration data, and all information regarding the monitored I/O channels shall be displayed on the LCD display panel. No display manipulation shall be required to view and assess the status of I/O points.

B. Remote Programming

The system shall be remotely programmable using a standard touch-tone telephone. All operational data, system setup and configuration data, and information regarding I/O channels shall be accessible and programmable. A user-programmable security password shall protect the system from unauthorized tampering. Remote programming shall be aided by menu-style voice guidance.

V. System Features

A. Power

The system shall be provided with a UL/CSA listed 15VAC grounded power transformer that the user may plug into a 110V AC outlet, +20%, 60HZ. The unit shall provide battery backed 12 volts DC (up to 100mA) and 24 volts DC (up to 350mA) to power 4–20mA current loops or other external devices.

B. Battery Backup

The system shall have a built-in 12V 3 AH sealed lead-acid rechargeable battery. This battery shall support approximately 6–12 hours of continued system operation in the absence of AC power. (Actual battery backup performance is dependent upon the age of the battery, the ambient temperature, the charge condition, and the number of external devices being powered by the system.)

C. Local Visual Indication

Each input shall have a corresponding LED that will indicate the alarm and acknowledgment status of each input. The system shall also have an LCD display that will list information about the current system status and input/output status.

D. Data Log

The system shall be capable of logging the input values on a user-defined time period via a serial printer *(optional cable required).* The system shall also log all system and alarm activity including, but not limited to: programming changes, alarms occurring and clearing, acknowledgments, call-ins, and alarm dialouts. The system shall be able to print the log information to a printer hooked up to its built-in RS232 serial port.

E. Halt Mode

The system shall be capable of entering a halt mode upon user command in which all inputs shall be disabled and dialout prevented. Halt mode shall end automatically after a preprogrammed time period.

F. Diagnostics and Testing

System diagnostics shall be performed each time the unit is started. The system shall be capable of performing a simulated alarm dialout for testing. The dialout can be requested locally or remotely.

G. Security

The system shall allow the user to lock the keypad to prevent unauthorized local or remote access unless a security password is entered.

VI. Remote Operation Features

A. Status Report with digitized user-recorded voice messages.

B. Acknowledgment

An alarm on any monitored channel may be acknowledged remotely by pressing tones on a touch-tone telephone keypad or by calling the system back within a specified time period. An alarm may also be acknowledged locally using the built-in keypad.

VII. Enclosure and Environmental

A. Enclosure

The system shall be housed in a NEMA-4 fiberglass enclosure with a latched window cover and shall be internally constructed such that modular plug-in expansion cards may be used to facilitate field upgrades, repair, and maintenance.

B. Electrical Protection

Power and telephone connections shall have internal spike and surge protection using metal oxide varistors. All input channels shall have fault protected input circuits.

C. Additional Electrical Surge Protection

Additional Power and Telephone line surge protection shall be available from the manufacturer. When so installed, the system shall be fully warranted against any damage caused by transient surges entering the system through Power or Telephone lines.

D. Environmental

The system shall function over an operating range of 32°F–120°F at up to 0–90% RH, non-condensing. The system may be stored over the temperature range of 0°–130°F.

E. Maintenance

The system manufacturer shall have in-house service facilities and technical assistance available during normal business hours, Monday–Friday 8AM–5PM(EST).

F. Safety Approvals

The system shall be approved by a Nationally Recognized Testing Laboratory (NRTL) to UL Standard 1950 “Information Technology Equipment” and CSA Standard 22.2 #950.

Specifications subject to change without notice.

Phonetics, Inc.
901 Tryens Road
Aston, PA 19014
Phone: 610-558-2700
FAX: 610-558-0222
www.sensaphone.com

APPENDIX E: RETURNING THE EXPRESS II FOR SERVICE

In the event that the Express II does not function properly, we suggest that you do the following:

1) Record your observations regarding the Express II's malfunction.

2) Call the Technical Service Department at 610-558-2700 prior to sending the unit to Phonetics, Inc. for repair.

If the unit must be sent to Phonetics, Inc. for Servicing, please do the following:

1) Turn the power switch Off, disconnect all wiring and unplug the unit.

2) Carefully pack the unit to avoid damage in transit. Use the original container (if available) or a sturdy shipping box.

3) You must include the following information to avoid shipping delays:

   a) Your name, address and telephone number.
   b) A note explaining the problem.

4) Ship your package to the address below:

SERVICE DEPARTMENT
Phonetics, Inc.
901 Tryens Road
Aston, PA 19014

5)Ship prepaid and insured via UPS or US Mail to ensure a traceable shipment with recourse for damage or replacement.

Test Log

Date	Inputs	Dialout	Call-In	Battery		Tested By
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	

Date	Inputs		Dialout		Call-In		Battery				Tested By
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	